Check for updates

OPEN ACCESS

DOI: 10.46903/gjms/24.1.2120

ORIGINAL ARTICLE

MULTIMODAL RADIOLOGICAL DIAGNOSIS OF UTEROVAGINAL MULLERIAN DUCT ANOMALIES; A THREE-YEAR EXPERIENCE IN TERTIARY CARE HOSPITAL, PESHAWAR

Nasreen Aman[1], Muhammad Imran[1], Fatima Sultan Ahmad[1], Shahzadi Saima Hussain[2], Fariha Afzal[3], Laila Khan[4]

[1]Department of Radiology & [2] Gynecology, MTI, Lady Reading Hospital, Peshawar, [3]Department of Radiology, Naseer Teaching hospital, Gandhara Medical university, Peshawar. [4]Department of Radiology, Mardan Medical Complex. Mardan, Khyber Pakhtunkhwa, Pakistan

ABSTRACT

Background: Müllerian duct anomalies (MDAs) are congenital uterovaginal malformations with significant reproductive and gynecological implications. Early and accurate diagnosis is essential for effective management. This study aimed to determine the frequency and spectrum of uterovaginal Müllerian duct anomalies in a tertiary care hospital and to assess the role of multimodal imaging using the ASRM MAC 2021 classification

Materials & Methods: This retrospective cross-sectional study was conducted at the Radiology Department of Lady Reading Hospital, Peshawar, using HMIS data from January 2022 to December 2024. Patients aged ≥12 years with radiologically confirmed uterovaginal anomalies were included (n=150). Ultrasound and pelvic MRI were used for evaluation, and anomalies were classified according to the ASRM Müllerian Anomaly Classification (MAC) 2021. Data were analyzed using SPSS v26. Descriptive statistics were reported; an independent-samples t-test compared uterine bud dimensions between infantile and prepubertal uterus. A total of 150 patients aged ≥12 years with radiologically confirmed uterovaginal anomalies were included. Imaging modalities used were ultrasound & MRI. Anomalies were classified per ASRM MAC 2021 criteria.

Results: Mean age was significantly lower in patients presenting with primary amenorrhea (16.8±4.07 years) compared with other presentations (27.22±9.58 years; $p<0.01$). The most frequent anomaly was dysplastic/infantile uterus (34.4%), followed by bicornuate uterus (24.0%) and transverse vaginal septum (13.9%). Ultrasound was the primary imaging modality (124/150), while MRI was used for problem-solving (26/150). Craniocaudal uterine bud length differed significantly between infantile and prepubertal uterus ($p=0.007$).

Conclusion: Uterovaginal MDAs constitute a substantial diagnostic workload in tertiary care. A structured multimodal imaging approach guided by ASRM MAC 2021 improves characterization and communication with gynecology teams, supporting appropriate clinical management.

KEY WORDS: Mullerian duct abnormalities; Uterine anomalies; Uterine duplication anomalies; Vaginal septum.

Cite as: Aman N, Imran M, Ahmad FS, Hussain SS, Afzal F, Khan L. Multimodal radiological diagnosis of uterovaginal Mullerian duct anomalies: a three-year experience in tertiary care hospital, Peshawar.. Gomal J Med Sci 2026 Jan-Mar;24(1):20-24. https://doi.org/1046903/gjms/24.1.2120

INTRODUCTION

Müllerian duct anomalies (MDAs) encompass a spectrum of congenital malformations of the uterus, cervix, and upper vagina, arising from disruptions in the development, fusion, or resorption of the paramesonephric ducts during embryogenesis. These anomalies, although infrequent in the general population (0.5–6.7%), are notably more prevalent in women with reproductive challenges, with rates reaching up to 16.7% among those experiencing recurrent pregnancy loss.[1] MDAs can present with primary amenorrhea, infertility, recurrent miscarriage, endometriosis, or complications during pregnancy and labour, highlighting the need for accurate diag-

Corresponding Author:

Dr. Muhammad Imran Khan
Assistant Professor
Department of Radiology
Lady Reading Hospital, Peshawar, Pakistan.
E-mail: mahsood@yahoo.com

Date Submitted: 06-08-2025
Date Revised: 28-02-2026
Date Accepted: 13-03-2026

nosis and classification.[2]

Imaging plays a critical role in evaluating uterovaginal anomalies. Two-dimensional transvaginal ultrasound (2D-TVUS) remains the first-line modality due to its accessibility and cost-effectiveness.[3] However, its limitations in assessing complex anomalies have necessitated the incorporation of advanced imaging techniques. Three-dimensional transvaginal ultrasound (3D-TVUS) improves diagnostic precision by visualizing both serosal and endometrial contours in the coronal plane, aiding in accurate morphological assessment. Magnetic Resonance Imaging (MRI) is widely regarded as the gold standard for its superior soft tissue resolution and multiplanar capabilities, particularly in complex or ambiguous cases.[3,4] MRI sequences, including T2-weighted orthogonal planes and fat-saturated T1-weighted images, are invaluable for classifying anomalies and identifying associated conditions such as hematometrocolpos and endometriosis.[5]

The complex nature of MDAs necessitates standardized classification systems which are essential for accurate diagnosis and clinical management. The American Society for Reproductive Medicine (ASRM) introduced the Müllerian Anomaly Classification (MAC) tool in 2021, which categorizes uterovaginal anomalies into nine groups while integrating cervical and vaginal variations. This updated system has enhanced diagnostic clarity, minimized misclassification, and supported effective treatment planning.[6,7] In contrast, the 2013 European Society of Human Reproduction and Embryology (ESHRE) in collaboration with the European Society for Gynecological Endoscopy (ESGE)ESHRE/ESGE classification, though comprehensive, faced criticism for its propensity to over-diagnose septate uterus, potentially leading to unnecessary interventions.[8]

A combined clinical and imaging approach is vital for the optimal evaluation of MDAs. Precise imaging interpretation, guided by robust classification tools like ASRM MAC 2021, ensures accurate anomaly characterization, informs clinical decision-making, and improves patient outcomes. Certain anomalies such as infantile uterus and hematometrocolpos present early due to obstructive symptoms, others may remain undetected until evaluated for reproductive issues.[9]

The present study aimed to determine the frequency and spectrum of uterovaginal Müllerian duct anomalies among patients at a tertiary care hospital, evaluating the utility of integrating clinical assessment with multimodal imaging techniques—guided by the ASRM MAC 2021 classification—for accurate diagnosis and characterization.[10]

MATERIALS AND METHOD

A cross-sectional, hospital-based, retrospective study was carried out from January 2022 to December 2024, cases collected in HMIS of Radiology Department of LRH, with the help of Radiology/ NM search engine, following institutional ethical research committee approval reference number 585/LRH/MTI, dated 31/12/2024. Total 150 reports that fulfilled the inclusion criteria were retrieved for uterovaginal Müllerian duct anomalies (MDAs) over the three-year study period. A retrospective consecutive sampling technique was employed, where all cases fulfilling the inclusion criteria were retrieved from HMIS records over the three-year period. The study included patients aged 12 years and above who were reported by radiologists to have uterovaginal anomalies. To minimize bias, patients with adnexal or ovarian abnormalities, those younger than 12 years, and those evaluated for ambiguous genitalia were excluded from the study.

The patients had been assessed on various modalities including Grey scale and Colour Doppler ultrasound performed by radiologist with Mindray DC-40 Ultrasound machine B-mode imaging having a 3.5 MHz curved array transducer, or a 7.5 MHz transvaginal transducer. Pelvic MRI was conducted using a 1.5 Tesla Toshiba scanner, employing SE T1-weighted, FSE T2-weighted, and fast STIR sequences with fat suppression. Imaging planes included sagittal, coronal, and paraxial orientations, with the paraxial sequences specifically aligned to generate accurate coronal views of the uterus. Data were entered and analyzed using Statistical Package for Social Sciences (SPSS), version 26.0. Continuous variables such as age and uterine morphometric measurements were expressed as mean ± standard deviation (SD), while categorical variables including types of uterovaginal Müllerian duct anomalies and imaging modalities used were summarized as frequencies and percentages.

As this was a retrospective descriptive study, no sample size calculation was performed. Comparative analysis was limited to morphometric evaluation of uterine bud dimensions between infantile uterus and prepubertal uterus. An independent samples t-test was applied for comparison of craniocaudal and transverse uterine dimensions, assuming approximate normal distribution of measurements. A p-value <0.05 was considered statistically significant. No multivariable analysis or outcome prediction modelling was attempted, as the primary objective of the study was descriptive characterization of anomalies rather than assessment of causality or risk factors Additionally, cross-tabulations were used to analyse associations between uterine anomalies and clinical presentations (such as primary amenorrhea and associated renal anomalies). Results were presented in tabular and graphical formats.

RESULTS

A total of 150 radiological reports fulfilled the inclusion criteria were retrieved for uterovaginal Müllerian

duct anomalies (MDAs) over the three-year study period. The mean age for patients with uterovaginal mullerian duct anomaly that had presented with primary amenorrhea was 16.8 +/- 4.07 years, and for patients with other complaints was 27.22 +/- 9.58 years. This age difference was statistically significant ($p < 0.01$), marking an earlier age for presentation with primary amenorrhea. Ultrasound was the most commonly used imaging modality, employed in 122 cases (80.8%). MRI of the pelvis was used in 22 cases (15.2%). These findings indicate a reliance on ultrasound as the primary tool for initial evaluation, with MRI used in more complex or ambiguous cases.

The frequency distribution of the various anomalies and imaging modalities used is presented in Table 1. The most frequently identified anomaly was dysplastic / infantile uterus, found in 52 cases (34.4%), followed by bicornuate uterus in 36 cases (24.0%).

Table 1: Frequency of Uterovaginal Anomalies

S r no	Uterovaginal anomaly	Frequency	Percentage
1	Congenitally Absent uterus/ uterine agenesis	15	9.9 %
2	Dysplastic/ Infantile uterus	52	34.4 %
3	Prepubertal Uterus	11	7.3 %
4	Septate Uterus	9	6.0 %
5	Unicornuate Uterus	3	2.0 %
6	Bicornuate Uterus	36	24.0 %
7	Uterus Didelyphys	3	2.0 %
8	Transverse vaginal septum	21	13.9 %
	Total	150	100%
IMAGING MODALITY			
ULTRASOUND		124	82.1
MRI PELVIS		26	17.8
Total		150	

Primary amenorrhea was observed in all patients of uterine agenesis, infantile uterus, prepubertal uterus, hematometrocolpos. Additionally, two patients with bicornuate uterus also presented with primary amenorrhea.

Among the patients with bicornuate uterus, the mean age was 27.69 ± 9.87 years. This group included 14 cases of one-cornu pregnancy, of which two had placenta previa and one had a cornual ectopic pregnancy. There were also 9 cases of one-cornu failed pregnancies, which included five nonviable pregnancies or missed abortions, two cases of gestational trophoblastic disease, and two cases of retained products of conception. Other clinical findings included a single case each of perimenopausal dysfunctional bleeding and endometrial polyp. Two patients had associated renal pathology, one with horseshoe kidney and other with hydronephrosis. The remaining 10 patients had an incidental diagnosis. Among the three patients with unicornuate uterus (aged 15–28 years), one had a distal noncommunicating rudimentary horn, while the other two did not have rudimentary horns. All three presented with dysmenorrhea, and two had associated renal anomalies—unilateral renal agenesis and crossed fused ectopia.

There were nine patients with a septate uterus, with a mean age was 27.00+/- 8.67 years. Amongst these, one patient had an ectopic pregnancy and two had associated fibroid. Three cases of uterus didelphys were identified. Among two patients aged 13 and 16 years one without any associated anomalies, while other one presenting as a complex case involving uterus didelphys, double vagina, and a right-sided vaginal septum resulting in hematometrocolpos. The third patient, aged 36 years, was diagnosed incidentally while being evaluated for cholelithiasis.

Morphometric analysis using an independent sample t-test revealed a statistically significant difference in the craniocaudal (CC) dimensions of the uterine bud in patients with infantile uterus (mean = 3.43 cm, SD = 1.17) compared to those with prepubertal uterus (mean = 4.54 cm, SD = 1.26), $t(57) = -2.796$, $p = 0.007$. However, no statistically significant difference was noted in the width of the uterine bud between the two groups.

Regarding ovarian visualization, absent ovaries were reported in 4 out of 15 patients with uterine agenesis and in 18 out of 49 patients with infantile uterus. In contrast, ovaries were present in patients with the remaining types of uterovaginal anomalies as shown in figure 1.

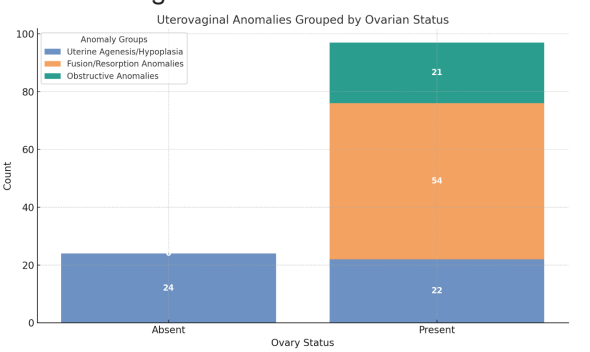


Figure 1: Uterovaginal Anomalies vs Ovarian status.

DICUSSION

This study evaluated the frequency and clinical relevance of uterovaginal Müllerian duct anomalies (MDAs) in a tertiary care hospital setting, employing

the ASRM Müllerian Anomaly Classification (MAC) 2021 system for standardized reporting. The MAC 2021 tool facilitated accurate diagnosis and interdisciplinary communication in managing these complex malformations.

Our findings revealed that the most frequently observed anomaly was infantile uterus (34.4%), followed by bicornuate uterus (24.0%) and Transverse vaginal septum (13.9%). Imaging modalities, particularly ultrasound and MRI, played a pivotal role in detecting these anomalies, with ultrasound serving as the primary diagnostic tool and MRI reserved for complex or ambiguous cases. A significant age difference was noted between patients presenting with primary amenorrhea (mean age 16.8 ± 4.07 years) and those with other complaints (mean age 27.22 ± 9.58 years, $p < 0.01$). This aligns with the clinical understanding that obstructive anomalies and hypoplasia/agenesis often manifest during adolescence due to absent menarche or cyclical pain.[1,4]

The predominance of infantile uterus in adolescent patients with primary amenorrhea aligns with prior studies by Chan et al.[11] and Ludwin et al.[12] , which highlight the role of 3D ultrasound and MRI in detecting hypoplastic uterine morphology. Our data further reinforces the necessity of early imaging evaluation in patients with delayed menarche.

Bicornuate uterus, identified in 24% of cases, presented with varied reproductive outcomes, including one-cornu pregnancies, placenta previa, and failed pregnancies. Given its embryological origin from incomplete paramesonephric duct fusion, accurate differentiation from septate uterus using imaging features such as intercornual angle and fundal contour is critical. MRI, with its superior soft tissue contrast and multiplanar capabilities, proved indispensable in cases where 3D ultrasound findings were inconclusive. Less frequent anomalies, such as uterus didelphys (2.0%) and unicornuate uterus (2.0%), carried significant clinical implications. In one adolescent patient, uterus didelphys was associated with a hemivaginal septum causing hematocolpos, emphasizing the importance of early detection to prevent complications like endometriosis. Unicornuate uterus was often linked with ipsilateral renal anomalies, consistent with the shared embryologic origin of the urinary and reproductive systems.[13] Septate uterus accounted for 6% of cases, correlating with its known association with recurrent miscarriages.[14]

Morphometric analysis in this study demonstrated a significant difference in craniocaudal uterine bud dimensions between infantile uterus (mean = 3.43 cm) and prepubertal uterus (mean = 4.54 cm, $p = 0.007$), suggesting a potential imaging parameter for distinguishing between pathological hypoplasia and developmental delay. A noteworthy finding in this study was the absence of ovaries in a significant proportion of patients with uterine agenesis (4 out of 15) and infantile uterus (18 out of 49). While typical cases of Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome exhibit normal ovarian presence and function.[15]

Ultrasound was utilized in 80.8% of cases, reaffirming its role as the first-line imaging modality due to its accessibility and high specificity. MRI, used in 15.2% of cases, proved crucial for detailed anatomical assessment in complex presentations. This diagnostic approach aligns with existing literature advocating for a tiered imaging strategy—ultrasound for initial evaluation and MRI for comprehensive characterization when required. The implementation of ASRM MAC 2021 classification system greatly enhanced the diagnostic workflow by encompassing a broader range of anomaly patterns, including cervicovaginal variations and combined forms. This comprehensive framework not only improved diagnostic precision but also facilitated interdisciplinary communication, supporting more informed clinical decision-making.

CONCLUSION:

This study demonstrates a considerable burden of uterovaginal Müllerian duct anomalies (MDAs) in tertiary care, emphasizing the pivotal role of radiologists in their detection and characterization. Combining clinical assessment with multimodal imaging—guided by the ASRM MAC 2021 classification—enhanced diagnostic precision and facilitated effective communication with gynaecologists.

A structured, classification-based approach is essential for accurate diagnosis, streamlined interdepartmental collaboration, and informed patient management. Integrating this workflow into routine practice is key to improving outcomes, particularly in resource-limited healthcare settings.

Limitations: This study is not without limitations. Its retrospective nature and single-center design may introduce selection bias and limit the generalizability of the findings. The relatively small number of cases for some rarer anomalies also restricts the statistical power for detailed analysis of their associations

RFEFRENCES

1. Dixit R, Duggireddy CS, Pradhan GS. Mullerian anomalies: revisiting imaging and classification. Insights Imaging. 2025;16(1):40.
2. Passos IMPE, Britto RL. Diagnosis and treatment of müllerian malformations. Taiwan J Obstet Gynecol. 2020;59(2):183–8. https://doi.org/10.1016/j.tjog.2020.01.003 PMID:32127135
3. Sugi MD, Penna R, Jha P, Põder L, Behr SC, Courtier J, et al. Müllerian duct anomalies: role in fertility and pregnancy. Radiographics. 2021;41(6):1857–75.
4. Garratt J, Siegelman ES. MR imaging of Müllerian anomalies. Magn Reson Imaging Clin N Am. 2023;31(1):11–28.

5. Ramakrishnan KK, Jerosha S, Subramonian SG, Murugappan M, Natarajan P. Comparing the diagnostic efficacy of 3D ultrasound and MRI in the classification of Müllerian anomalies. Cureus. 2024;16(10):e70632. https://doi.org/10.7759/cureus.70632 PMID:39483598 PMCID:PMC11526810
6. Pfeifer SM, Attaran M, Goldstein J, Lindheim SR, Petrozza JC, Rackow BW, et al. ASRM müllerian anomalies classification 2021. Fertil Steril. 2021;116(5):1238–52. https://doi.org/10.1016/j.fertnstert.2021.09.025
7. Al Najar MS, Al Ryalat NT, Sadaqah JS, Husami RY, Alzoubi KH. MRI evaluation of mullerian duct anomalies: practical classification by the new ASRM system. J Multidiscip Healthc. 2022;15:2579–89. https://doi.org/10.2147/JMDH.S386936
8. Panagiotopoulos M, Tseke P, Michala L. Obstetric complications in women with congenital uterine anomalies according to the 2013 ESHRE–ESGE classification: a systematic review and meta-analysis. Obstet Gynecol. 2022;139(1):138–48. https://doi.org/10.1097/AOG.0000000000004627 PMID:34856567
9. Engku-Husna EI, Nik-Ahmad-Zuky NL, Muhammad-Nashriq K. Müllerian duct anomalies with term pregnancy: a case report. J Med Case Rep. 2020;14(1):209. https://doi.org/10.1186/s13256-020-02506-6 PMID:33131504 PMCID:PMC7604928
10. 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;13(4):807. https://doi.org/10.3390/diagnostics13040807
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;17(6):761–71. https://doi.org/10.1093/humupd/dmr028
12. Ludwin A, Ludwin I. Comparison of the ESHRE–ESGE and ASRM classifications of Müllerian duct anomalies in everyday practice. Hum Reprod. 2015;30(3):569–80. https://doi.org/10.1093/humrep/deu344
13. Orazi C, Lucchetti MC, Schingo PM, Marchetti P, Ferro F. Herlyn-Werner-Wunderlich syndrome: uterus didelphys, blind hemivagina and ipsilateral renal agenesis. Sonographic and MR findings in 11 cases. Pediatr Radiol. 2007;37(7):657–65. https://doi.org/10.1007/s00247-007-0497-y
14. Grimbizis GF, Di Spiezio Sardo A, Saravelos SH, Gordts S, Exacoustos C, Van Schoubroeck D, et al. The Thessaloniki ESHRE/ESGE consensus on diagnosis of female genital anomalies. Hum Reprod. 2016;31(1):2–7. https://doi.org/10.1093/humrep/dev264
15. Mooren ER, Cleypool CG, de Kort LM, Goverde AJ, Dik P. A retrospective analysis of female Müllerian duct anomalies in association with congenital renal abnormalities. J Pediatr Adolesc Gynecol. 2021;34(5):681–5. https://doi.org/10.1016/j.jpag.2021.04.013

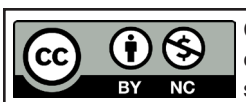
CONFLICT OF INTEREST
Authors declare no conflict of interest.
GRANT SUPPORT AND FINANCIAL DISCLOSURE
None declared.

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	NA, MIK
Acquisition, Analysis or Interpretation of Data:	NA, MIK, FSA, SSH, FA, LK
Manuscript Writing & Approval:	NA, MIK, FSA, SSH, FA, LK

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.


Copyright © 2026. Nasreen Aman, et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that original work is cited properly.