



ROLE OF MRI IN EVALUATION OF UTERINE ANOMALIES AND ITS COMPARISONS WITH USG.

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ABSTRACT

Introduction: Female genital tract anomalies account for approximately 8 to 10% recurrent pregnancy loss. Incidence of Müllerian duct anomalies (MDAs) is approximately 1% in general population and it is approximately 3% in patients with infertility. Such anomalies lead to multiple obstetric & gynecological problems. Many of the anomalies are initially diagnosed at **Hysterosalpingography(HSG)** and **Ultrasonography(USG)**, however further imaging is often required for definitive diagnosis and elaboration of secondary findings. At this time, **Magnetic resonance imaging(MRI)** is the study of choice because of its high accuracy and detailed elaboration of uterovaginal anatomy and accuracy in classifying uterine anomalies. **Aims & objective:** 1. To evaluate the role of MRI in diagnosis of Uterine anomalies.

2. To allow proper classification of Uterine anomalies by MRI.

3. To allow accurate morphologic demonstration of Uterine anomalies by MRI better than other imaging modalities (USG and HSG). 4. To better delineate associated uterine pathology and renal anomalies by MRI. **Material & method:** During the period of October 2018 to October 2020, a prospective study of thirty patients was carried out. All the patients were referred from the Obstetrics and Gynecology department to the Radiology department. All patients were included after meeting the inclusion criteria which depends on clinical suspicion and/or ultrasonography (trans-abdominal and/or trans-vaginal ultrasonography) data. All these included patients underwent MRI pelvis examination. **Result:** Uterine anomalies were diagnosed most commonly in 23-27 years age group. The most common main clinical presentation was repeated miscarriages which included 10(33%) patients. MRI findings based most commonly diagnosed class of uterine anomalies is class V septate uterus which includes 10 (33%) patients. **Conclusion:** MRI examination of the pelvis fulfills the demands for accurate diagnosis of all classes of MDA in females at a reproductive age. It could be considered the corner stone in diagnosis and characterization of all classes with no use of ionizing radiation or vigorous techniques. Overall MRI was more accurate than USG in evaluating uterine anomalies, associated renal anomalies and associated uterine pathologies.

KEYWORDS : Uterine anomalies, Female genital tract anomalies

INTRODUCTION

The prevalence of female genital tract anomalies is 4%–7% in general population and up to 8%–10% in women who have recurrent pregnancy loss. Incidence of Müllerian duct anomalies (MDAs) is approximately 1% in general population and it is approximately 3% in patients with infertility.^{1,2}

Uterine anomalies (UAs) result from non development or non fusion of mullerian ducts.

They are associated with high incidence of decreased fertility and multiple obstetric problems (recurrent pregnancy loss, preterm delivery, malpresentation or uterine rupture).³

Many of the anomalies are initially diagnosed at **Hysterosalpingography(HSG)** and **Ultrasonography(USG)**; however further imaging is often required for definitive diagnosis and elaboration of secondary findings. At this time, Magnetic resonance imaging(MRI) is the study of choice because of its high accuracy and detailed elaboration of uterovaginal anatomy and accuracy in classifying uterine anomalies.⁴Laparoscopy and hysteroscopy is reserved for women in whom interventional therapy is likely to be undertaken.

AIMS & OBJECTIVE

1. To evaluate the role of MRI in diagnosis of Uterine anomalies.

2. To allow proper classification of Uterine anomalies by MRI.

3. To allow accurate morphologic demonstration of Uterine anomalies by MRI better than other imaging modalities (USG and HSG).

4. To better delineate associated uterine pathology and renal anomalies by MRI.

MATERIAL & METHOD

During the period of October 2018 to October 2020, a prospective study of thirty patients was carried out. All the patients were referred from the Obstetrics and Gynecology department to the Radiology department. All patients were included after meeting the inclusion criteria which depends on clinical suspicion and/or ultrasonography (trans-abdominal and/or trans-vaginal ultrasonography) data. All these included patients underwent MRI pelvis examination.

1. INCLUSION CRITERIA

Patients with a history of primary amenorrhea, repeated miscarriage, dysmenorrhea, irregular menstrual cycle or severe recurrent abdominal pain and/or abnormal gynecological ultrasonography.

2. EXCLUSION CRITERIA

Patients with normal ultrasonography and no clinical suspicion.

All patients underwent:

1. Full history taking with special emphasis on menstrual and obstetric history.
2. Ultrasonographic examination either abdominal and/ or transvaginal using USG machine with convex probe (3.75MHz frequency) and TVS probe (6 MHz frequency).
3. MRI examination of the pelvis using Siemens Magnetom Essenza 1.5 Tesla MRI machine.
4. Hysteroscopy and/or Laparoscopy for confirmation.

A written informed consent in vernacular language was taken from all the patients.

Technique of MRI examination

The following MRI sequences were performed in all patients:

- An inversion-recovery image of the uterus in the sagittal plane was obtained initially to determine uterine lie. Fast spin-echo (FSE) T2-weighted images were then acquired parallel to the long axis of the uterus to characterize the external uterine contour in coronal plane, depending on uterine lie.
- For the purpose of MDA classification, coronal oblique T2-weighted images of the uterus were the most critical, since these were necessary for proper assessment of the uterine fundal contour. Finally, a coronal fast-spin gradient-echo image or a single-shot fast spin-echo T2-weighted image was obtained by using the body coil, with a large field of view to enable assessment of the kidney.
- Imaging parameters are demonstrated in below table.

MRI SEQUENCES USED IN THE STUDY

Sequence	TR (msec.)	TE (msec.)	FOV (mm)	Matrix	Slice thickness(mm)
T2 sagittal	3000	90	290×290	208×205	4
T2 axial	3700	100	288×350	292×180	5
T1 axial	500	10	260×216	263×171	5
T2 coronal	5000	90	300×300	272×200	4.5

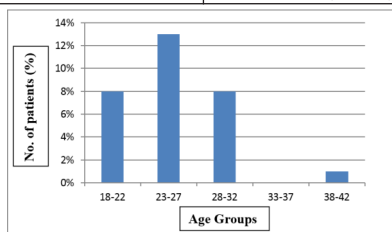
- **Image analysis:** MRI data were collected regarding: presence or absence of uterus, uterine size and differentiation of its zonal anatomy, external fundal contour evaluation, measuring inter-cornual distance, presence of any uterine or vaginal septum, type of the septum, associated pelvic lesions or renal anomalies. Patients were diagnosed according to classification of American Society of Infertility.

RESULT

A prospective study of 30 female patients was done. Age wise distribution of patients is given in the table below.

Table 1: Age Wise Distribution Of The Study Patients.

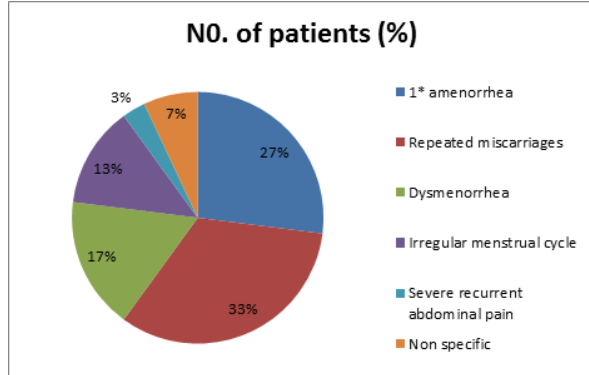
AGE(YEARS)	TOTAL
18-22	08(27%)
23-27	13(43%)
28-32	08(27%)
33-37	00(00%)
38-42	01(03%)
TOTAL	30(100%)



Over all, Uterine anomalies were diagnosed most commonly among age group 23-27 years, which included 13(43%) patients.

Table 2: Main Clinical Presentation Based Distribution Of The Study Patients

1* Amenorrhea	08(27%)
Repeated miscarriages	10(33%)
Dysmenorrhea	05(17%)
Irregular menstrual cycle	04(13%)
Sever recurrent abdominal pain	01(03%)
Non specific	02(07%)
TOTAL	30(100%)



The most common main clinical presentation was repeated miscarriages which included 10(33%) patients.

Table 3: Usg Findings Based Distribution Of Study Patients.

USG FINDINGS	NO. OF PATIENTS
Absent uterus	05(17%)
Hypoplastic uterus	02(07%)
Unicornuate uterus	02(07%)
Uterine didelphys	01(03%)
Bicornuate uterus	07(23%)
Septate uterus	05(17%)
Arcuate uterus	01(03%)
Normal uterus	07(23%)
TOTAL	30(100%)

USG findings wise most commonly diagnosed uterine anomaly was bicornuate uterus which included 07 (23%) patients.

02(07%) patients out of 30(100%) patients showed associated renal anomalies (cross fused ectopic pelvic kidneys, bilateral malrotated kidneys).

01(03%) patient out of 30(100%) patients showed associated uterine pathology (fibroid).

Table 4: Mri Findings Based Distribution Of Study Patients.

MRI FINDINGS	NO. OF PATIENTS
Absent uterus	04(13%)
Hypoplastic uterus	03(10%)
Unicornuate uterus	02(07%)
Unicornuate uterus with non communicating rudimentary horn	01(03%)
Uterus didelphys	02(07%)
Bicornuate uterus	06(20%)
Septate uterus with incomplete septum	05(16%)
Septate uterus with complete fibrous septum	03(10%)
Septate uterus with complete muscular septum	02(07%)
Arcuate uterus	02(07%)
TOTAL	30(100%)

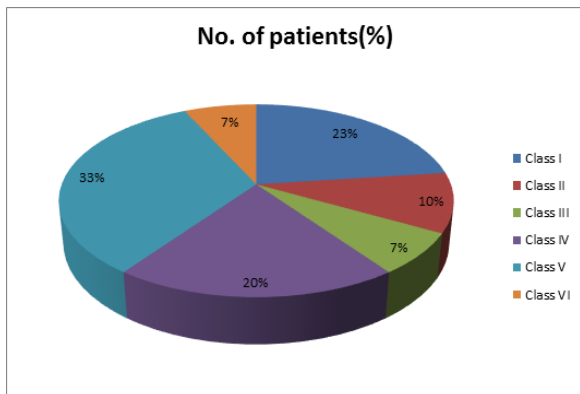
MRI findings wise most commonly diagnosed uterine anomaly was septate uterus which included 10 (33%) patients.

03(10%) patients out of 30(100%) patients showed associated renal anomalies (cross fused ectopic pelvic kidneys, bilateral malrotated kidneys and horseshoe kidney).

02(07%) patient out of 30(100%) patients showed associated uterine pathology (fibroid and adenomyotic uterus).

Table 5: American Society Of Infertility Classes Wise Distribution Of Study Patients Depending On Mri Findings.

CLASSES	NO. OF PATIENTS
Class I:	07(23%)
• Absent uterus	• 04(13%)
• Hypoplastic uterus	• 03(10%)
Class II:	03(10%)
• Unicornuate uterus	• 02(07%)
• Unicornuate uterus with non communicating rudimentary horn	• 01(03%)
• Unicornuate uterus with non communicating functional horn	• 00(00%)
Class III: Uterine didelphys	02(07%)
Class IV: Bicornuate uterus	06(20%)
Class V:	10(33%)
• Septate uterus with incomplete septum	• 05(16%)
• Septate uterus with complete fibrous septum	• 03(10%)
• Septate uterus with complete muscular septum	• 02(07%)
Class VI: Arcuate uterus	02(07%)
TOTAL	30(100%)



MRI findings based most commonly diagnosed class of uterine anomalies was class V septate uterus which includes 10 (33%) patients.

Table 6: Hysteroscopy And/or Laparoscopy Findings Wise Distribution Of Study Patients.

HYSTEROSCOPY AND/OR LAPAROSCOPY FINDINGS	NO. OF PATIENTS
Absent uterus	04(13%)
Hypoplastic uterus	03(10%)
Unicornuate uterus	02(07%)
Unicornuate uterus with non communicating rudimentary horn	01(03%)
Uterine didelphys	02(07%)
Bicornuate uterus	06(20%)
Septate uterus with incomplete septum	05(16%)
Septate uterus with complete fibrous septum	03(10%)
Septate uterus with complete muscular septum	02(07%)
Arcuate uterus	02(07%)
TOTAL	30(100%)

Hysteroscopy and/or Laparoscopy findings wise most commonly diagnosed uterine anomaly was septate uterus which included 10 (33%) patients.

Table 7: Comparison Between Usg And Mri Findings Of Study Patients.

FINDINGS	NO. OF PATIENTS ON USG	NO. OF PATIENTS ON MRI
Absent uterus	05(17%)	04(13%)
Hypoplastic uterus	02(07%)	03(10%)
Unicornuate uterus	02(07%)	03(10%)
Uterine didelphys	01(03%)	02(07%)
Bicornuate uterus	07(23%)	06(20%)
Septate uterus	05(17%)	10(33%)
Arcuate uterus	01(03%)	02(07%)
Normal uterus	07(23%)	00(00%)
TOTAL	30(100%)	30(100%)

The USG findings were compared with MRI findings.

- In class I; one patient was diagnosed as uterine agenesis in USG, but a remnant of the uterine tissue was found in MRI hypoplastic.
- In class II; one patient showed normal uterus in USG, showed unicornuate uterus in MRI.
- In class III; one patient showed bicornuate uterus in USG, found to be uterus didelphys in MRI.
- In class V; five patients showed normal uterus in USG, found to have septate uterus by MRI.
- In class VI; one patient showed normal uterus on USG, found to have arcuate uterus on MRI.
- Associated renal anomalies were diagnosed in 02(07%) patients in USG, where as in 03(10%) patients in MRI.
- Associated uterine pathologies were diagnosed in 01(03%) patient in USG, where as in 02(07%) patients in MRI.

Table 8: Comparison Between Mri And Hysteroscopy And/or Laparoscopy Findings Of Study Patients.

FINDINGS	NO. OF PATIENTS ON MRI	NO. OF PATIENTS ON HYSTEROSCOPY AND/OR LAPAROSCOPY
Absent uterus	04(13%)	04(13%)
Hypoplastic uterus	03(10%)	03(10%)
Unicornuate uterus	02(07%)	02(07%)
Unicornuate uterus with non communicating rudimentary horn	01(03%)	01(03%)
Uterine didelphys	02(07%)	02(07%)
Bicornuate uterus	06(20%)	06(20%)
Septate uterus with incomplete septum	05(16%)	05(16%)
Septate uterus with complete fibrous septum	03(10%)	03(10%)
Septate uterus with complete muscular septum	02(07%)	02(07%)
Arcuate uterus	02(07%)	02(07%)
TOTAL	30(100%)	30(100%)

MRI findings were confirmed by Hysteroscopy and/or Laparoscopy. Findings on both MRI and hysteroscopy/laparoscopy were same for all the classes.

DISCUSSION

- In our study sensitivity for evaluating uterine anomaly of the USG is 70% and of MRI is 100% which is comparable to the Yasmin Mouner Tohamey et al study⁵ in which sensitivity of USG is 81% and of MRI is 100%.

Table 9: Comparison Of Sensitivity Of Mri And Usg Of Our Study For Evaluation Of Uterine Anomalies With Yasmin Mouner Tohamey Study.⁵

USG/MRI	SENSITIVITY(%)	
	OUR STUDY	YASMIN MOUNER TOHAMEY et al. STUDY ⁵
USG	70%	81%
MRI	100%	100%

- Transvaginal ultrasonography has been the foremost imaging modality for assessing the female genital tract for decades. Magnetic resonance imaging has extended the usefulness of imaging in evaluation of pelvic disorders in the last 10 years.
- Müllerian duct anomalies can cause reproductive problems in about 25% of women, including increased risk for spontaneous abortion, prematurity, intrauterine growth retardation, abnormal fetal lie, and dystocia at delivery. Accurate characterization of Müllerian duct anomalies is essential because pregnancy outcomes and treatment options vary between different classes of anomalies.
- In our study we found that in class I MDA, MRI with its excellent soft-tissue resolution and multiplanar imaging capabilities can accurately diagnose uterine agenesis via the detection of uterine absence. Infantile uterus can be easily diagnosed via measuring the inverted corpora-cervical ratio. This was concordant with what **Nadia et al.**, **Saleem et al.**, **Troiano et al.** and **Mueller et al.** stated in their reports.^{4,7,8,15}

Table 10: Comparison Of Detection Of Absent/ Hypoplastic Uterus By Mri In Our Study And Nadia Et Al. Study.⁸

ABSENT UTERUS/ HYPOPLASTIC UTERUS	OUR STUDY	NADIA et al. STUDY
Absent uterus	17%	12%
Hypoplastic uterus	07%	12%

- MRI proved to be accurate in the evaluation of zonal differentiation and the detection of the presence or absence of functioning endometrium. **Imaoka et al.**, **Pellerito et al.** and **Reinhold et al.** stated that it is important in patients with hypoplastic and unicornuate uterus to evaluate the function of uterine corpus and cervix to predict the future fertility and incidence of endometriosis.^{9,10,11}
- Pelvic MRI can detect associated renal anomalies which is the commonest secondary finding in patients with MDA specially class I. Variable renal anomalies such as fused crossed ectopia, malrotated kidneys and horseshoe kidney were reported in our study. This was concordant with multiple various studies such as by **Brody et al.** and others who stated that renal tract anomalies were associated with MDA in 30% of the cases and referred this to the close embryologic proximity of mesonephric and paramesonephric duct.¹²

Table 11: Comparison Of Renal Anomalies Association With Uterine Anomalies Between Our Study And Brody Et Al. Study.¹²

STUDY	ASSOCIATED RENAL ANOMALIES
OUR STUDY	10%
BRODY et al. STUDY ¹²	30%

- Hysterosalpingography (HSG) does not always allow reliable differentiation between septate and bicornuate anomalies because we cannot see the endometrium in HSG. On contrary to MRI, with its high morphological capabilities, accurate differentiation between septate, bicornuate and didelphic uterus can easily be achieved. Convex fundus was the corner stone in differentiation between septate from a bicornuate or didelphic uterus while extension of the septum into the cervical canal

differentiates didelphic from bicornuate or deeply septate. MR imaging helps confirming the presence of a bicornuate uterus by depicting a deep (> 1 cm) fundal cleft in the outer uterine contour and an intercornual distance of more than 4 cm which agreed with previous studies including **Steinkuehler et al.** and others.¹³

- Unicornuate uterus was the most difficult MDA to diagnose. Rudimentary horn, hematometra, endometriosis and complex renal anomalies were frequently seen associated. When rudimentary horn is non communicating it appears markedly distended and simulates the bicornuate uterus that was seen in one of our patients. This agreed with **Brody et al.** and **Steinkuehler et al.** who stated that unicornuate uterus is difficult to diagnose but MRI can help in the detection of the rudimentary horn and evaluation of its endometrium whether it is functioning or not.^{12,13}
- In our study we also found that the thickness of the septum and its signal in patients with septate uterus can differentiate between fibrous and muscular septum. This was amenable to **Nadia et al.**, **Pellerito et al.** and **Carrington et al.** who stated that these three different classes of anomalies must be differentiated from each other because they have a different treatment approach. Septate uterus requires septectomy, while a bicornuate or didelphic uterus does not. Also fibrous septum needs hysteroscopy resection while muscular septum necessitates a transabdominal metroplasty.^{8,9,14}

Table 12: Comparison Of Different Types Of Septum Detection In Septate Uterus By Mri Between Our Study And Nadia Et Al. Study.⁸

DIFFERENT TYPE OF SEPTUM IN SEPTATE UTERUS	OUR STUDY	NADIA et al. STUDY ⁸
Septate uterus with incomplete septum	16%	15%
Septate uterus with complete fibrous septum	10%	11%
Septate uterus with complete muscular septum	07%	06%

CONCLUSION

- Uterine anomalies were diagnosed most commonly in 23-27 years age group.
- The most common main clinical presentation was repeated miscarriages which included 10(33%)patients.
- MRI findings based most commonly diagnosed class of uterine anomalies is class V septate uterus which includes 10 (33%) patients.
- MRI examination of the pelvis fulfills the demands for accurate diagnosis of all classes of MDA in females at a reproductive age. It could be considered the corner stone in diagnosis and characterization of all classes with no use of ionizing radiation or vigorous techniques.
- Overall MRI was more accurate than USG in evaluating uterine anomalies, associated renal anomalies and associated uterine pathologies.
- All findings of MRI were comparable with findings of Hysteroscopy and/or Laparoscopy.

Images

CASE: A 21 year old female patient presenting with primary amenorrhea.(a)(b)

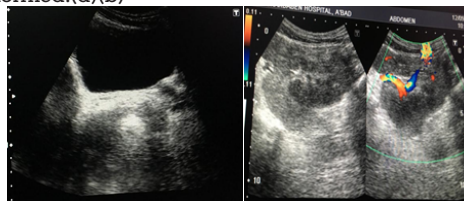


Figure: (a) & (b) TAS image showed no uterine tissue between

bladder anteriorly and rectum posteriorly; fused ectopic pelvic kidneys are well noted.

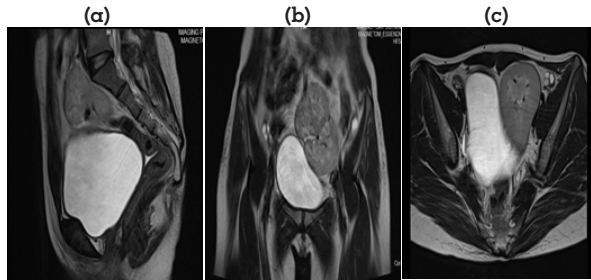


Figure: (a) Sagittal T2WI showed no uterine tissue between bladder anteriorly and rectum posteriorly; fused ectopic pelvic kidneys are well noted (b) Coronal T2WI showed no uterus; fused ectopic pelvic kidney; right ovary with multiple follicles is also noted. (c) Axial T2WI showed no uterus; fused ectopic pelvic kidneys; a left ovary with multiple follicles. Final diagnosis class I MDA (Rokitensky–Mayer syndrome).

CASE: A 32 year old female patient presenting with dysmenorrhea

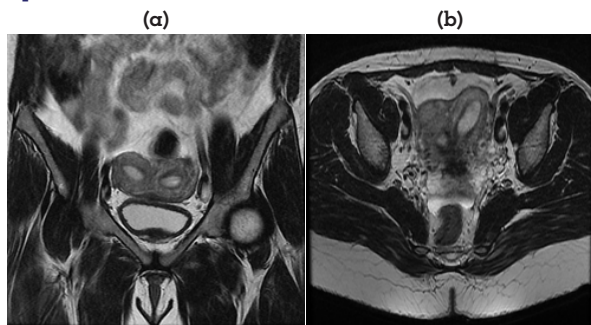


Figure: (a) Coronal & (b) axial T2WI images showed two uterine corpora with one cervix. Normal zonal anatomy is well demonstrated. Final diagnosis class IV MDA (bicornuate uterus).

CASE: A 25 year old female patient presenting with repeated miscarriages.

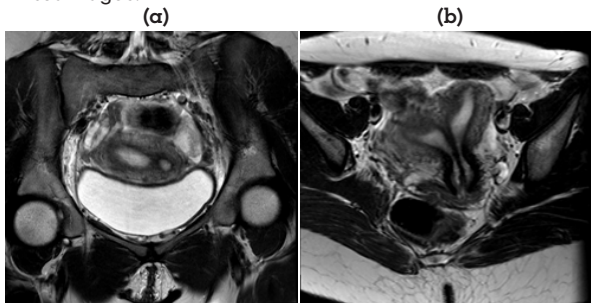


Figure: (a) Coronal & (b) Axial T2WI images showed deep complete muscular septum splitting the uterine cavity. The uterine fundus is seen broad and flattened. Final diagnosis class V MDA (septate uterus).

REFERENCE

1. Sotirios H. Saravelos; Karen A. Cocksedge; Tin-Chiu Li. "Prevalence and diagnosis of congenital uterine anomalies in women with reproductive failure: a critical appraisal". Human Reproduction Update. Volume 14, issue 5, 1 September 2008, pages 415-429.
2. 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. Human Reproduction update 2011; 17(6):761–771.
3. Devi Wold AS, Pham N, Arici A. Anatomic factors in recurrent pregnancy loss. Semin Reprod Med 2006; 24(1):25–32.
4. Mueller GC, Hussain HK, Smith YR et al. Müllerian duct anomalies: comparison of MRI diagnosis and clinical diagnosis. AJR Am J Roentgenol 2007; 189(6):1294–1302.
5. Yasmin Mounir Tohameya, Asmaa Mahmoud AbdelMagieda, Lamia Adel Salah El Dina, Reham Ashraf Mohamedb. MRI is it complementary or

- mandatory to ultrasound in classification of different congenital anomalies of female reproductive tract? Egyptian journal of radiology and nuclear medicine, Volume 49, Issue 2, June 2018, Pages 571-578.
6. Troiano RN, McCarthy SM. Mullerian duct anomalies: imaging and clinical issues. Radiology 2004; 233(1):19–34.
7. S.N. Saleem MR imaging diagnosis of uterovaginal anomalies: current state of the art RadioGraphics, 23 (2003).
8. Nadia FEI Ameena, Mohamed A. Ebraheema, Neveen M. Nour El Dien. MR assessment of Müllerian duct anomalies: Does it help? Egyptian journal of radiology and nuclear medicine, Volume 45, Issue 2, June 2014, Pages 561-567.
9. Pellerito JS, McCarthy SM, Doyle MB, Glickman MG, DeCherney AH. Diagnosis of uterine anomalies: relative accuracy of MR imaging, endovaginal sonography, and hysterosalpingography. Radiology 1992; 183(3):795–800.
10. Imaoka, A. Wada, M. Matsuo, M. Yoshida, H. Kitagaki, K. Sugimura MR imaging of disorders associated with female infertility: use in diagnosis, treatment, and management, RadioGraphics, 23 (2003), pp. 1401-1421.
11. C. Reinhold, H. Hricak, R. Forstner, et al. Primary amenorrhea: evaluation with MR imaging Radiology, 203 (1997), pp. 383-390.
12. J.M. Brody, S.L. Koelliker, G.N. Fishman Unicornuate uterus: imaging appearance, associated anomalies, and clinical implications AJR Am J Roentgenol, 171 (1998), pp. 1341-1347.
13. J.A. Steinkuehler, C.A. Woodfield, E. Lazarus, M.M. Hillstrom Female infertility: a systematic approach to radiologic imaging and diagnosis, RadioGraphics, 29 (2009), pp. 1353-1370.
14. Carrington BM, Hricak H, Nuruddin RN, Secaf E, Laros RK, Hill EC. Müllerian duct anomalies: MR imaging evaluation. Radiology 1990; 176(3): 715–720.
15. Troiano RN, McCarthy SM. Mullerian duct anomalies: imaging and clinical issues. Radiology 2004; 233(1):19–34.