Section: Obstetrics and Gynaecology

Original Research Article

COMPARATIVE EVALUATION OF 3D ULTRASOUND AND HYSTEROSCOPY IN DIAGNOSING UTERINE ANOMALIES: A PROSPECTIVE OBSERVATIONAL STUDY

Ritu Raj[1], Rajeev Ranjan[2], Palash Majumdar[3], Somajita Chakraborty[4]

[1]Department of Obstetrics and Gynaecology, AIIMS, New Delhi, India.
[2]Department of Radiodiagnosis, NMCH, Patna, India.
[3]Department of Obstetrics and Gynaecology, DMGM, Purulia, India.
[4]Department of Obstetrics and Gynaecology, CNMCH, Kolkata, India.

Received *: 30/03/2024*
Received in revised form *: 14/05/2024*
Accepted *: 31/05/2024*

Corresponding Author:
Dr. Ritu Raj,
Department of Obstetrics and Gynaecology, AIIMS, New Delhi, India.
Email: rituraj1908@gmail.com

DOI: 10.5530/ijmedph.2024.2.163

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2024; 14 (2); 844-849

ABSTRACT

Background: Uterine anomalies can lead to various reproductive issues, including abnormal uterine bleeding, recurrent pregnancy loss, and infertility. This study aims to compare the diagnostic accuracy of 3D ultrasound and hysteroscopy in detecting uterine anomalies as well as acquired uterine abnormalities.

Material and Methods: A prospective observational study was conducted at a Public Tertiary Hospital in Kolkata, West Bengal, from February 2020 to January 2021 and again at a medical facility of Patna from August'2023 to January'2024. A total of 100 women aged 20 to 45 years, with symptoms suggestive of uterine anomalies, were enrolled. Each participant underwent both 3D ultrasound (TVS) and hysteroscopy. The findings of both diagnostic methods were compared to determine their sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy.

Results: 3D ultrasound detected normal uterine anatomy in 64 cases (64%) and uterine anomalies in 36 cases (36%).Hysteroscopy identified normal uterine anatomy in 58 cases (58%) and uterine anomalies in 42 cases (42%). The anomalies detected by 3D ultrasound included septate uterus (14%), bicornuate uterus (10%), arcuate uterus (8%), unicornuate uterus (2%), didelphys uterus (2%), and other abnormalities (4%). Hysteroscopy identified septate uterus (16%), bicornuate uterus (12%), arcuate uterus (10%), unicornuate uterus (2%), didelphys uterus (2%), and other abnormalities (5%) Comparative analysis showed true positives in 34 cases (34%), false negatives in 8 cases (8%), and false positives in 4 cases (4%). The sensitivity, specificity, PPV, NPV, and overall accuracy of 3D ultrasound were 81%, 94%, 89%, 87%, and 88%, respectively.

Conclusion: While 3D ultrasound is a valuable non-invasive diagnostic tool, hysteroscopy remains the gold standard for diagnosing uterine anomalies due to its higher sensitivity. Combining both methods can improve diagnostic accuracy and patient outcomes.

Keywords: Uterine anomalies, 3D ultrasound, TVS, hysteroscopy, diagnostic accuracy, reproductive health, prospective observational study, Kolkata.

INTRODUCTION

Uterine anomalies are structural abnormalities of the uterus that can significantly impact a woman's reproductive health.[1] These anomalies can lead to various complications, including abnormal uterine bleeding, recurrent pregnancy loss, infertility, and adverse pregnancy outcomes.[2] Accurate and timely diagnosis of uterine anomalies is crucial for effective management and treatment.[3]

Traditionally, hysteroscopy has been considered the gold standard for diagnosing uterine anomalies due to its direct visualization capability.[4] Hysteroscopy allows for a thorough examination of the uterine cavity and the identification of structural abnormalities with high precision. However, it is an invasive procedure, requiring anesthesia and carrying potential risks associated with surgical interventions.[5]

With advancements in imaging technology, 3D ultrasound has emerged as a promising non-invasive diagnostic tool for detecting uterine anomalies.[6] 3D ultrasound provides detailed images of the uterine cavity and its structures, allowing for the identification of various anomalies. It offers the advantages of being less invasive, cost-effective, more comfortable for patients, and quicker to perform compared to hysteroscopy.[7]

Despite these advantages, the accuracy of 3D ultrasound in diagnosing uterine anomalies compared to hysteroscopy remains a topic of debate. While some studies suggest that 3D ultrasound is highly accurate, others indicate discrepancies in its diagnostic capabilities, particularly in detecting certain types of anomalies.

This study aims to compare the diagnostic accuracy of 3D ultrasound and hysteroscopy in detecting uterine anomalies. By evaluating the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of both methods, this study seeks to determine the reliability of 3D ultrasound as a diagnostic tool and its potential role in clinical practice. The findings of this study will provide valuable insights into the strengths and limitations of 3D ultrasound and help guide clinical decision-making in the diagnosis and management of uterine anomalies.

MATERIAL AND METHODS

Study Design

This prospective observational study was conducted at Medical College and Hospital, Kolkata, West Bengal, from February 2020 to January 2021. Another portion of the same study was done at a private medical facility in Patna in association with Primescan Imaging Intervention and Diagnostic Centre Pvt. Ltd, Patna from August'2023 to January'2024. The study aimed to compare the diagnostic accuracy of 3D ultrasound and hysteroscopy in detecting uterine anomalies.

Study Population

A total of 100 women aged 20 to 45 years, presenting with symptoms suggestive of uterine anomalies, were enrolled in the study. Inclusion criteria included abnormal uterine bleeding, recurrent pregnancy loss, or infertility. Exclusion criteria included pregnancy, active pelvic infection, and a history of uterine surgery that could interfere with the evaluation.

Procedures

Each participant underwent both 3D ultrasound and hysteroscopy. The 3D ultrasound was performed first, followed by hysteroscopy within one week to minimize the risk of interval changes in the uterine anatomy.

3D Ultrasound

The 3D ultrasound examinations were conducted using a high-resolution ultrasound machine equipped with a 3D transvaginal probe. The procedure was performed by an experienced radiologist. The images were analyzed to identify any structural abnormalities of the uterus, including septate, bicornuate, arcuate, unicornuate, and didelphys uterus.

Hysteroscopy

Hysteroscopy was performed under local or general anesthesia, as appropriate, by a gynecologist experienced in hysteroscopic procedures. A hysteroscope was inserted through the cervix into the uterine cavity preferably with vaginoscopy, allowing direct visualization of the uterine structure. Any anomalies detected during the procedure were documented.

Data Collection and Analysis

Data were collected on the presence or absence of uterine anomalies as detected by both 3D ultrasound and hysteroscopy. The types of anomalies identified by each method were also recorded.

The concordance between 3D ultrasound and hysteroscopy in detecting uterine anomalies was assessed. Diagnostic accuracy measures, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, were calculated using hysteroscopy as the reference standard.

Statistical Analysis

Sensitivity was calculated as the proportion of true positive cases detected by 3D ultrasound among those confirmed by hysteroscopy. Specificity was calculated as the proportion of true negative cases detected by 3D ultrasound among those without anomalies confirmed by hysteroscopy. PPV and NPV were calculated to assess the probability that cases identified by 3D ultrasound were true positives or true negatives, respectively. Overall accuracy was calculated as the proportion of true positive and true negative cases among the total cases.

The data were analyzed using statistical software. Descriptive statistics were used to summarize the demographic characteristics of the study population. The diagnostic accuracy of 3D ultrasound was compared to hysteroscopy using standard statistical tests.

Ethical Considerations

The study was conducted following ethical guidelines and principles. Informed consent was obtained from all participants prior to enrollment. The study protocol was reviewed and approved by the institutional ethics committee of the medical facility.

RESULTS

Sample Characteristics

A total of 100 women were enrolled in the study conducted with 70 and 30 patients respectively in Kolkata, West Bengal, from February 2020 to January 2021 and in Patna, Bihar from August'2023 to January'2024. The age range of the participants was 20 to 45 years, with a mean age of 32.6 years. Participants were selected based on the presence of symptoms suggestive of uterine anomalies, such as abnormal uterine bleeding, recurrent pregnancy loss, or infertility. [Table 1]

Diagnostic Findings

3D Ultrasound

Out of the 100 women evaluated using 3D ultrasound, 64 cases (64%) had normal uterine anatomy, while 36 cases (36%) were diagnosed with uterine anomalies. The types of anomalies detected by 3D ultrasound included septate uterus (14 cases, 14%), bicornuate uterus (10 cases, 10%), arcuate uterus (8 cases, 8%), unicornuate uterus (2 cases, 2%), and didelphys uterus (2 cases, 2%) (Tables 2 and 3). Other disease entities involving the uterus and adnexa could be ascertained with precision by an expert sonologist with good ultrasound machines. [Figure 1]

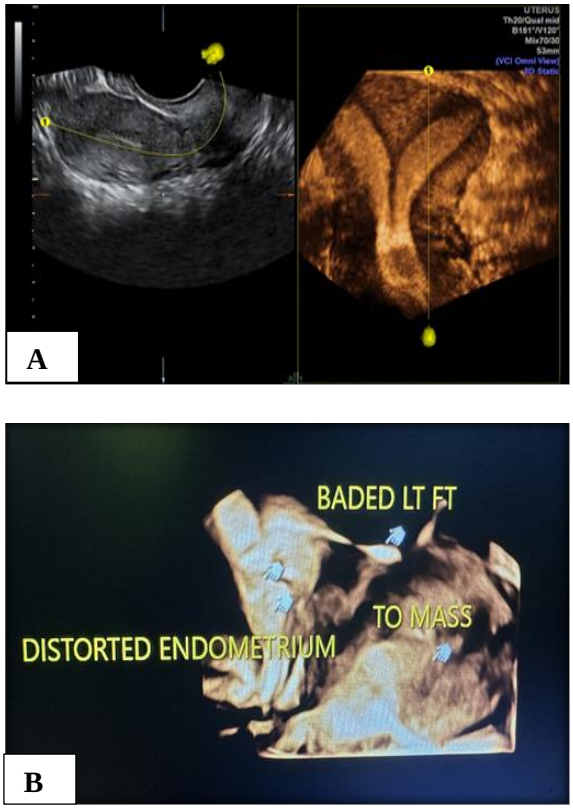
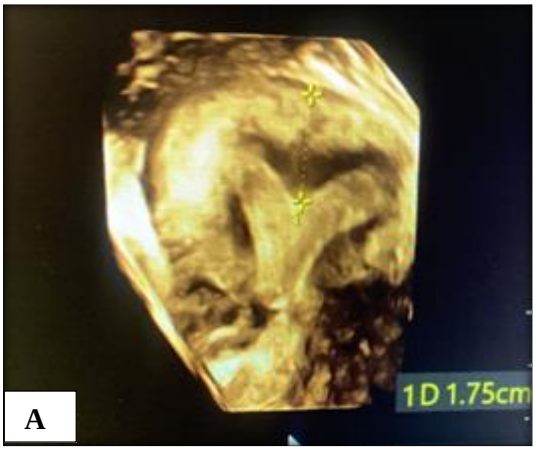


Figure 1: (A) demonstrates the 3D TVS image of a septate uterus with septum extending upto the isthmus of uterus. (B) demonstrates 3D TVS image in a patient with Genital TB



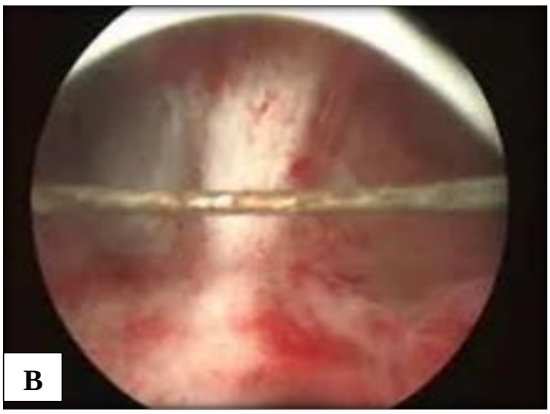


Figure 2: Comparative description of uterine anomaly in a patient with recurrent pregnancy losses. (A) 3D TVS confirmed the size, thickness of septum. (B) Hysteroscopy image of the same patient taken up for septal resection being done by Colins knife.

Diagnostic Accuracy

The diagnostic accuracy of 3D ultrasound compared to hysteroscopy was calculated and revealed the following metrics: sensitivity was 81% (34/42), specificity was 94% (54/58), positive predictive value (PPV) was 89% (34/38), negative predictive value (NPV) was 87% (54/62), and the overall accuracy was 88% (88/100). [Table 7]

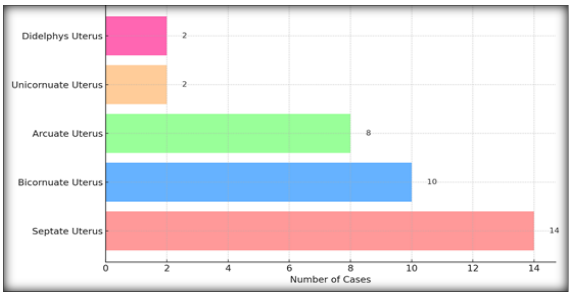


Figure 1: Types of Uterine Anomalies Detected by 3D Ultrasound

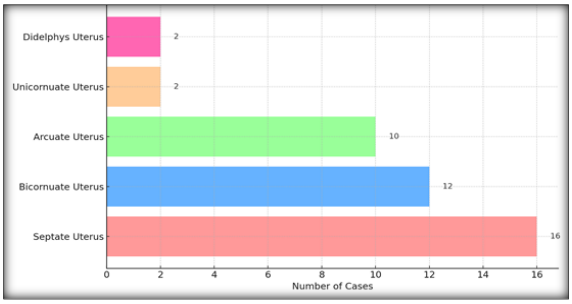


Figure 2: Types of Uterine Anomalies Detected by Hysteroscopy

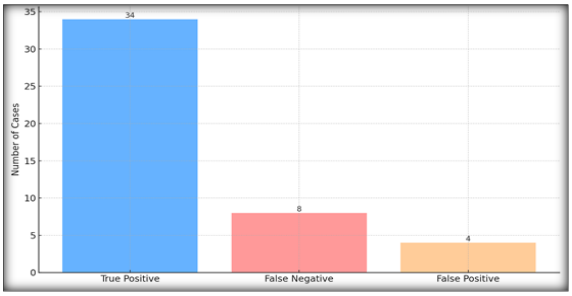


Figure 3: Comparative Analysis of 3D Ultrasound and Hysteroscopy

Table 1: Sample Characteristics

Age Range (years)	Mean Age (years)	Symptoms Present
20-45	32.6	Abnormal uterine bleeding, recurrent pregnancy loss, infertility

Table 2: Diagnostic Findings - 3D Ultrasound

Diagnosis	Number of Cases	Percentage (%)
Normal Uterine Anatomy	64	64
Uterine Anomalies	36	36

Table 3: Types of Uterine Anomalies Detected by 3D Ultrasound

Type of Anomaly	Number of Cases	Percentage (%)
Septate Uterus	14	14
Bicornuate Uterus	10	10
Arcuate Uterus	8	8
Unicornuate Uterus	2	2
Didelphys Uterus	2	2
Other Abnormalities (Fibroid, Synechiae, etc.)	4	4

Table 4: Diagnostic Findings – Hysteroscopy

Diagnosis	Number of Cases	Percentage (%)
Normal Uterine Anatomy	58	58
Uterine Anomalies	42	42

Table 5: Types of Uterine Anomalies Detected by Hysteroscopy

Type of Anomaly	Number of Cases	Percentage (%)
Septate Uterus	16	16
Bicornuate Uterus	12	12
Arcuate Uterus	10	10
Unicornuate Uterus	2	2
Didelphys Uterus	2	2
Other Abnormalities (Fibroid, Synechiae, etc.)	5	5

Table 6: Comparative Analysis of 3D Ultrasound and Hysteroscopy

Diagnostic Outcome	Number of Cases	Percentage (%)
True Positive	34	34
False Negative	8	8
False Positive	4	4

Table 7: Diagnostic Accuracy of 3D Ultrasound

Metric	Value	Calculation
Sensitivity	81%	34/42
Specificity	94%	54/58
Positive Predictive Value (PPV)	89%	34/38
Negative Predictive Value (NPV)	87%	54/62
Overall Accuracy	88%	88/100

DISCUSSION

This study aimed to evaluate and compare the diagnostic accuracy of 3D ultrasound and hysteroscopy in detecting uterine anomalies. The results demonstrated that while both methods are effective, hysteroscopy remains the superior diagnostic tool.

Key Findings

The findings indicate that 3D ultrasound detected uterine anomalies in 36% of cases, while hysteroscopy identified anomalies in 42% of cases. The most common anomalies detected by both methods were septate uterus, bicornuate uterus, and arcuate uterus as well as fibroid and synechiae in patients with menstrual disturbances. However, hysteroscopy detected a higher number of anomalies overall, highlighting its superior diagnostic capability[8,9].

Diagnostic Accuracy

The diagnostic accuracy measures of 3D ultrasound, when compared to hysteroscopy, were as follows: sensitivity was 81%, specificity was 94%, positive predictive value (PPV) was 89%, negative predictive value (NPV) was 87%, and overall accuracy was 88%. These results suggest that 3D ultrasound is a reliable non-invasive diagnostic tool with high specificity and reasonable sensitivity. With good skills in 3D ultrasound and a good ultrasound machine, uterine fibroids, polyp, distorted endometrial cavity could be assessed beautifully by 3D TVS alleviating the need for invasive diagnostic hysteroscopy (FIG 3,4). These disease entities patients can be accordingly directly planned for operative procedures. However, the lower sensitivity compared to hysteroscopy indicates that 3D ultrasound may miss some anomalies[10,11].

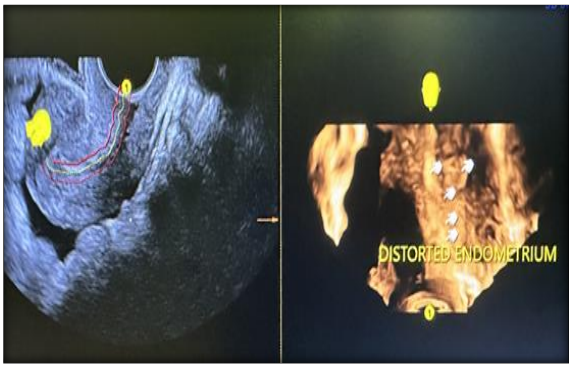


Figure 3: **Elicits 3D TVS image of a patient with scanty menses reflecting distorted endometrial cavity, one of the marker of asherman's syndrome.**

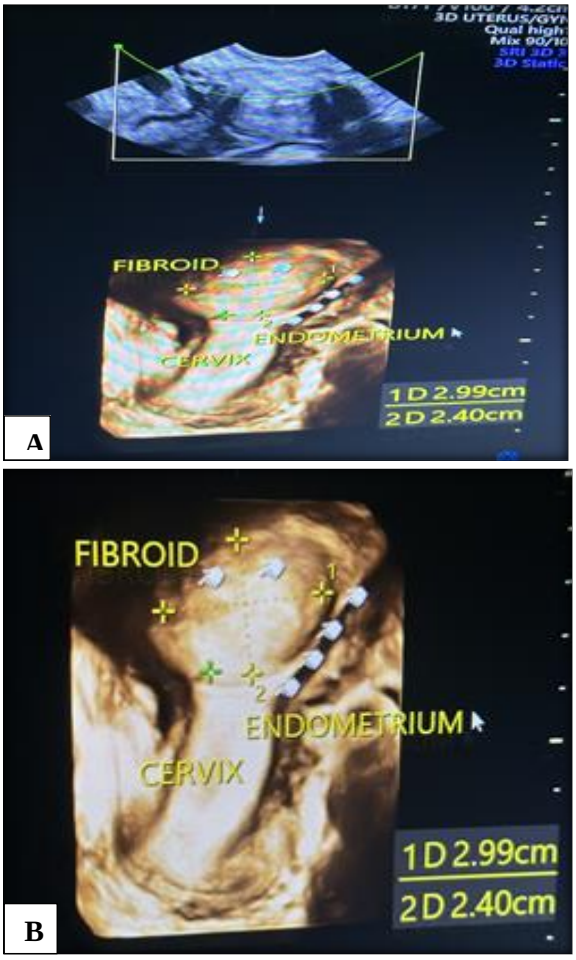


Figure 4: (A),(B) represents 3D TVS image in a patient with subfertility having sub-mucosal fibroid.

Strengths and Limitations

Strengths:

- The prospective observational design allowed for systematic data collection and analysis.
- The use of hysteroscopy as the reference standard provided a robust comparison for evaluating the accuracy of 3D ultrasound.[12]
- The study included a representative sample of women from both public and private medical facility, with symptoms suggestive of uterine abnormalities, enhancing the generalizability of the findings.

Limitations

- The study's small sample size and involving only 2 centers may limit the generalizability of the findings to other settings.
- Although hysteroscopy is considered the gold standard, it is not without limitations, such as the potential for operator variability and the invasiveness of the procedure.
- The time gap between the two diagnostic procedures, although minimized to within one week, could still introduce some variability.

Clinical Implications

The findings from this study have significant clinical implications. While 3D ultrasound offers a non-invasive and patient-friendly option for the initial evaluation of uterine anomalies, it should be followed by hysteroscopy when clinical suspicion remains high, even if the ultrasound findings are normal. This dual approach can enhance diagnostic accuracy, ensure timely and accurate diagnosis, and guide appropriate management strategies.[13]

3D ultrasound, with its high specificity, is particularly useful for ruling out anomalies when the results are negative. However, due to its lower sensitivity, reliance solely on 3D ultrasound may result in missed diagnosis, particularly for subtle or complex anomalies. Hysteroscopy, with its ability to directly visualize the uterine cavity, remains indispensable for confirmatory diagnosis.[14]

Future Directions

Future research should focus on multi-center studies to validate these findings across different populations and settings. Additionally, advances in imaging technology and techniques, such as the integration of artificial intelligence for image analysis, may further enhance the diagnostic accuracy of 3D ultrasound. Exploring these advancements could provide valuable insights into improving non-invasive diagnostic tools.

CONCLUSION

From the results we can conclude that, while 3D ultrasound is a valuable and reliable non-invasive diagnostic tool with high specificity for detecting uterine anomalies, hysteroscopy remains the gold standard due to its superior sensitivity and direct visualization capability. A combined approach using both methods can optimize diagnostic accuracy, improve patient outcomes, and inform effective management of uterine anomalies. The study underscores the importance of integrating advanced imaging techniques with traditional methods to enhance diagnostic precision in clinical practice.

REFERENCES

1. Grigore M, Pristavu A, Iordache F, Gafitanu D, Ursulescu C. Comparative Study of Hysteroscopy and 3D Ultrasound for Diagnosing Uterine Cavity Abnormalities. Rev Med Chir Soc Med Nat Iasi. 2016 Oct-Dec;120(4):866-73. PMID: 30141843.
2. Apirakviriya C, Rungruxsirivorn T, Phupong V, Wisawasukmongchol W. Diagnostic accuracy of 3D-transvaginal ultrasound in detecting uterine cavity abnormalities in infertile patients as compared with hysteroscopy. Eur J Obstet Gynecol Reprod Biol. 2016 May; 200:24-8. doi: 10.1016/j.ejogrb.2016.01.023. Epub 2016 Feb 26. PMID: 26967342.
3. Emanuel MH, Verdel MJ, Wamsteker K, Lammes FB. A prospective comparison of transvaginal ultrasonography and diagnostic hysteroscopy in the evaluation of patients with abnormal uterine bleeding: clinical implications. Am J Obstet Gynecol. 1995 Feb;172(2 Pt 1):547-52. doi: 10.1016/0002-9378(95)90571-5. PMID: 7856684.
4. Thellier E, Levaillant JM, Pourcelot AG, Houllier M, Fernandez H, Capmas P. Are 3D ultrasound and office hysteroscopy useful for the assessment of uterine cavity after late foetal loss? J Gynecol Obstet Hum Reprod. 2018 May;47(5):183-186. doi: 10.1016/j.jogoh.2018.02.002. Epub 2018 Feb 21. PMID: 29475047.
5. Naredi N, Sharma R, Gurmeet P. Can Three-Dimensional Transvaginal Sonography Replace Office Hysteroscopy in Detecting Uterine Abnormalities in Infertility Patients? J Hum Reprod Sci. 2021 Oct-Dec;14(4):392-399. doi: 10.4103/jhrs.jhrs_97_21. Epub 2021 Dec 31. PMID: 35197685; PMCID: PMC8812396.
6. Kaveh M, Sadegi K, Salarzaei M, Parooei F. Comparison of diagnostic accuracy of saline infusion sonohysterography, transvaginal sonography, and hysteroscopy in evaluating the endometrial polyps in women with abnormal uterine bleeding: a systematic review and meta-analysis. Wideochir Inne Tech Maloinwazyjne. 2020 Sep;15(3):403-415. doi: 10.5114/wiitm.2020.93791. Epub 2020 Mar 19. PMID: 32904526; PMCID: PMC7457193.
7. Alcázar JL, Carriles I, Cajas MB, Costa S, Fabra S, Cabrero M, et al. Diagnostic Performance of Two-Dimensional Ultrasound, Two-Dimensional Sonohysterography and Three-Dimensional Ultrasound in the Diagnosis of Septate Uterus-A Systematic Review and Meta-Analysis. Diagnostics (Basel). 2023 Feb 20;13(4):807. doi: 10.3390/diagnostics13040807. PMID: 36832295; PMCID: PMC9955687.
8. Varlas V, Rhazi Y, Cloțea E, Borș RG, Mirică RM, Bacalbașa N. Hysterolaparoscopy: A Gold Standard for Diagnosing and Treating Infertility and Benign Uterine Pathology. J Clin Med. 2021 Aug 23;10(16):3749. doi: 10.3390/jcm10163749. PMID: 34442042; PMCID: PMC8396885.
9. Pal L, Lapensee L, Toth TL, Isaacson KB. Comparison of office hysteroscopy, transvaginal ultrasonography and endometrial biopsy in evaluation of abnormal uterine bleeding. JSLS. 1997 Apr-Jun;1(2):125-30. Erratum in: J Soc Laparoendosc Surg 1997 Oct-Dec;1(4):395. PMID: 9876659; PMCID: PMC3021277.
10. Graupera B, Pascual MA, Hereter L, Browne JL, Úbeda B, Rodríguez I, et al. Accuracy of three-dimensional ultrasound compared with magnetic resonance imaging in diagnosis of Müllerian duct anomalies using ESHRE-ESGE consensus on the classification of congenital anomalies of the female genital tract. Ultrasound Obstet Gynecol. 2015 Nov;46(5):616-22. doi: 10.1002/uog.14825. Epub 2015 Oct 5. PMID: 25690307.
11. Chan YY, Jayaprakasan K, Zamora J, Thornton JG, Raine-Fenning N, Coomarasamy A. The prevalence of congenital uterine anomalies in unselected and high-risk populations: a systematic review. Hum Reprod Update. 2011 Nov-Dec;17(6):761-71. doi: 10.1093/humupd/dmr028. Epub 2011 Jun 24. PMID: 21705770; PMCID: PMC3191936.
12. Ghi T, Casadio P, Kuleva M, Perrone AM, Savelli L, Giunchi S, et al. Accuracy of three-dimensional ultrasound in diagnosis and classification of congenital uterine anomalies. Fertil Steril. 2009 Aug;92(2):808-13. doi: 10.1016/j.fertnstert.2008.05.086. Epub 2008 Aug 9. PMID: 18692833.
13. Kim MA, Kim HS, Kim YH. Reproductive, Obstetric and Neonatal Outcomes in Women with Congenital Uterine Anomalies: A Systematic Review and Meta-Analysis. J Clin Med. 2021 Oct 20;10(21):4797. doi: 10.3390/jcm10214797. PMID: 34768344; PMCID: PMC8584292.
14. Peitsidis N, Tsakiridis I, Najdecki R, Michos G, Chouliara F, Zachomitros F, et al. Hysteroscopic Identification of Intrauterine Pathology in Oocyte Donation Cycles: A Retrospective Study. Cureus. 2023 Apr 12;15(4):e37470. doi: 10.7759/cureus.37470. PMID: 37187651; PMCID: PMC10176530.