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INVITED DEBATE

Hysteroscopy is Superior to 3D Ultrasound in Gynecological Diagnosis

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Editor-In-Chief's Note

Ever since 3D ultrasound became available for us as a diagnostic modality, the opinions are divided regarding it being superior to hysteroscopy as diagnostic modality. Hysteroscopy was considered ideal to accurately diagnose intracavitary structural abnormalities, and later when 3D ultrasound was introduced, it was considered an option to reduce the number of hysteroscopies in such cases. Clinicians may find it difficult to choose the right modality in different clinical situations in their practice. Both these tools give valuable information on clinical conditions like abnormal uterine bleeding, infertility recurrent pregnancy loss, neoplastic conditions, etc. what are the indications for hysteroscopy? Can noninvasive 3D USG replace the time tested modality, hysteroscopy? To find answers to these queries, authors experienced in their own fields are debating in this article regarding which is the superior method and present their own views supported by reviews and reports in the literature. I hope readers find this debate interesting and it helps them clear doubts and queries on this debatable issue. **Professor Suvarna Khadilkar, Editor in chief.**

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For the motion
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Introduction

Hysteroscopy, the word derives from Greek words '*Skopeo*' – *to view* and '*Hystera*' – *Uterus*. It is the process of viewing and operating in the endometrial cavity from a transcervical approach. If we look into the milestones in the evaluation of hysteroscopy, first documented usage of hysteroscopy was done by Pantaleoni in 1869. In 1925, Rubin used CO_2 to distend the uterus, cold light source was first used in 1952. Transparent balloon was used to distend the cavity in 1963, and liquid distension media was first used in 1980.

The distention media used during hysteroscopy opens the potential space of uterine cavity. The distention media leaves the uterine cavity either by cervical leakage, tubal leakage or intravasation. When using fluid distention medium, intrauterine distention can be achieved by gravity fall system or pressure cuff system or more effectively by*endomat or hysteromat*. Proper vision of the uterine cavity during hysteroscopy depends mainly on the distention of the uterine cavity. Uterine distention requires around 75 mm of pressure. If there is inadequate cavity distention, we must suspect leakage through cervix, equipment leakage, excessive outflow, bent tubing, significant intravasation or uterine rupture (Fig. 1).

Hysteroscope basically has three main parts. Objective lens, eyepiece and barrel. Vision inside the cavity depends on the angle of the objective lens. 0^0 giving panoramic view and 30^0 or 70^0 gives better view of ostia and lateral walls in an abnormally shaped cavity (Fig. 2). Hysteroscopes vary from 3 to 7 mm diameter. Smaller ones are usually single flow. But now, 5 mm scopes are available with continuous flow channels and operating channels. These can be used with minimal anesthesia. For bigger lesions and myomas, we may have to use resectoscope (Fig. 3). Resectoscopes are usually 7 to 8 mm diameter and usually need cervical dilation. Cervical dilation is usually not needed if we are using smaller scopes.

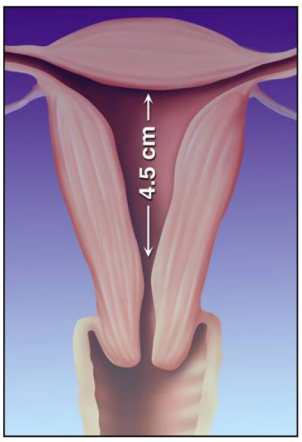


Fig. 1 Uterine cavity

Fig. 2 Continous flow rigid hysteroscope

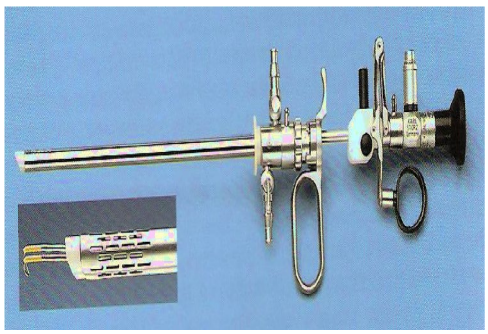


Fig. 3 Resectoscope

Many hysteroscopic procedures have replaced old, invasive techniques, such as dilatation and curettage. As instruments have reduced in size, office hysteroscopy has begun to replace operating room procedures. Even hysteroscopy can be done without speculum with thinner office hysteroscopes.

The different lesions that can be diagnosed with hysteroscopy include intrauterine adhesions, submucous fibroids and endometrial polyps, which can be treated in the same setting. It is also highly useful in the diagnosis of some types of congenital anomalies of the uterus. This helps in counseling and planning the treatment for the same and the postoperative period can be planned accordingly. Another important role of hysteroscopy is in the accurate localization of misplaced IUCDs and in the retrieval of the same under visual guidance. When hysteroscopy is combined with directed endometrial sampling, it serves as an accurate method for the early detection of endometrial hyperplasia, benign lesions and other conditions causing abnormal uterine bleeding.

Hysteroscopic surgery is considered as a minimally invasive surgery. This being associated with highly precise surgery with minimal trauma to the uterine lining thus rules out the need for major surgical procedures in many settings. One of the major advantage of these procedures include shorter hospital stay and faster recovery time.

Indications for Diagnostic Hysteroscopy

- Evaluation of AUB
- As part of basic infertility work up
- Investigations for causes of recurrent pregnancy loss
- Localization of a misplaced intrauterine contraceptive device or foreign body
- Diagnosis of cervical and uterine neoplasia

Evaluation of AUB

Different uterine factors causing AUB like submucous myoma, endometrial polyp and cancer can be correctly diagnosed using hysteroscopy with directed biopsy. About 40–85% of patients having abnormal uterine bleeding will usually have some uterine abnormality. Panoramic hysteroscopy is superior to 3D USG and curettage in making an accurate diagnosis of intrauterine pathology. As per the study being put forward by Ali Babacan (1), hysteroscopy seems to perform better for most uterine conditions particularly for diagnosing polyps, especially with size less than 1 cm with a better sensitivity ($p < 0.001$) with no much difference in specificity ($p = 1.0$). Mukhopadhaya et al. found a high sensitivity (71.4%) and specificity (100%) for hysteroscopy for diagnosing polyps with strong agreement with biopsy findings ($k = 0.81$) (2). They concluded that in women with AUB, small myomas and polyp may be missed when using USG alone and hence we can definitely say that hysteroscopy is superior to USG in diagnosing small intrauterine lesions (Figs. 4 and 5).

As Part of Basic Infertility Work Up

The uterine cavity assessment is one of the basic steps of infertility work up. Different methods are there for uterine cavity assessment. These methods include USG, HSG and

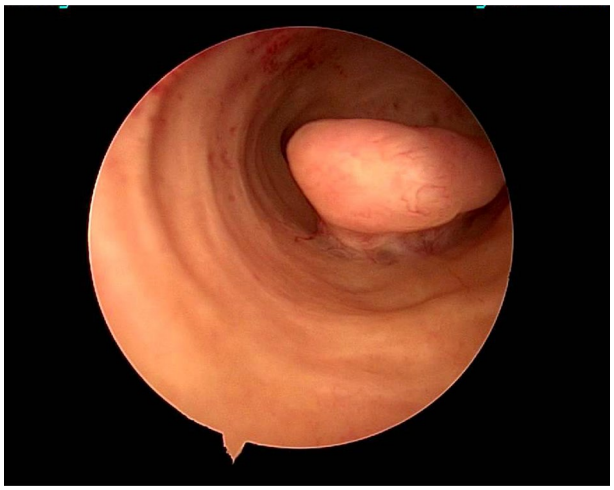


Fig. 4 Hysteroscopic appearance of a small polyp arising from the posterior wall of uterus which is likely to be missed in USG

Fig. 5 Submucous fibroid from anterior wall of uterus as seen by hysteroscopy

hysteroscopy. Hysteroscopy provides much more specific information and clarifies uncertain aspects of indirect techniques. In patients with abnormal USG, hysteroscopy not only helps in confirming the diagnosis, but also helps in localization and determining the nature of lesion. As per the study put forward by MotyPansky, the incidence of uterine pathologies (congenital and acquired) in women with primary or secondary infertilityis approximately 30% and diagnostic hysteroscopy should be included as a primary investigation of infertile women (3).

Another important finding with respect to infertility which is likely to be missed on USG and can be easily picked up with hysteroscopy is intra uterine adhesions (Fig. 6). Makris et al. demonstrated sensitivity and specificity of 91.9% and 98.8% in using 3D USG to detect any intrauterine abnormalities including intrauterine adhesions (IUA), myoma, polyps and Mullerian anomalies. However, hysteroscopy is still 33% more sensitive in diagnosing IUA. Hysteroscopy can be used to evaluate the extent and location of IUA as well as provide a means of treatment (12).

Hysteroscopy is an accurate and useful diagnostic method in diagnosing uterine cavity abnormalities in an infertile woman. USG is also a simple, noninvasive screening procedure in studying the uterine cavity pathology. Whenever there is doubtful finding is there in USG, the next modality for confirming the diagnosis is hysteroscopy. The advantage of hysteroscopy over USG in such setting is that it is both diagnostic and therapeutic at the same setting.

Investigation of Causes of Recurrent Pregnancy Loss (RPL)

One of the causes for RPL is uterine anomalies. Around 20–25% of women with Mullerian anomalies like unicornuate, bicornuate, didelphys and/or septate uterus have difficulty with reproductive functioning which includes RPL (4). Second trimester recurrent pregnancy losses are mainly attributable to uterine fusion defects. The incidence of spontaneous abortion in women with Mullerian anomalies include: 48% in unicornuate uterus, 43% in uterine didelphys, 35% in bicornuate uterus and 67% in those with septate uterus (5). Ready diagnosis will be provided by hysteroscopy, based on which further treatment can be planned or initiated. For the diagnosis of septate and bicornuate uterus, hysteroscopy needs to be combined with laparoscopy for assessing the external anatomy of the uterus. In those patients with RPL and septate uterus, hysteroscopic resection remains a good treatment option. As on comparing with 3D USG with hysteroscopy in these setting, 3D USG can be used for only diagnosis in RPL (Fig. 7).

Misplaced Intrauterine Contraceptive Device

Usually in case of misplaced IUCD, the radiologic investigations that are usually used include abdominal or pelvic X-ray or an ultrasound for localization of misplaced IUCD. However, there can occur misdiagnosis when using these

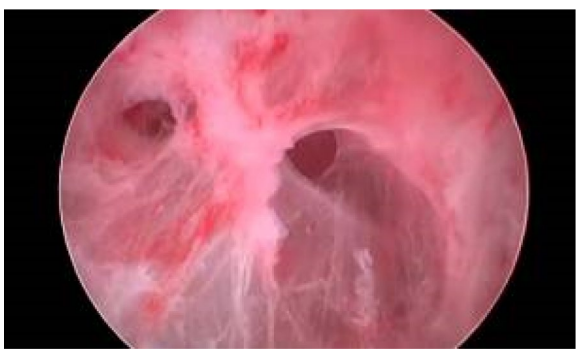


Fig. 6 Intrauterine adhesion

Fig. 7 Septate uterus

diagnostic modalities. In these cases, hysteroscope can be used for the diagnosis and confirmation of the presence and localization of the misplaced IUCD in uterine cavity. If the IUCD has been located, the removal of the same can be done in the same setting by using grasping forceps and pulling out the thread as well as the IUCD. Thus, hysteroscopy can considered as an ideal tool for removing the misplaced IUCD in the uterine cavity (6) and thus can be considered superior over 3D USG (Fig. 8).

Diagnosis of Endometrial Neoplasia

The most common malignancy affecting the endometrium is the uterine adenocarcinoma. And its most common presenting symptom is abnormal uterine bleeding. Mostly the incidence of cases has been reported more in post menopausal women. The traditional way of evaluating these cases was by fractional dilatation and curettage (FC) in such patients. Since FC being a blind procedure, there is a high chance of missing the lesion easily. With the advent of hysteroscopy, we can directly detect these lesions easily which otherwise would have been missed. These are particularly useful when we are evaluating those women with AUB who shows no signs of intrauterine pathology with USG. The combination of hysteroscopy and endometrialbiopsy is ideal for use in symptomatic patients for the early detection of endometrial neoplasia, its precursors, and benign lesions that cause AUB (7).

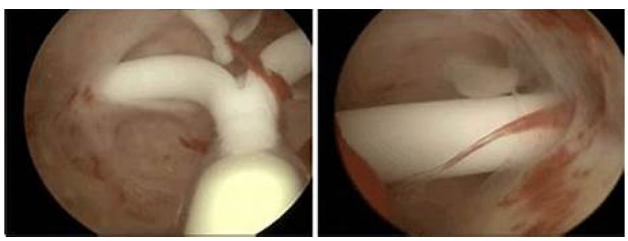


Fig. 8 Hysteroscopic picture of misplaced IUCD

Endometritis

Endometritis is estimated to be a cause for 9 to 67% of recurrent pregnancy losses and 30.3% of women with recurrent implantation failure (8) (9). This is because endometritis can cause delayed endometrial maturation, leading to asynchrony with implantation. With modern high-resolution endoscopes, it is easy to distinguish from normal endometrium (Fig. 9).

Investigation of Scars After Surgery

Uterine rupture during pregnancy chance is very less in those women who have undergone cesarean section for non obstructive obstetric causes like myomectomy, metroplasty or tubal corrective surgeries. In case of information about the integrity of the scar in the inter pregnancy interval, the investigation modalities available include USG, MRI and hysteroscopy (10). When compared with 3D USG, the degree of fibrosis and depth of any defect can be accurately assessed hysteroscopically.

Hysteroscopy and ART

Several studies have come forward regarding the role of pre IVF hysteroscopy. Most of the studies not supporting the role of routine hysteroscopy prior to first IVF in improving the implantation rate. But as per the latest studies and Cochrane evidence, in patients having recurrent implantation failure(RIF), pre-IVF hysteroscopy is beneficial to increase the odds of implantation, clinical pregnancy and live birth (11).

Fig. 9 Hysteroscopic appearance of chronic endometritis

Therapeutic Hysteroscopy

Apart from the role of hysteroscopy in diagnostic purpose, it has advantage over 3D USG in acting as a therapeutic tool. The various roles of hysteroscopy in therapeutic proceduresinclude: hysteroscopic submucous myomectomy, hysteroscopic polypectomy, lysis of intrauterine adhesions,hysteroscopic tubal cannulation, transection or resection of uterine septum and endometrial ablation. The introduction of hysteroscopic morcellation opens the option of hysteroscopic surgery for the majority of patients without the need for extensive training and experience.

Office Hysteroscopy

With the invent of smaller scopes, hysteroscopy has become a simple procedure with minimal anesthesia. Now, hysteroscopes are available with diameter 1.2 mm to 3 mm. It does not require the use of an operating room, hospital admission and general or locoregional anesthesia. The appropriate surgical techniques, allied to pain control, allow office hysteroscopy to resolve much more than 90% of the surgical needs of the intracavitary uterine pathology, thus being an important contribution for patient safety.

3D USG

When comparing hysteroscopy and 3D USG, the availability of 3D USG is limited as compared to 2D USG. Most of the clinicians are more experienced and comfortable with 2D USG. As for an inexperienced user, manipulating with 3D USG can be cumbersome and time consuming process. Because of this reason, most clinicians want to stay on safe ground and not make full use of 3D USG. It has been fully established that the volume of data obtained with 3D USG is remarkably large while archiving, sharing or transferring will be problematic, especially in busy hospitals. Another pitfall with 3D USG is the problem of artifact, which is not there with hysteroscopy.

Conclusion

Hysteroscopy has become the standard investigational and therapeutic tool in current gynecologic practice. This is one of the most reliable procedure for directly inspecting the uterine cavity and detection of many intra uterine anomalies precluding the need for major surgeries. The advantage of hysteroscopy includes lesser hospitalization with minimal or no anesthesia, diagnostic and as well as therapeutic at the same sitting and rapid return to normal activity.

References

1. Babacan A, Gun I, Kizilaslan C, et al. Comparison of transvaginal ultrasonography and hysteroscopy in the diagnosis of uterine pathologies. Int J ClinExp Med. 2014;7(3):764–769. Published 2014 Mar 15.
2. Mukhopadhayay S, Bhattacharyya SK, Ganguly RP, Patra KK, Bhattacharya N, Barman SC. Comparative evaluation of perimenopausal abnormal uterine bleeding by transvaginalsonography, hysteroscopy and endometrial biopsy. J Indian Med Assoc. 2007;105:624, 626–628.
3. Pansky M, Feingold M, Sagi R, Herman A, Schneider D, Halperin R. Diagnostic hysteroscopy as a primary tool in a basic infertility workup. *JSLS*. 2016;10(2):231–235.
4. Patton PE. Anatomic uterine defects. ClinObstetGynecol 1994;37:705–21.
5. Buttram VC Jr, Gibbons WE. Mullerian anomalies: a proposed classification (an analysis of 144 cases). FertilSteril 1979;32:40–6.
6. Preutthipan S, Linasmita V, Theppisai U. Diagnostic hysteroscopy: a result of 125 patients at Ramathibodi Hospital. J Med Assoc Thai 1997; 80:575–9.
7. Mencaglia L, Scarselli G, Tantini C. Hysteroscopic evaluation of endometrial cancer. J Reprod Med 1984;29:701–4.
8. Dana Mcqueenetal, Chronic endometritis in women with recurrent early pregnancy loss and/or fetal demise Fertility Sterility 2014; 1026–1030
9. JalehZoghardietal The value of hysteroscopy in diagnosis of chronic endometritis in patients with unexplained recurrent spontaneous abortion European Journal of Obstetrics and Gynecology and Reproductive Biology 2011; 217–220
10. Petrikovsky BM. Endoscopic assessment of the integrity of the postcesarean uterine wall before a trial of labor. Transcervical endoscopy registry. J Reprod Med 1994;39:464–6.
11. Mohan S Kamath, Jan Bosteels, Thomas Hooghe et al. Screening hysteroscopy in subfertile women and women undergoing assisted reproduction. Cochrane database;2019.
12. Makris N, Kalmantis K, Skartados N, Papadimitriou A, Mantzaris G, Antsaklis A. Three-dimensional hysterosonography versus hysteroscopy for the detection of intracavitary uterine abnormalities. Int J GynaecolObstet 2007;97:6–9.

Against the motion
Dr. Chander P. Lulla

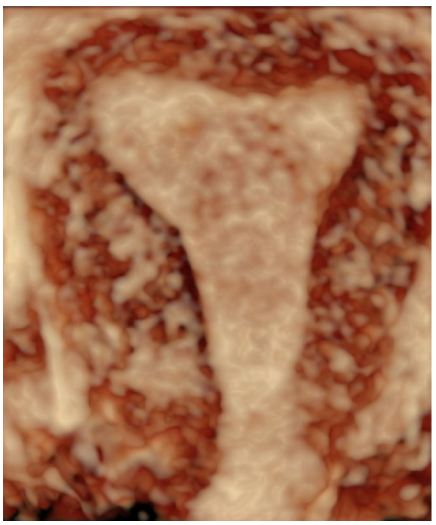


Fig. 1 Normal coronal view of uterus, you can see endometrial cavity and surrounding myometrium

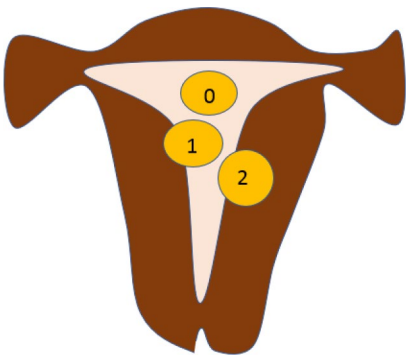


Fig. 2 Relationship of fibroid to endometrial cavity

Fig. 4 Type I submucous fibroid

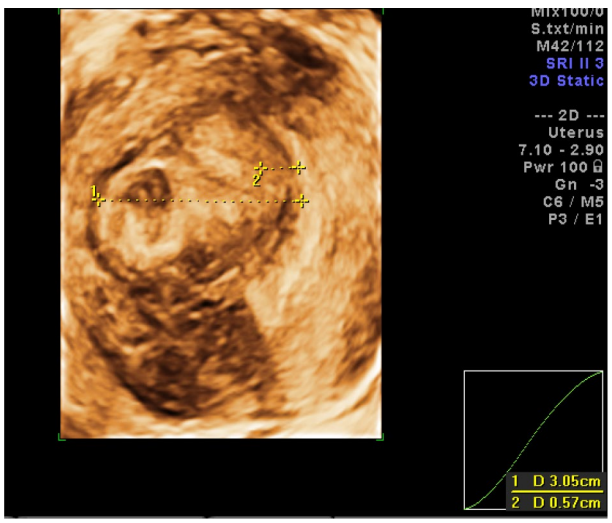
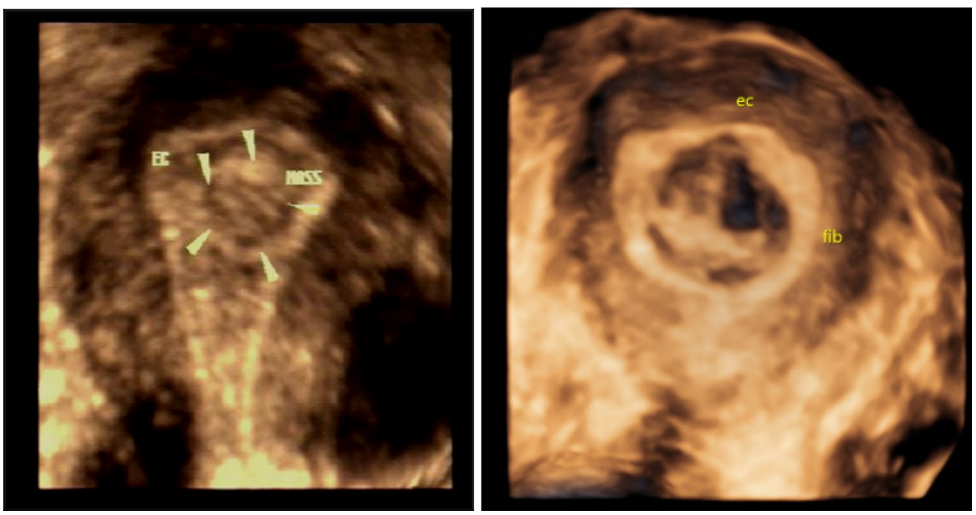


Fig. 5 Type II submucous fibroids

Fig. 3 Type 0 submucous fibroids



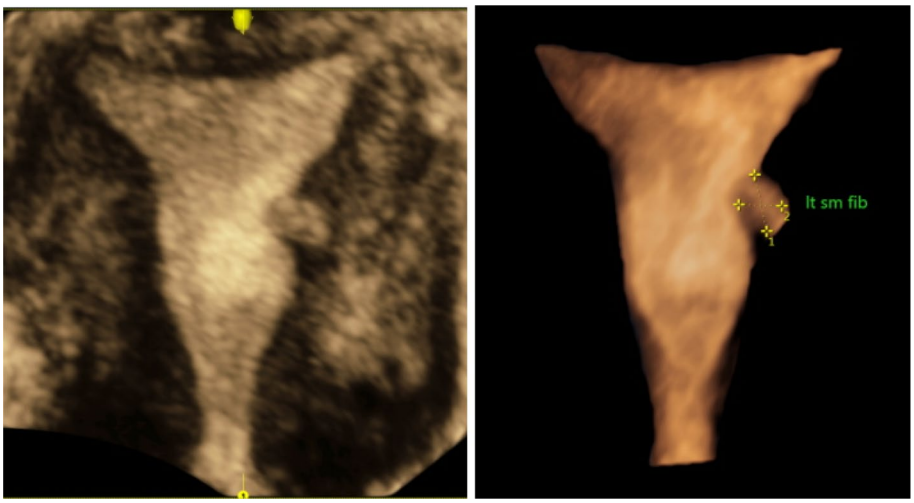


Fig. 6 Type II submucous fibroids

Introduction

Three-dimensional ultrasound (3D USG) has evolved as a highly accurate imaging technique in gynecology since the last 30 years. In some areas, it is now an indispensable tool in evaluation of the gynecological patient.

The 3D USG data are electronically stored and processed to display three orthogonal planes (multiplanar imaging). This provides great accuracy to a diagnosis as compared to fixed image orientation with hysteroscopy. These planes can be rotated or moved as desired and can be united to form a single surface rendered 3D image.

The data volume in 3D USG which is acquired in seconds can be stored and reviewed later. This shortens the examination time and makes it possible to manipulate and review the data even in the absence of the patient (like a virtual patient). This data can also be used for consulting colleagues, auditing and educational purposes.

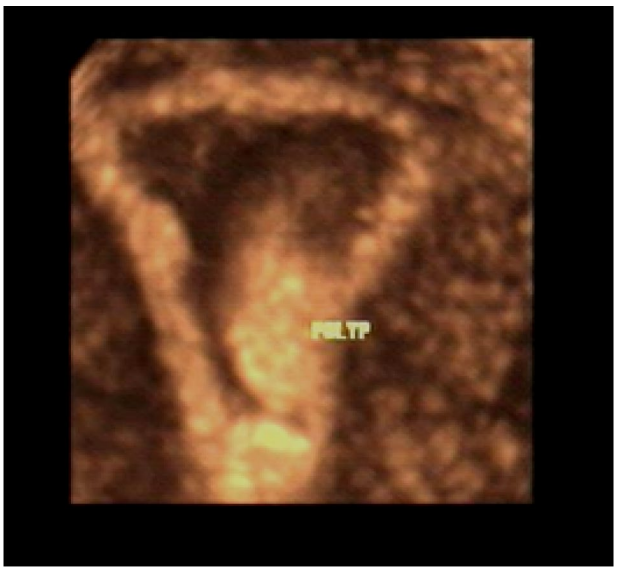


Fig. 8 3D SIS shows a large polyp in the endometrial cavity

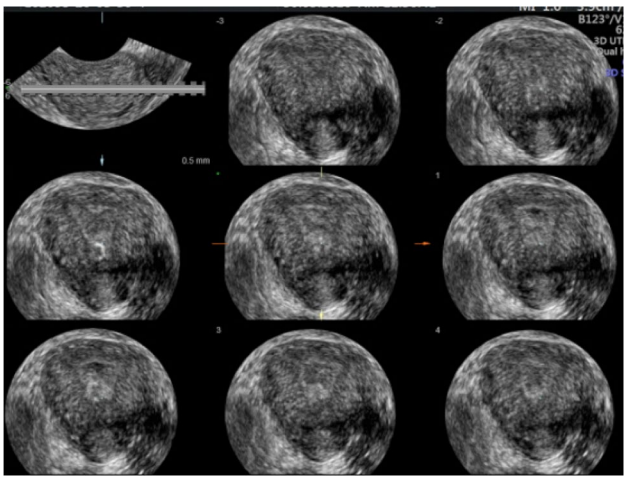


Fig. 7 small polyp seen in multislice imaging

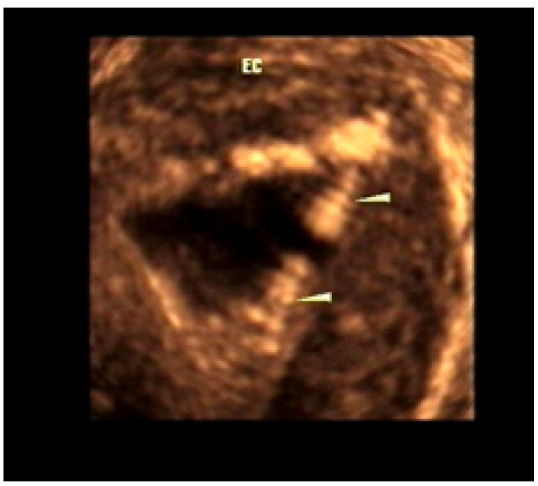


Fig. 9 3D SIS shows endometrial adhesions

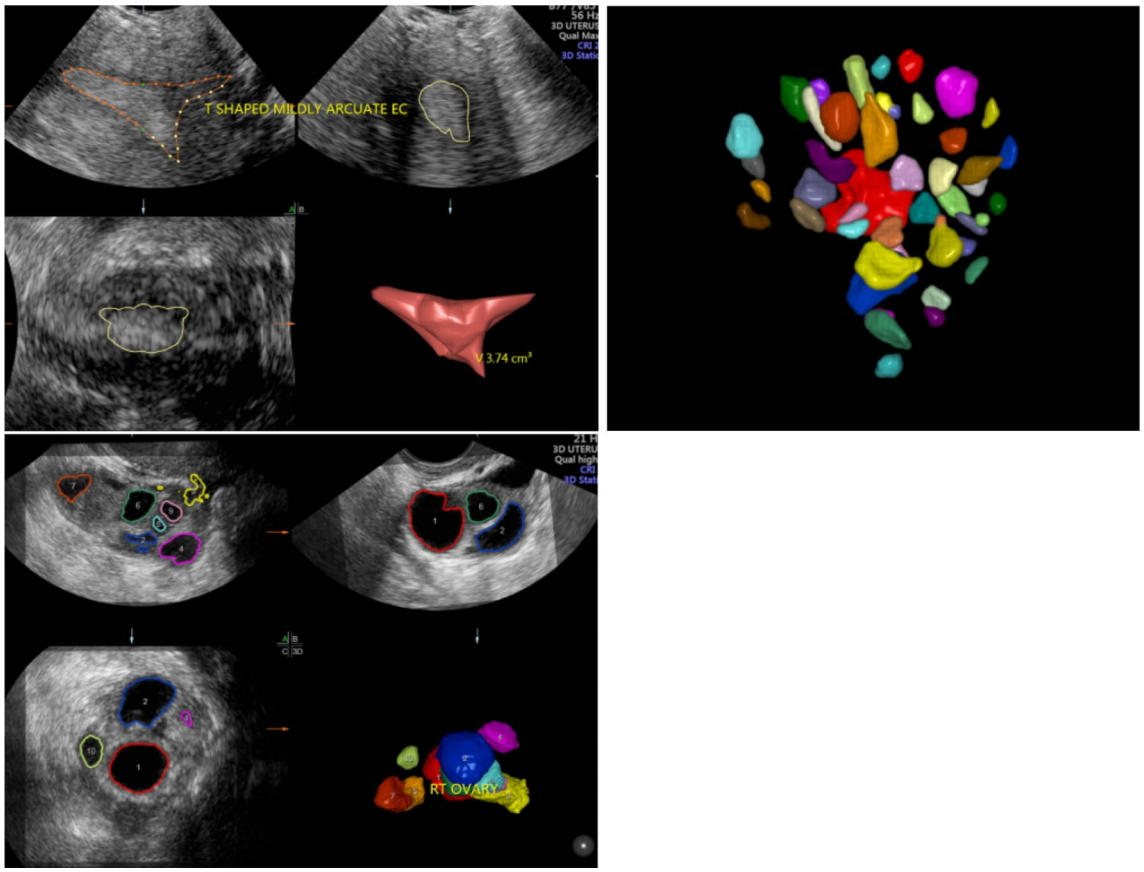


Fig. 10 Sono AVC for antral follicle count

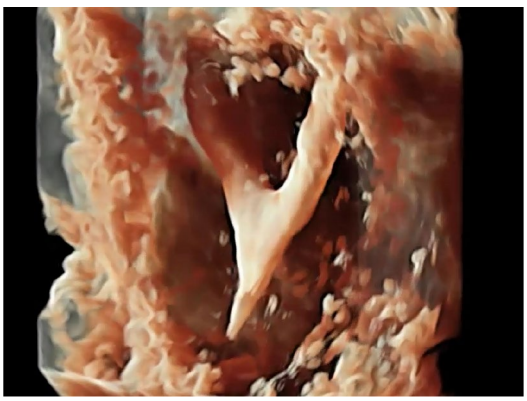


Fig. 11 Surface rendered image of subseptate uterus

The main advantage of 3D USG is that it provides detailed information of the pelvic structures so the cavity of the uterus and its surface can be well visualized in the same view (Fig. 1). This allows one to view uterus along with its spatial relationship to the surrounding adnexal structures. On the other hand, on hysteroscopy only the internal endometrial cavity related pathologies can be visualized (Fig. 2).

Indications of 3D USG are as follows:

- Evaluation and provisional diagnosis of abnormal uterine bleeding (AUB), including mapping of fibroids, polyps, neoplasia, etc.

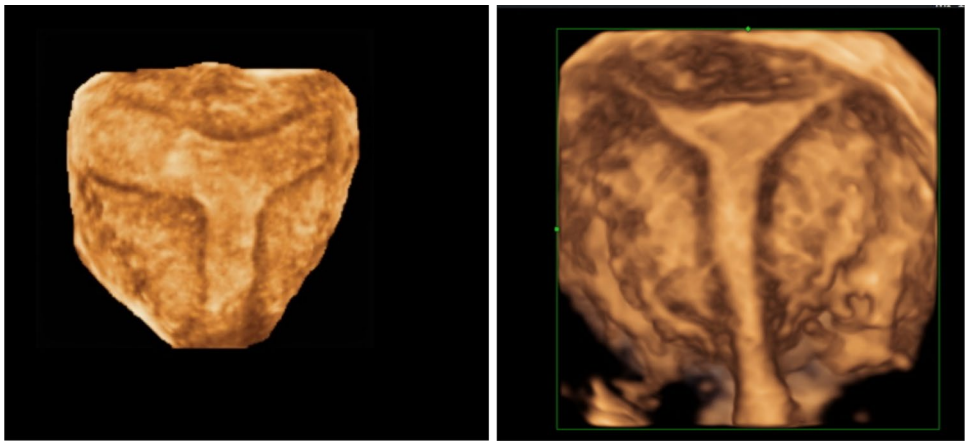


Fig. 12 Class U1 T-shaped uterus

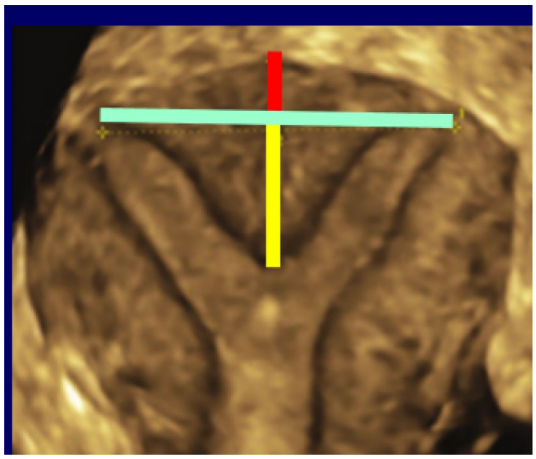


Fig. 13 U2 Partial

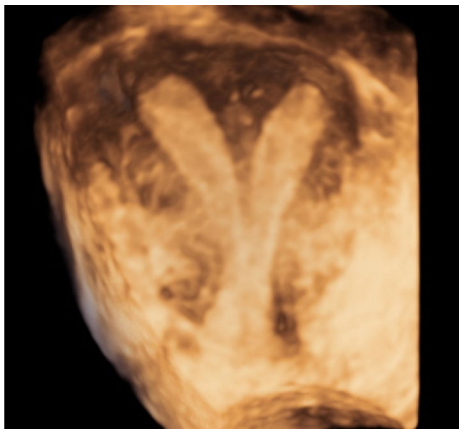


Fig. 14 U2 complete

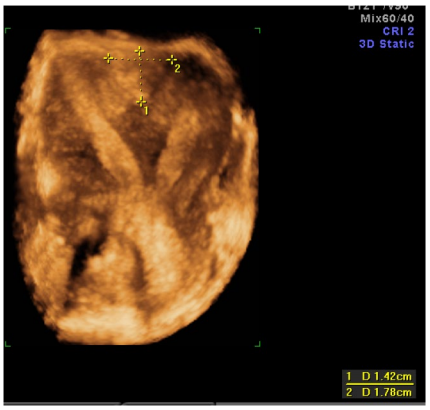


Fig. 15 Class U3a or partial bicorporeal uterus

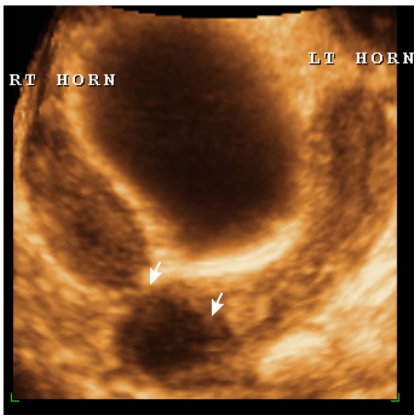


Fig. 16 Class U3c or bicorporeal septate uterus

- As a part of infertility work up
- Investigations for causes of recurrent pregnancy loss (RPL)
- Localization of a misplaced intrauterine contraceptive device (IUCD) or foreign body
- To diagnose gynecological carcinomas
- When 2D USG is unsatisfactory to achieve a diagnosis

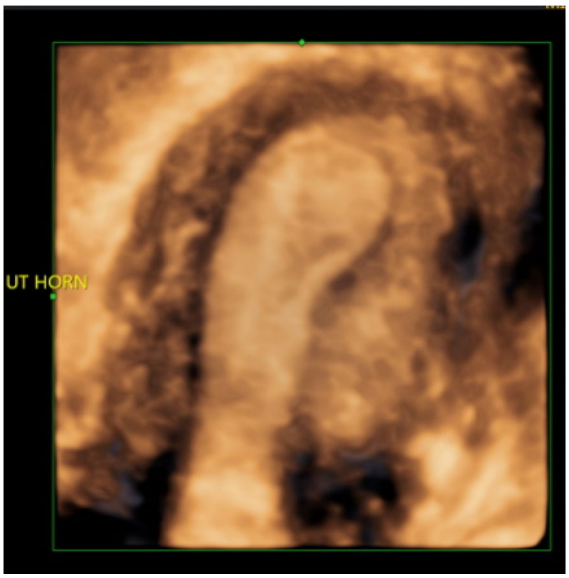


Fig. 17 Class U4b or hemi-uterus without rudimentary (functional) cavity

Evaluation and Provisional Diagnosis of AUB

The causes of AUB vary from submucous myomas, endometrial polyps to endometrial carcinomas.

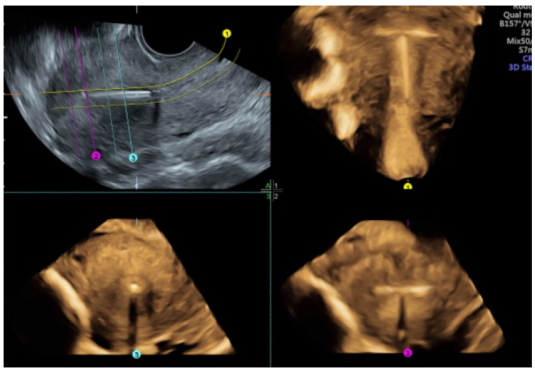


Fig. 18 Multiplanar imaging of IUCD

The European Society of endoscopic surgery classification of submucosal fibroids, originally developed by Wamsteker et al. (1) is used with 3D coronal view USG to map fibroids as follows:

- Type 0 - Pedunculated no intramural extension
- Type I - > 50% intracavitary < 50% intramural extension > 90% angle of myoma surface to the uterine wall
- Type II - < 50% intracavitary, > 50% intramural extension ≥ 90% angle of myoma surface to the uterine wall

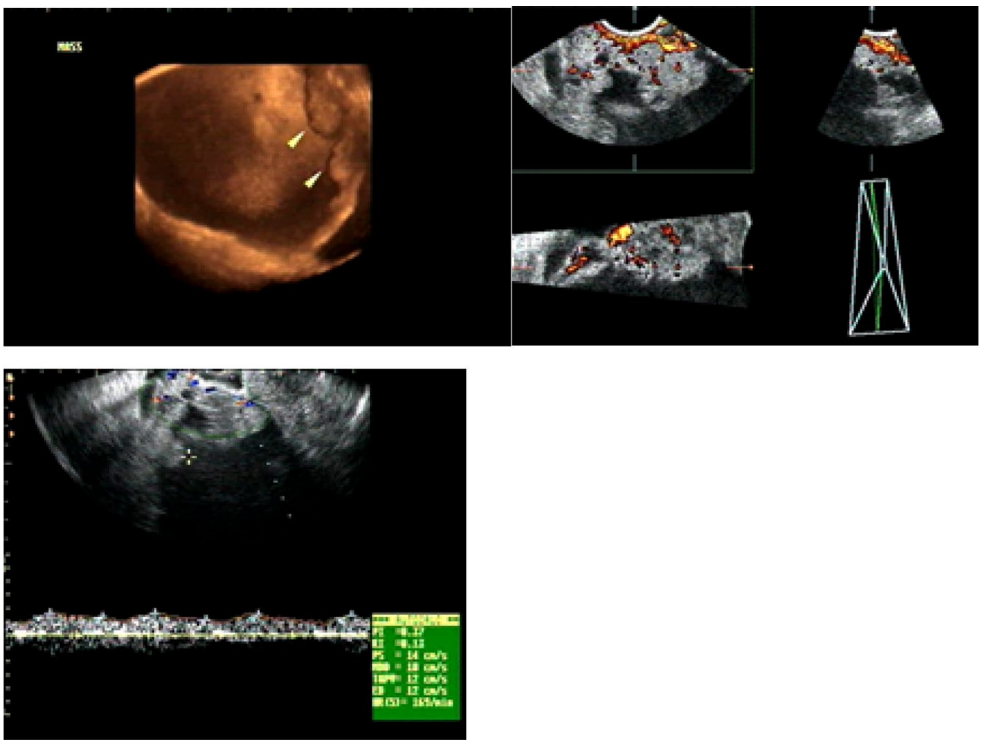
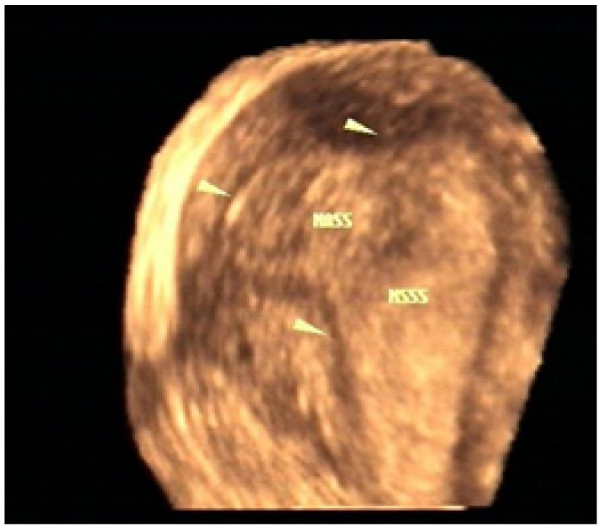


Fig. 19 Complex ovarian cyst with flow patterns and indices



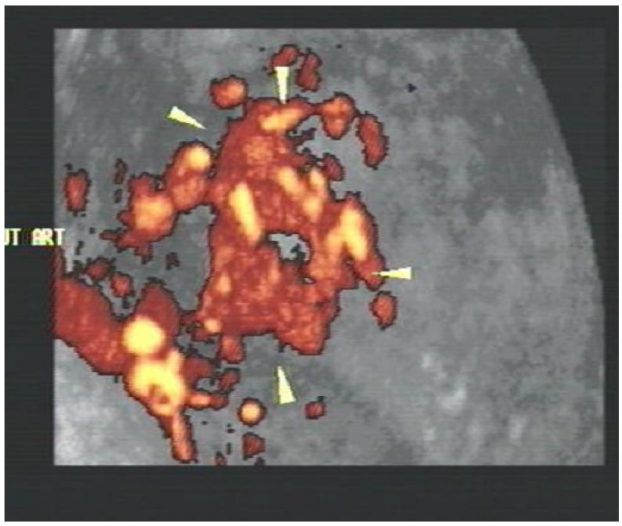
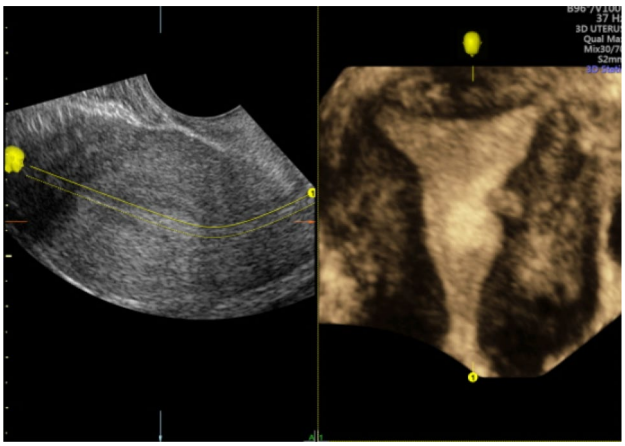


Fig. 20 Endometrial malignancy seen with increased vascularity on coronal imaging

Following is coronal images of endometrial cavity and relationship with submucosal fibroids (Figs. 3, 4, 5, and 6)



Hysteroscopic myomectomy is the surgical procedure of choice for the treatment of submucous fibroids (2–5). Type II (Transmural fibroids) cannot be resected with hysteroscopy because of high chance of perforation of the uterine wall. Resection should be done only if adequate amount of normal myometrium is located behind or above the fibroid.

3D USG can precisely map the location of leiomyomas and depict their intramural and submucosal components. This knowledge is of advantage and necessary for hysteroscopic treatment of fibroids.3D ultrasonography is hence a vital tool prior to hysteroscopic treatment of fibroids.

The volume of images on 3D USG can be seen as multiple slices as seen with CT scan and MRI (multislice imaging). The number of slices and the space between them are user-defined. This can thus help in detection of very tiny polyps which may otherwise be missed.

As a Part of Basic Infertility Work Up

Abou-Salem et al. compared the efficacy of 2D SIS (saline infusion sonography), 3D SIS and hysteroscopy in diagnosing the etiology of abnormal uterine bleeding in 70 women. They reported 92% sensitivity and 89% specificity for 3D SIS in diagnosing intrauterine lesions such as submucous myomas, endometrial polyps and endometrial hyperplasia. These results were significantly better than 2D SIS and comparable to those of diagnostic hysteroscopy [1].

Intrauterine adhesions are a well-known cause of infertility. A study comparing 3D USG and HSG reported that 3D USG had a sensitivity of 100% and HSG of 66.7% for correctly diagnosing and grading intrauterine adhesions [2].

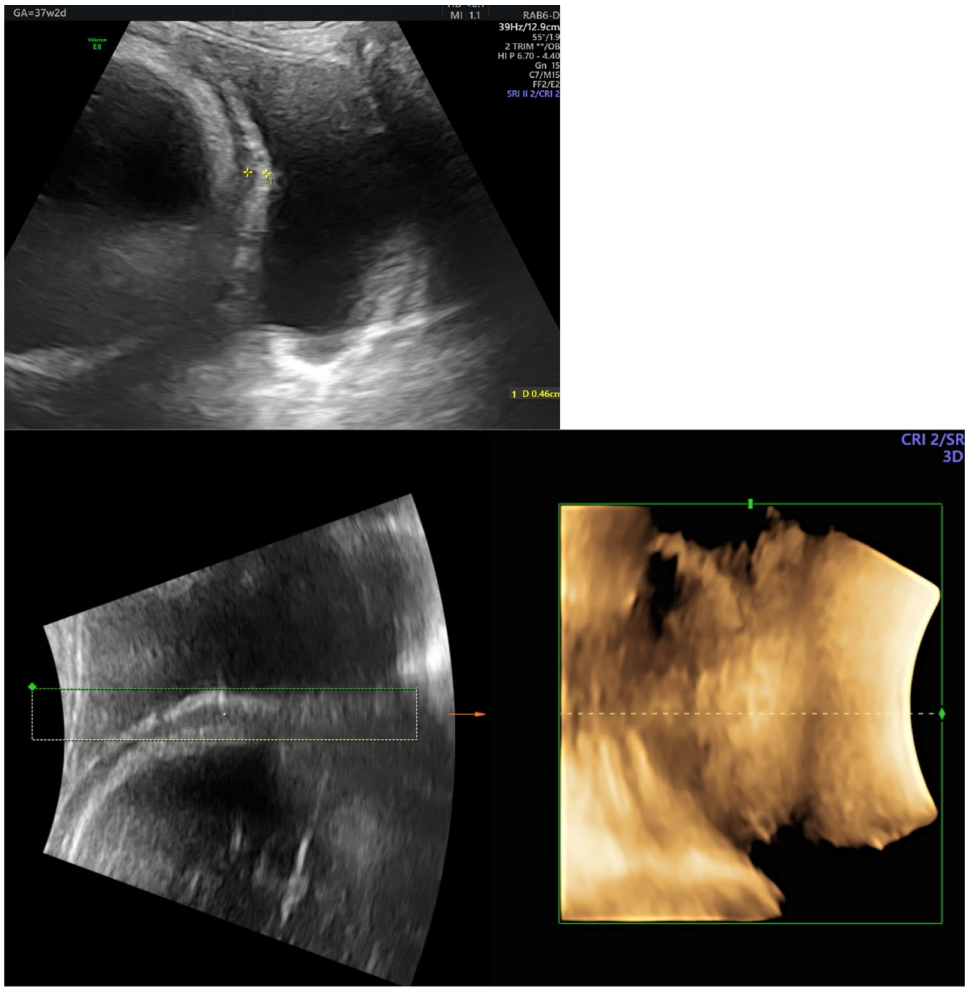


Fig. 21 2D and 3D USG of LSCS scar

3D USG and ART

3D USG technology also provides new applications useful for ART, such as automated volume calculation (SonoAVC). It is mainly used for counting antral follicles and monitoring follicular growth in in vitro fertilization (IVF) cycles and also for monitoring endometrial volume. Measuring follicles using SonoAVC is found to reduce examination time significantly and is more accurate [3, 4], which is invaluable in a busy IVF clinic setting.

Endometrial volume showing a statistically significant difference between pregnant and nonpregnant women (4.11 ± 1.19 vs. 3.4 ± 1.1 $p = 0.019$) on day of triggering and at ET (4.02 ± 1.15 vs. 3.45 ± 0.90, $p = 0.022$). Vascularization flow index (VFI) a quantitative measure was significantly higher in pregnant group at both days of triggering and ET (0.54 ± 0.48 vs. 0.33 ± 0.31 and 0.47 ± 0.22 vs. 0.34 ± 0.2, $p = 0.02$). At cutoff values of 3.265 and 2.95 cm3 (70 and 80% sensitivity, specificity 64.5 and 51.6%, a positive predictive value 38.9 and 34.8%, and negative predictive value 87.0 and 88.9%) to predict pregnancy on the day of hCG trigger and ET, respectively. Cutoff value for endometrial VFI on the day of ET was 0.674 (sensitivity of 70%, specificity of 80.6%, PPV 53.8% and NPV 89.3%). Higher endometrial volume and VFI were associated with pregnancy.

Investigations for Causes of Recurrent Pregnancy Loss (RPL)

One of the most important and mostly correctable causes of RPL is Mullerian anomalies.3D USG can be invaluable in diagnosing these anomalies (Figs. 7, 8, 9, and 10).

The image (Fig. 11) shown is surface rendered image of the cavity of the uterus as seen on hysteroscopy. This is done in minutes without the risks associated with hysteroscopy.

It appears to be a partially septate uterus. The exact length of the septum can be measured and hence resection can be done appropriately. This is an advantage over diagnostic hysteroscopy and also a very good guide during hysteroscopic resection of the septum.

An outstanding property of 3D USG is its capability to obtain the coronal plane of imaging where the surface of the endometrial cavity and the fundal myometrial outline can be seen in one image, which hysteroscopy cannot do. (Figure 11)

This aides in classification of Mullerian anomalies according to ESHRE/ESGE CLASSIFICATION (11) (Fig. 12, 13, 14, 15, 16, and 17) and also for mapping uterine lesions, such as fibroids

Class U2 (septate) and U3 (bicornuate) uterus is differentiated by the following method uterus with normal outline and an internal indentation at the fundal midline exceeding 50% of the uterine wall thickness.

Green line (interostial line)

Yellow line (septal thickness) (This is the length to be resected on hysteroscopy for treatment)

Red Line (fundal myometrial thickness also called uterine wall thickness) (This is the residual myometrium to be left after resection)

Class U3 or bicorporeal uterus incorporates all cases of fusion defects.

Faivre et al. [5] and Ghi et al. [6] have reported 100% specificity and sensitivity for 3D USG and a concordance of 100 and 96%, respectively, when compared with laparoscopy and concurrent hysteroscopy obviating the need of an invasive procedure for diagnosis of a Mullerian anomaly.

3D USG can be used not only for reaching a diagnosis, but also for optimizing the treatment. Ludwin et al. [14] used real time 3D transrectal USG during hysteroscopic metroplasty for uterine septum. With this method, the surgeon knows exactly how much septum is left in real time. This helps in preventing overzealous incisions and reduces the risk of incomplete septum resection.

Localization of a Misplaced Intrauterine Contraceptive Device (IUCD) or Foreign Body

Misplaced IUD's, malpositioned IUDs or those embedded in the myometrium may cause abnormal bleeding and pelvic pain.

Coronal view of the uterus in 3D USG can clearly show the entire IUD, its location in the cavity and its relationship with the myometrium [7]. As seen in Fig. 18

To Diagnose Gynecological Carcinomas

An adnexal mass can be mapped accurately with 3D USG. It is better at demonstrating septate, cyst wall irregularities and papillary projections [8].

Meta-analysis by Dodge et al. reported an overall sensitivity of 93.5% and specificity of 91.5% of 3D gray-scale USG for identifying suspicious adnexal masses [8]. 3D USG power Doppler (3D PD) has shown various vascular indices for neoplasia evaluation. It is believed that vascularization index (VI) represents the amount of vessel in the examined volume, flow index (FI) shows the flow intensity, and vascularization-flow index (VFI) reflects the combination of both [9]. These were significantly higher in malignancy.

Endometrial volume (EV) has been investigated as a criterion for malignancy. Endometrial volume is measured using virtual organ computer-aided analysis (VOCAL). Studies have shown that EV is a better predictor of endometrial cancer than ET [10–12].

However, each study has defined a different cutoff value for EV, ranging between 1.35 and 3.56 ml. Yaman et al. performed 3D endometrial volume measurements on 213 patients with postmenopausal bleeding. After histopathological examination, 42 patients were diagnosed to have endometrial carcinoma. They reported that sensitivity was 100%, specificity 69%, PPV 44% and NPV 100% using 2.7 ml as a cutoff value [12]. To improve on these results, researchers added 3D PD to their studies. Vascular indices, namely VI, FI and VFI, were significantly higher in patients with endometrial carcinoma compared to endometrial hyperplasia [12, 13].

Investigations of Scars after Surgery

The role of utrasound versus hysteroscopy in assessment of cesarean section scar in non pregnant females has been studied before [15]. It was found that hysteroscopy can't comment on thickness of scar of previous sections but transvaginal ultrasound can do it in all patients of the study by mean value 1.57 mm and median 1.50 mm standard deviation of 0.71.

In a further study, the accuracy of 2D and 3D ultrasound in measurement of cesarean section (CS) scar thickness was evaluated.The best cutoff value for 2D and 3D transabdominal ultrasound was 3.8 and 5.0 mm, with AUC of 0.737and 0.824, yielding a sensitivity of 60% and 100%, specificity of 91.4% and 62.86%, respectively. The best cutoff value for 2D and 3D transvaginal ultrasound was 2.0 and 1.9 mm with AUC of 0.931 and 0.974 with sensitivity of 100% and 100%,

specificity of 65.71% and 87.14%, respectively. It was concluded that ultrasound is a reliable method for measuring the LUS thickness and scar integrity in patients with previous CS. The use of transvaginal 3D ultrasound in measuring the muscular layer thickness of LUS is the most reliable route with high sensitivity and specificity.

Therapeutic Role of 3D USG

Here, we concede that hysteroscopy has therapeutic benefits over 3D USG. The only possibly therapeutic benefit of 3D USG is after doing sonosalpingo/hysterography. The saline infusion can dislodge mucosal plugging of the fallopian tubes

Conclusion: 3D V/s Hysteroscopy

3D USG in routine gynecological workup is beneficial for clinicians, as it provides fast and accurate imaging, and hence it is more cost effective and less time consuming as compared to hysteroscopy.

The advantages of 3D USG is that it provides information of the cavity of the uterus and its surface in the same view. On the other hand, on hysteroscopy only the internal endometrial cavity related pathologies can be visualized. Hence, exact uterine fibroid mapping and other diagnostic advantages are possible as mentioned above compared to hysteroscopy, 3D ultrasound is safer as it is noninvasive. It carries no anesthesia or surgical risks and is an exclusively outpatient (office) procedure (Figs. 18, 19, 20, and 21).

3D USG allows storage of electronic volume data (useful in network consultation) and exchange of the data, interactive retrospective review at any time without the presence of the patient (virtual patient). These reasons upgrade the 3D transvaginal USG to an ideal diagnostic modality to asses in detail the complete uterine morphology.

References

1. Abou-Salem N, Elmazny A, El-Sherbiny W. Value of 3-dimensional sonohysterography for detection of intrauterine lesions in women with abnormal uterine bleeding. J Minim Invasive Gynecol. 2010;17(2):200–4.
2. Knopman J, Copperman AB. Value of 3D ultrasound in the management of suspected Asherman's syndrome. J Reprod Med. 2007;52(11):1016–22.
3. Raine-Fenning N, Jayaprakasan K, Deb S, et al. Automated follicle tracking improves measurement reliability in patients undergoing ovarian stimulation. Reprod Biomed Online. 2009;18(5):658–63.
4. Ata B, Tulandi T. Ultrasound automated volume calculation in reproduction and in pregnancy. Fertil Steril. 2011;95(7):2163–70.
5. Faivre E, Fernandez H, Deffieux X, et al. Accuracy of three-dimensional ultrasonography in differential diagnosis of septate and bicornuate uterus compared with office hysteroscopy and pelvic magnetic resonance imaging. J Minim Invasive Gynecol. 2012;19(1):101–6.
6. Ghi T, et al. Accuracy of three-dimensional ultrasound in diagnosis and classification of congenital uterine anomalies. Fertil Steril. 2009;92(2):808–13.
7. Benacerraf BR, Shipp TD, Bromley B. Three-dimensional ultrasound detection of abnormally located intrauterine contraceptive devices which are a source of pelvic pain and abnormal bleeding. Ultrasound Obstet Gynecol. 2009;34(1):110–5.
8. Armstrong L, Fleischer A, Andreotti R. Three-dimensional volumetric sonography in gynecology: an overview of clinical applications. Radiol Clin North Am. 2013;51(6):1035–47.
9. Dodge JE, Covens AL, Lacchetti C, et al. Preoperative identification of a suspicious adnexal mass: a systematic review and meta-analysis. Gynecol Oncol. 2012;126(1):157–66.
10. Mansour GM, El-Lamie IKI, El-Kady MA, et al. Endometrial volume as predictor of malignancy in women with postmenopausal bleeding. Int J Gynaecol Obstet. 2007;99(3):206–10.
11. Odeh M, Vainerovsky I, Grinin V, et al. Three-dimensional endometrial volume and 3-dimensional power Doppler analysis in predicting endometrial carcinoma and hyperplasia. Gynecol Oncol. 2007;106(2):348–53.
12. Yaman C, Habelsberger A, Tews G, et al. The role of threedimensional volume measurement in diagnosing endometrial cancer in patients with postmenopausal bleeding. Gynecol Oncol. 2008;110(3):390–5.
13. Alcazar JL, Galvan R. Three-dimensional power Doppler ultrasound scanning for the prediction of endometrial cancer in women with postmenopausal bleeding and thickened endometrium. Am J Obstet Gynecol. 2009;200(1):43–4.
14. Ludwin A, Ludwin A, Pitynski K et al. Role of morphologic characteristics of the uterine septum in the prediction and prevention of abnormal healing outcomes after hysteroscopic metroplasty. Hum Reprod. 2014.
15. Abdel-AzizEl-Ewiny II, Kassab FA, Abdul-Jaleel KN. Role of ultrasound versus hysteroscopy in assessment of Cesarean section scar in non pregnant females. Egypt J Hospital Med. 2019;74(4):775–81.

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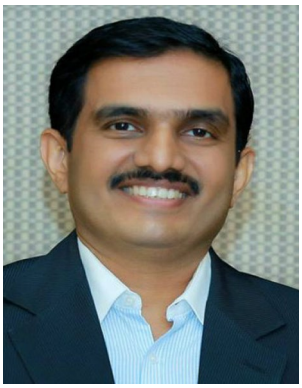

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