Role of Three-dimensional Pelvic Ultrasound in the Assessment of Risk Factors for Intrauterine Device Misplacement and Dislocation

Sushila Arya¹, Zuber D Mulla², Tracy N Nguyen³, Sanja Kupesic-Plavsic⁴

ABSTRACT

Objectives: Our objectives were to improve the quality and safety of future intrauterine device (IUD) insertion by introducing a systematic approach to identifying patients at risk for IUD misplacement and dislocation using the 3D ultrasound.

Design: Risk factors for IUD misplacement and dislocation were assessed in a case-control study of patients who presented to our ultrasound clinic for IUD localization: 49 cases (women with IUD misplacement and/or dislocation) were compared to 108 controls (women with IUDs in the normal position). Adjusted odds ratios (AOR), 95% confidence intervals (CI), and *p* values were calculated from logistic regression models using Firth's penalized maximum likelihood estimation to reduce bias.

Results: The most common type of IUD complication was caudal dislocation in the lower uterine segment (LUS) and/or cervix, with or without an embedment, occurring in 41 patients (83.67%). The presence of submucosal and/or intracavitary uterine fibroids (vs other fibroid location or no fibroids) was positively associated with IUD misplacement and dislocation: AOR = 19.24, 95% CI: 1.42–260.23, *p* = 0.03. The presence of sonographic features of adenomyosis was positively associated with IUD dislocation, AOR = 7.40, 95% CI: 2.71–20.24, *p* < 0.0001. Both narrow (<30 mm) and wide (>32 mm) uterine cavity transverse diameters of the fundus assessed in the coronal plane increased the odds of a displaced IUD (vs a diameter of 30–32 mm): narrow diameter AOR = 4.95 (95% CI: 1.41–17.36, *p* = 0.013), and wide diameter AOR = 5.44 (95% CI: 1.39–21.22, *p* = 0.015). The AOR for IUD dislocation for a uterine cavity length of <30 mm (vs 30 mm or greater) was 3.60, 95% CI: 1.40–9.21, *p* = 0.008. Copper-containing IUDs (TCu380A/ParaGard®) were displaced more frequently than other types of IUDs: AOR = 2.82, 95% CI: 1.04–7.65, *p* = 0.04.

Conclusion: Our data confirm that 3D ultrasound is the method of choice for IUD localization and can be used for the objective selection of candidates for intrauterine contraception.

Keywords: Intrauterine device displacement, Quality improvement, Risk factors for intrauterine device displacement, Three-dimensional ultrasound, Uterine cavity diameter.

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INTRODUCTION

It is well known that a significant discrepancy between the size of the uterine cavity and the size of the IUD can cause complications such as expulsion, perforation, dislocation, and embedment, which are manifested by abnormal uterine bleeding (AUB) and pelvic pain, commonly leading to IUD removal.^{1–4} Because IUD dislocation is associated with decreased contraceptive effectiveness, its early diagnosis is critical.⁵ Although IUDs are very effective in the prevention of pregnancies, higher discontinuation and failure rates of IUDs lead to increased unintended pregnancies, especially in adolescent patients.^{4,6–10} Previous studies have reported IUD displacement rates of up to 25%.^{5,11} The discontinuation rate was noted to be as high as 45% at the end of the 1st year of ParaGard or LNG-IUS use, with no difference between the types of IUD.⁴ We believe that these complications could be minimized by an appropriate selection of the candidates before IUD insertion.

Preparation for IUD placement includes a thorough history to exclude the symptoms of an ongoing pelvic infection (e.g., presence of mucopurulent discharge and cervical motion tenderness, consistent with cervicitis). A bimanual examination assessing the uterine size, mobility and position, and cervix inspection are mandatory. Patients with uterine enlargement and a history of AUB are commonly directed to the pelvic ultrasound to rule out the uterine cavity distortion by submucosal and/or intracavitary

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fibroids, or the presence of other uterine cavity abnormalities. Unfortunately, routine bimanual pelvic examinations and 2D pelvic ultrasound are not accurate in ruling out uterine cavity distortion by a small submucosal and/or intracavitary lesion or congenital uterine anomaly, nor do they assess the uterine cavity size, which is the principal determining factor for the tolerability of IUD within the uterine cavity.^{12,13}

Patients with a history of a recurrent pregnancy loss require a detailed evaluation of the uterine anatomy because distortion of the uterine cavity by a congenital uterine defect, submucosal, or intracavitary abnormality render these women unsuitable candidates for the use of intrauterine contraception.

Our 3D ultrasound study aimed to assess and compare the uterine cavity anatomy and morphology of the patients with IUD malposition and dislocation with women whose IUD was in a normal location. In addition to a qualitative assessment, we aimed to determine the relationship between 3D ultrasound measurements of the uterine cavity, expressed by UCTD, UCL, and CL, and the odds of IUD misplacement and dislocation in patients who presented in our ultrasound clinic. On the basis of the outcomes of the study, we propose an algorithm for a systematic preprocedural evaluation of IUD candidates consisting of a history taking, a clinical evaluation, and a 3D ultrasound assessment of the uterine cavity to determine patients at risk for IUD misplacement and dislocation.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board for the Protection of Human Subjects of Texas Tech University Health Sciences Center El Paso (TTUHSC El Paso). We reviewed the medical records and ultrasound images of women who had a 3D pelvic ultrasound for localization of the IUD from January 1, 2016 to March 1, 2018, at the TTUHSC El Paso Department of Obstetrics and Gynecology Clinic. The study population included women who had a 3D ultrasound examination performed at 4–6 weeks after IUD insertion for surveillance, which is a common clinical practice in our department. The data on the following variables were collected by a review of medical records: age, body mass index (BMI), gravidity, parity, number of cesarean deliveries (CD), vaginal deliveries, type of IUD, the indication of IUD insertion, difficulty at the time of the IUD insertion, duration since last childbirth, and symptoms after insertion (AUB or abdominal/pelvic pain) (Table 1).

A 3D pelvic ultrasound was performed using the Voluson E8 ultrasound system (GE Healthcare Technologies, Milwaukee, WI, USA) using a 5–9 MHz transvaginal transducer. 3D volume acquisition of the uterus in addition to 2D images was obtained for all patients who were scanned for IUD localization. A single, highly experienced examiner (S.K.P.) conducted 3D reconstruction and interpretation of each of the ultrasound images for all patients. 3D images were reconstructed offline to evaluate the position of the IUD in relation to the uterine cavity, endometrium distortion by fibroid and configuration of the uterus. The uterine cavity was rendered in a coronal view to demonstrate the position of the entire IUD, taking care to visualize the outer edges of the actual arms.

Uterine morphology information (including the position of the uterus, and uterine dimensions in the longitudinal, anteroposterior, and transverse planes) was assessed by 3D multiplanar imaging. Using the volumetric data acquired from 3D ultrasound, the uterus was displayed in its coronal plane, enabling the assessment of the uterine fundal contour and uterine cavity anatomy, as well as the acquisition of the UCTD, UCL, and CL measurements (Fig. 1). Associated congenital uterine anomalies and lesions such as uterine fibroids and adenomyosis were visualized and recorded. Adenomyosis was diagnosed if two or more sonographic markers were present (heterogeneous myometrium with echogenic linear striations and posterior shadowing, loss of endometrial–myometrial interface, asymmetrical myometrial thickening, and presence of myometrial cysts).¹⁴

The IUD was determined to be in “normal position” if it was entirely within the confines of the uterine cavity and not lower than 4 mm from the fundal endometrium.⁹ In normally positioned IUDs, both arms are extended towards cornua, and neither the arms or the stem should extend into the myometrium. Dislocation of the IUD was considered to be present if any part of the IUD was seen past the confines of the uterine cavity.

Displacement encompassed the definition of IUD misplacement and dislocation, and included the following criteria: (1) complete expulsion; (2) complete perforation leading to migration of IUD into the abdominal cavity; (3) embedment of one or two arms or stem in the myometrium without extension through the serosa in the upper uterine segment; (4) IUD dislocation in the lower uterine segment (LUS); (5) IUD dislocation in the cervix; (6) IUD dislocation in the LUS and cervix; and (7) IUD dislocation and embedment in the

Table 1: Characteristics of 157 women with IUD inserted, 49 patients with IUD dislocation, and 108 patients with IUD in place

Characteristic	Displaced IUD (N = 49)	IUD in normal position (N = 108)	p value
Age, mean years (SD)	32.6 (9.2)	30.1 (7.9)	0.08
Body mass index, mean kg/m ² (SD)	30.6 (6.4)	29.8 (6.3)	0.50
Smoker, N (%)			0.19
Yes	6 (12.2)	6 (5.6)	
No	43 (87.8)	102 (94.4)	
Indication for IUD, N (%)			0.04
AUB only	13 (26.5)	13 (12.0)	
Contraception only	35 (71.4)	86 (79.6)	
AUB and contraception	1 (2.0)	9 (8.3)	
Nulligravida, N (%)	4 (8.2)	15 (13.9)	0.31
History of CD, N (%)	22 (44.9)	29 (26.9)	0.03

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Characteristic	Displaced IUD (N = 49)	IUD in normal position (N = 108)	p value
Uterine position, N (%)			0.39
Anteverted	36 (73.5)	86 (79.6)	
Retroverted	13 (26.5)	22 (20.4)	
Uterine cavity transverse diameter, N (%)			<0.0001
<30 mm	24 (49.0)	49 (45.4)	
30–32	4 (8.2)	42 (38.9)	
>32	21 (42.9)	17 (15.7)	
Uterine cavity length, N (%)			<0.0001
<30 mm	29 (59.2)	28 (25.9)	
≥30	20 (40.8)	80 (74.1)	
Cervical length, mean mm (SD)	39.4 (2.9)	37.3 (3.3)	0.0002
Distortion of uterine cavity present (including arcuate uterus), N (%)	11 (22.5)	1 (0.93)	<0.0001
Location of first uterine fibroid*, N (%)			0.001
Submucosal and/or intracavitary	6 (12.2)	1 (0.9)	
Intramural distorting the cavity	3 (6.1)	0 (0.0)	
Subserosal/intramural not distorting the cavity	2 (4.1)	7 (6.5)	
No fibroid	38 (77.6)	100 (92.6)	
Location of second uterine fibroid*, N (%)			0.12
Submucosal and/or intracavitary	0 (0.0)	0 (0.0)	
Intramural distorting the cavity	2 (4.1)	0 (0.0)	
Subserosal/intramural not distorting the cavity	1 (2.0)	2 (1.9)	
No fibroid	46 (93.9)	106 (98.2)	
Adenomyosis, N (%) (sonographic evidence)	27 (55.1)	13 (12.0)	<0.0001
Type of IUD, N (%)			0.02
ParaGard®	21 (42.9)	27 (25.0)	
Mirena®	19 (38.8)	39 (36.1)	
Liletta®	8 (16.3)	41 (38.0)	
Skyla®	1 (2.0)	1 (0.9)	

CD, cesarean delivery; AUB, abnormal uterine bleeding; SD, standard deviation; N, number; *five patients had two uterine fibroids

LUS and/or cervix (Fig. 2). Criteria 4–6 implied that the IUD moved to the LUS and/or endocervical canal with no signs of the arm(s) or stem embedment in the myometrium. While caudal IUD dislocation typically occurs during the postinsertion period, perforation and

embedment (criteria 2, 3 and 7) usually take place at the time of insertion (misplacement), and require immediate evaluation by the pelvic ultrasound. Difficult or incomplete IUD removal is another indication for ultrasound imaging to rule out embedment, retention, and/or fragmentation of an IUD within the myometrium and/or cervix. Although routinely performed, this indication for ultrasound assessment is out of the scope of this publication and is not discussed in this manuscript.

Fig. 1: Uterine cavity measurements obtained in the coronal plane of the uterus

Statistical Analysis

Data were analyzed using SAS 9.4 software (SAS Institute, Inc., Cary, North Carolina, USA). A case-control study was conducted. Cases were patients who had a displaced IUD, while controls were patients whose IUD were not displaced. Means and standard deviations were calculated for continuous variables and reported for cases and controls along with *p* values from two-sample *t* tests. For categorical variables, the counts and percentages by case status were calculated and chi-square or Fisher's exact tests were performed as appropriate. Two-sided testing with a significance level of 0.05 was used for all analyses.

Adjusted odds ratios (OR), 95% confidence intervals (CI), and *p* values were calculated from multiple logistic regression models. Independent variables deemed to be of clinical significance were included in the model. Our study dataset did not contain a

Figs 2A to C: Illustrations of different types of caudal IUD displacement: (A) IUD in the lower uterine segment and cervix, with no evidence of embedment; (B) IUD in the lower uterine segment and cervix, embedding myometrium with both arms; (C) IUD in the lower uterine segment and cervix, embedding posterior myometrium with one arm

race/ethnicity variable; however, confounding by the patient's ethnicity is unlikely, given that the majority of the patients seen in our clinic are of Hispanic ethnicity. Two logistic regression models were fit: one with a dichotomous gravidity variable (nulligravida: yes vs no) and one without the nulligravida variable. Tolerances were calculated to determine if a harmful level of correlation, known as multicollinearity, was present among the independent variables.¹⁵ The area under the receiver operating characteristic curve was calculated for the final logistic regression model.¹⁶

For continuous independent variables, the logistic regression model assumes that the logit is linear in the variable.¹⁶ This assumption was assessed by inspecting logit plots.¹⁷ If this assumption was violated, then appropriate groups/categories were created, and the variable was entered into the model using dummy variables.

Given the high number of independent variables relative to the number of cases in our study, the occurrence of sparse data bias was a possibility.¹⁸ Penalized maximum likelihood estimation is one method that is used to address the situation in which there are many independent variables but few outcome events.^{19,20} We used Firth's bias-reducing penalized likelihood to minimize the risk of sparse data bias.^{18,20}

Given the small number of records that had missing values for the variables that were included in our logistic regression models, a complete-case analysis, rather than multiple imputation for missing values, was performed. Our final sample was restricted to one record per patient. To clarify, if a patient had two episodes of care during the study period, then only the first episode of care was included in our study.

RESULTS

The initial sample included 171 records. Six records were deleted because they represented a second episode of care in the same patient. Of the remaining 165 patients, 53 women were classified as cases, and 112 were classified as controls. After deleting the records of patients who had missing values for the variables under study, the final sample size was 157 patients. Uterine cavity reconstruction was successful in all of the 157 subjects, and 108 of them were noted to have a normally placed IUD (the controls) and 49 were diagnosed with IUD dislocation (the cases).

Table 1 reports demographic and clinical characteristics of the study population along with *p* values from univariate analyses. The study population was young, with a mean age of 32.6 years and 30.1 years for cases and controls, respectively ($p = 0.08$). The mean BMI, and the distribution of smoking status, nulligravida, uterine position, and presence/location of a second fibroid were not significantly different between cases and controls. Cases were more likely than controls to have undergone one or more CD ($p = 0.03$).

The UCTD, UCL, and CL were originally recorded as continuous variables. Inspection of the logit plots revealed a roughly U-shaped distribution for the UCTD and UCL (data not shown), and hence, these variables were converted to categorical variables (Table 1).

The frequency distribution of the type of IUD misplacement and dislocation in the 49 cases was as follows: complete expulsion: 2 (4.1%), complete perforation: 1 (2.0%), incomplete perforation in the upper uterine segment: 5 (10.2%), dislocation in the LUS: 8 (16.3%), dislocation in the cervix: 3 (6.1%), dislocation in the LUS and cervix (Figs 3A to C): 12 (24.5%; one of these 12 patients had a fragmented IUD), and IUD dislocation and embedment in the LUS and/or cervix: 18 (36.7%).

Adjusted ORs for IUD misplacement and dislocation are found in Table 2. These ORs were calculated from a logistic regression model that used Firth's bias-reducing penalized likelihood. The area under the receiver operating characteristic curve was 0.89, which indicates that the logistic regression model had an excellent ability to discriminate between those patients who did and did not have a displaced IUD.¹⁶ Each of the ORs in Table 2 is adjusted for the remaining variables found in the table. The presence of submucosal and/or intracavitary fibroids (vs fibroids in other locations or no fibroids) increased the odds of IUD misplacement and dislocation: adjusted OR = 19.24, 95% CI: 1.42–260.23, $p = 0.03$.

Patients with dislocated IUDs were 7.4 times as likely as controls to have sonographic evidence of adenomyosis ($p < 0.0001$). Both a small UCTD (<30 mm) and a large UCTD (>32 mm) increased the odds of IUD caudal dislocation about fivefold relative to the referent category of 30–32 mm. The odds of a patient having a displaced IUD increased by 23% for each 1 mm increase in CL: adjusted OR = 1.23, 95% CI: 1.05–1.44, $p = 0.01$.

A second multiple logistic regression model was also fit (data not shown). This model contained all of the independent variables

Figs 3A to D: Uterine cavity coronal planes of the unsuitable candidates for the use of intrauterine contraception: (A) Extremely wide uterine cavity; (B) Infantile type of the uterine cavity; (C) Submucosal/intracavitary fibroid; (D) Arcuate uterus

shown in Table 2 plus a dichotomous gravidity variable, nulligravida (yes vs no). The adjusted OR for a displaced IUD for nulligravida was 1.25 (95% CI: 0.29–5.34, $p = 0.77$). Given that most of the adjusted ORs of the variables shown in Table 2 were similar to those calculated from the second logistic regression analysis, the first logistic regression model was chosen as the final model as it was the most parsimonious.

DISCUSSION

The 3D pelvic ultrasound is superior to the conventional 2D ultrasound for evaluation of the uterine cavity owing to multiplanar imaging, surface rendering, and visualization of the coronal plane, leading to a precise assessment of the uterine abnormalities, congenital uterine anomalies, and accurate localization of the IUD. On the conventional 2D ultrasound, in the longitudinal plane, the copper IUD is visualized as a highly echogenic linear structure, and in the transverse plane, the arms are visualized as fully echogenic symmetrical echoes.^{21,22} Because the arms of the LNS-IUS are echogenic only in the proximal and distal ends, the evaluation of the arm positioning by 2D imaging is commonly misleading. Owing to multiplanar imaging and visualization of the coronal plane, the 3D ultrasound leads to more accurate localization of the LNG-IUS.^{11,21–23}

In our study, 3D reconstruction enabled visualization of all parts of the IUD in every patient, independently on the type of the IUD and uterine position (122 anteverted vs 35 retroverted uteri). Furthermore, the position of the uterus (anteverted vs retroverted) did not affect the odds of IUD misplacement and dislocation.

Table 2: Adjusted odds ratios (OR)[†] for a displaced IUD in 157 patients[‡]. Calculated from a multiple logistic regression model using Firth's penalized likelihood

Possible risk factor	OR	95% confidence interval	p value
Indication for IUD insertion			
AUB only or AUB and contraception	0.73	0.23–2.37	0.60
Contraception only	1	(Referent)	–
Fibroid location			
Submucosal and/or intracavitary	19.24	1.42–260.23	0.03
Other location or no fibroids	1	(Referent)	–
Adenomyosis present (sonographic evidence)			
Yes	7.40	2.71–20.24	<0.0001
No	1	(Referent)	–
Uterine position			
Retroverted	0.99	0.33–2.97	0.98
Anteverted	1	(Referent)	–
Uterine cavity transverse diameter			
<30 mm	4.95	1.41–17.36	0.013
30–32	1	(Referent)	–
>32	5.44	1.39–21.22	0.015
Uterine cavity length			
<30 mm	3.60	1.40–9.21	0.008
≥30	1	(Referent)	–
Cervical length (for each 1 mm increase)	1.23	1.05–1.44	0.01
Type of IUD			
ParaGard®	2.82	1.04–7.65	0.04
Other type	1	(Referent)	–

[†]Each odds ratio is adjusted for the remaining variables found in the table

[‡]49 cases were compared to 108 controls. AUB, abnormal uterine bleeding; IUD, intrauterine device

Interestingly, one complete perforation occurred in a patient with anteverted retroflexed uteri with suspected endometriosis, and a history of two CDs.^{24,25}

Moshesh et al. found that patients with the IUD in the LUS and/or cervix were more likely to have a higher BMI than patients with a normally positioned IUD.²⁶ The majority of our 49 cases (83.7%) had experienced dislocation in the LUS and/or cervix. Our univariate analysis did not detect an association between BMI and having a displaced IUD. Interestingly, ParaGard IUDs were more frequently displaced compared to other types of IUDs.

Our study compared the uterine cavity shape, UCTD, UCL, and CL in 108 patients with normal and 49 abnormal IUD location. We noted an increased odds of IUD misplacement and dislocation when the UCTD was <30 mm or >32 mm, with adjusted ORs of 4.95 and 5.44, respectively (Figs 3A and B). A voluminous uterine cavity with a transverse diameter greater than the IUD size increased the risk of expulsion or dislocation (Fig. 3A). Shipp et al. found that women with an embedded IUD have a narrower uterine width compared to those with correctly placed devices: the mean $\pm$ SD values of the fundal uterine cavity for the non-embedded and embedded IUDs were 32 ± 1.0 and 25 ± 0.8 mm, respectively ($p = 0.0003$).³ Liang et al. noted a higher rate of expulsion if the maximum transverse diameter of the uterus was ≥ 37 mm cavity width for TCu380a users.²⁷ In our study, a UCL of <30 mm more than tripled the odds of IUD dislocation after controlling for the presence/location of uterine fibroids, uterine position, and other variables. Bahamondes et al. found no association between the UCL and IUD expulsion; however, they did not control for any confounders in their statistical analysis.²⁸

The most common type of IUD complication was caudal dislocation in the LUS and/or cervix, with or without an embedment, occurring in 41 patients (83.67%). After controlling for the uterine position and other variables, the presence of submucosal and/or intracavitary uterine fibroids (vs other fibroid location or no fibroids) was positively associated with IUD dislocation. Uterine cavity distortion was noted mostly from submucosal and/or intracavitary fibroids (Fig. 3C), followed by intramural fibroids impinging the uterine cavity and congenital uterine anomalies, arcuate uteri, in two patients (Fig. 3D and Table 1). Zapata et al. also reported higher rates of IUD dislocation and expulsion in women with uterine fibroids.²⁹

In addition to previously identified risk factors for dislocation, we found a significant positive association between IUD dislocation and sonographic evidence of adenomyosis (AOR = 7.40, 95% CI: 2.71–20.24, $p < 0.0001$). A possible explanation for this finding is dysfunctional myometrial contractility and hyperperistalsis of the ultra-structurally changed smooth muscle cells in patients affected with adenomyosis.³⁰

Strengths of our study are that 3D ultrasound evaluation and measurement of the uterine cavity was performed by an experienced sonographer with special skills in female pelvic sonography and 3D imaging required to perform a 3D reconstruction. An additional strength was the use of a statistical technique known as penalized maximum likelihood estimation, which was employed to reduce the risk of sparse data bias. The major limitation of our study is the possibility of selection bias. Correction of selection bias is possible if external data are available; however, this additional (external) data are rarely available in practice.³¹

In academic institutions and primary care facilities, the common failures of IUD services pertain to an inconsistent

selection of the candidates during the preprocedural evaluation. To improve the quality, safety, and efficiency of IUD placement, we propose that primary care providers and resident physicians be trained to recognize patients who are at risk of IUD misplacement and malposition and who may benefit from the preinsertion 3D pelvic ultrasound as a part of a systematic assessment, which includes a preprocedural history taking, clinical evaluation, and counseling. We believe that objective uterine cavity assessment and measurement in these patients may reduce long-term costs by preventing complications and adverse health outcomes.

CONCLUSION

Our results indicate that candidates for intrauterine contraception presenting with uterine and adnexal enlargement, AUB, and history of recurrent pregnancy loss may benefit from preinsertion assessment by the 3D pelvic ultrasound. Patients presenting with AUB and pain during the postinsertion period require evaluation by the 3D pelvic ultrasound, as well as patients with difficult or incomplete IUD removal.

3D ultrasound is superior to the conventional 2D ultrasound for accurate localization of the IUD. Pre-insertion 3D ultrasound can detect patients who are at risk of IUD complications such as misplacement and dislocation due to distortion of the uterine cavity (e.g., presence of submucosal and/or intracavitary fibroids), abnormal uterine position (e.g., anteverted retroflexed uterus), abnormal echotexture of the myometrium (e.g., sonographic evidence of adenomyosis), and abnormal anatomy of the uterine cavity (e.g., presence of congenital uterine anomalies).

Uterine cavity measurements by the 3D ultrasound in the coronal plane can detect a discrepancy between the size of the uterine cavity and the size of the IUD, which can cause complications such as dislocation, embedment, perforation, compression, or expulsion, which are manifested by AUB and pelvic pain, commonly leading to IUD removal.

We propose the following algorithm for the utilization of the 3D ultrasound to assess the suitability of the uterine cavity: (1) obtain a coronal plane of the uterine cavity prior to IUD insertion if the patient has a history of AUB or uterine fibroids if there is a suspicion of a congenital uterine anomaly, and if there is a history of previous IUD expulsion or dislocation. Preprocedural 3D ultrasound should be recommended for all adolescent patients. (2) Consider alternate methods of contraception if there is uterine cavity distortion by uterine fibroids or congenital uterine anomaly and/or the UCTD is <30 mm or >32 mm. (3) Ultrasound-guided IUD insertion is recommended if the patient has a history of any of the following: CD, previous IUD expulsion, failed standard attempt due to cervical stenosis, unfavorable uterine position, and the Asherman syndrome.

Finding suitable candidates for IUD insertion by the preprocedural 3D transvaginal ultrasound may reduce the side effects and discontinuation rate, which will outweigh the additional cost associated with the preprocedural 3D ultrasound.

A cost-benefit analysis involving studies with a larger sample size evaluating the role of 3D ultrasound before or at the time of IUD insertion in the reduction of the frequency of complications, failures, and dissatisfaction with IUDs is required.

Despite the widespread movement towards precision medicine, little consideration has been placed on the differences in uterine cavity shape and biometry before IUD insertion. Given

the noncontraceptive benefits of LNG-IUS, the number of potential users, especially adolescent and nulliparous patients, has increased over time. These young patients are especially vulnerable to possible complications due to the injudicious use of intrauterine contraception. It is expected that in the not-to-distant future, the use of artificial intelligence will enable an automated or semi-automated volumetric measurement of the uterine cavity, leading to the appropriate selection of the candidates for the intrauterine contraception.

AUTHORS' CONTRIBUTION

SA and SKP conceived and designed the study; SA and TNN collected and entered the data; SA and SKP interpreted the clinical findings; ZDM analyzed the data; all the authors participated in drafting the manuscript. All the authors read and approved the final manuscript.

PATIENT CONSENT FORM

Not applicable (our article does not contain personal medical information that would identify individuals).

ETHICS APPROVAL

This study was approved by the Institutional Review Board (IRB) for the Protection of Human Subjects of Texas Tech University Health Sciences Center El Paso (IRB # E18076).

DATA SHARING STATEMENT

Reasonable requests to access study data should be sent to the corresponding author.

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