



## Diagnostic Accuracy of 3-Dimensional Ultrasound in Mullerian Duct Anomalies in Comparison to MRI

Ghazal Mehtab<sup>1</sup>, Arooj Afzal<sup>1</sup>, Muhammad Riaz Aamir<sup>2</sup>, Samia Nawaz<sup>3</sup>, Adnan Rashid<sup>4</sup>, Irshad Ahmad<sup>5</sup>

<sup>1</sup>Department of Radiology, Allied Hospital, Faisalabad, Punjab, Pakistan.

<sup>2</sup>Department of Radiology, DHQ Hospital, Bhakkar, Punjab, Pakistan.

<sup>3</sup>Department of Radiology, Brigadier Shafeeq Memorial Trust Hospital, Bhakkar, Punjab, Pakistan.

<sup>4</sup>Department of Radiology, Department of Radiology, Rai Medical College, Sargodha, Punjab, Pakistan.

<sup>5</sup>Department of Radiology, Niazi Medical and Dental College, Sargodha and Niazi Welfare Teaching Hospital, Sargodha, Punjab, Pakistan.

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**Correspondence to:** Ghazal Mehtab  
Department of Radiology, Allied Hospital,  
Faisalabad, Punjab, Pakistan.

**Email:** [ghazal.mehtab77@gmail.com](mailto:ghazal.mehtab77@gmail.com)

### Declaration

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### ABSTRACT

**Introduction:** Müllerian duct anomalies (MDAs) are the congenital anomalies of female reproductive tract that can have significant impact on a woman's fertility and her pregnancy outcomes. Accurate imaging is essential for their diagnosis and management. 2-dimensional ultrasound (2D US) and MRI are the traditional methods that have been mainstays for the diagnosing purpose, but the introduction of 3D Ultrasound in the domain of ultrasound has offered potential advantages in visualization and enhancing diagnostic accuracy. **Objective:** To find out what is the diagnostic accuracy of 3-Dimensional ultrasound in diagnosing Mullerian duct anomalies as compared to MRI. **Materials and Methodology:** Articles included in this review were identified through systematic searches of databases such as Pub Med, Paywall, Wiley.com and Google Scholar. Studies were selected based on their relevance to the use of 3D ultrasound in diagnosing Müllerian duct anomalies. **Results:** Based on different studies we found that 3 Dimensional Ultrasound proved to be highly accurate in diagnosis of Uterine anomalies and showed strong agreement with MRI ( $P < 0.01$ ). **Conclusion:** 3D ultrasound has proved to be an excellent modality for the diagnosis of mullerian duct modalities. It's low cost, easy access and real time imaging make it promising and a good diagnosing tool. Although MRI is the standard reference, 3D ultrasound can be preferred over it if its limitations are minimized as the diagnostic accuracy is almost similar to MRI if performed by experienced hands.

### INTRODUCTION

Müllerian duct anomalies (MDAs) are congenital abnormalities of the female reproductive tract that can significantly impact fertility and pregnancy outcomes<sup>1</sup>. They occur when there is some problem in the development of mullerian ducts. Either there is failure of fusion of mullerian ducts, arrested development of mullerian duct or failure of resorption of medial septum<sup>2</sup>. It affects 1 to 5% of all women with an increased incidence seen in those with history of repeated miscarriages, infertility and preterm labour. Accurate imaging plays a crucial role in diagnosing and managing these anomalies. Traditional methods like 2D ultrasound and magnetic resonance imaging (MRI) have been used, but 3D ultrasound has emerged as a promising alternative due to its ability to provide detailed, real-time, and multiplanar images of complex anatomical structures. Several studies have evaluated the diagnostic accuracy of 3D US in detecting MDAs. 3D US allows for multiplanar reconstruction and better visualization of complex

anatomical structures compared to 2D US. It is non-invasive, widely available, and cost-effective. 3D ultrasound allows for the acquisition of volumetric datasets that can be reconstructed into multiple planes, providing detailed visualization of uterine morphology, septa, cervix, and vaginal canal. Studies have shown that 3D US can accurately identify various types of MDAs, including septate uterus, unicornuate uterus, bicornuate uterus, and didelphys uterus<sup>3</sup>. The ability to visualize uterus in three dimensions reduces the chance of misdiagnosis and improves accuracy. While MRI has traditionally been considered the gold standard for diagnosing MDAs due to its superior soft tissue contrast and multiplanar capabilities, 3D ultrasound has shown comparable accuracy in many studies. Although MRI is regarded as gold standard it has certain limitations such as its high cost, longer scan times, and claustrophobia in some patients which makes 3D ultrasound to be used as a good alternative technique for evaluation. 3D ultrasound represents a valuable imaging modality for diagnosing

Müllerian duct anomalies, offering advantages over traditional 2D ultrasound and comparable accuracy to MRI in many cases. Its real-time imaging capabilities and accessibility make it a preferred choice for initial evaluation and follow-up monitoring of patients with MDAs. With ongoing advancements and standardization efforts, 3D ultrasound is poised to play an increasingly important role in the clinical management of these complex congenital anomalies.

This review highlights the current state of knowledge regarding the use of 3D ultrasound in Müllerian duct anomalies, emphasizing its strengths, limitations, and future directions for research and clinical practice.

## METHODOLOGY

This systemic review was done based on the articles collected and studied from several databases including Pub Med, Unpaywall, wiley.com and Google Scholar. Studies were selected based on their relevance to the use of 3D ultrasound in diagnosing Müllerian duct anomalies and their comparison to other imaging modalities including MRI. Most studies included those patients for evaluation that had history of infertility, repeated abortions, preterm labour. Also all patients were evaluated by 2D US, hystero-graphy, 3D ultrasound and MRI. ESHRE-ESGE and ASRM classifications of mullerian duct anomalies were considered in studies.

### Inclusion And exclusion Criteria

Only those studies were included for the review that were based on diagnostic utility of 3 dimensional ultrasound and MRI in assessment of Mullerian duct anomalies, their comparison and their accuracy. Also those articles were included that compared 3D ultrasound with hysteroscopy or 2D ultrasound or discussed use of 3D ultrasound for diagnosis of MDAs alone.

Studies done before the year 2000 were excluded. Duplicated articles were removed and studies that only discussed MRI as the imaging modality were excluded. Some studies were excluded as the original articles were not available on databases. Reviews and case reports were also not included.

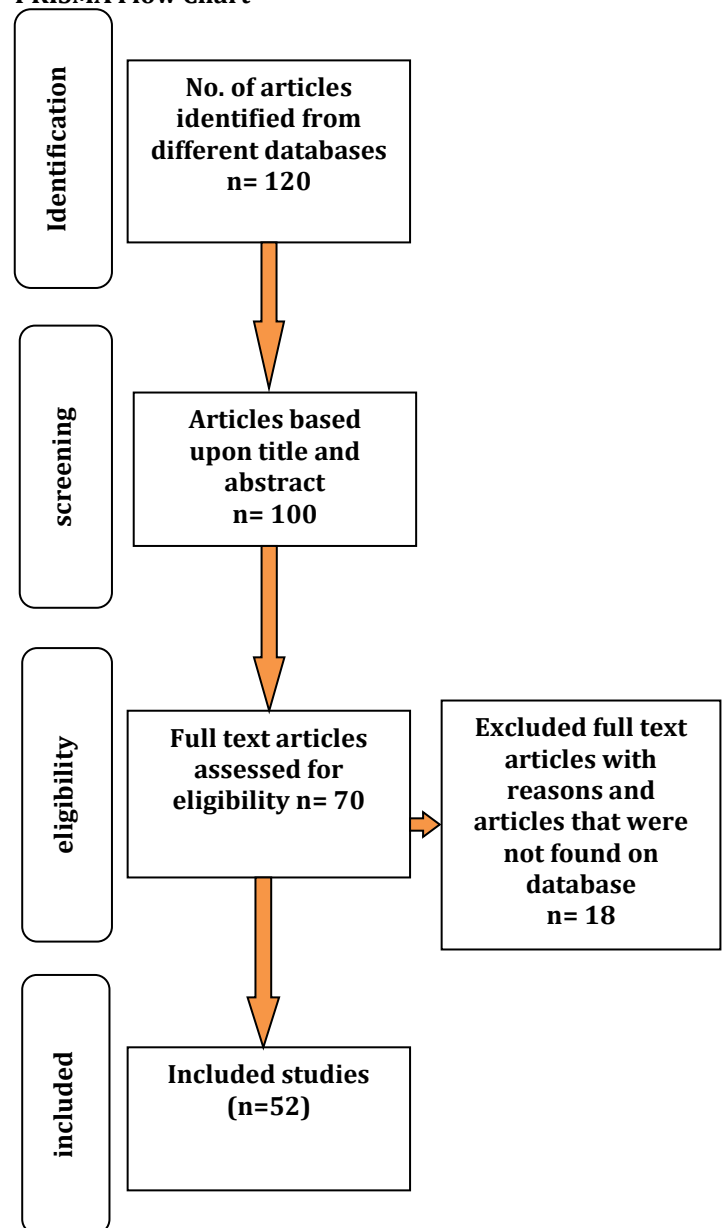
A study conducted in Egyptian journal of radiology and nuclear medicine was based on 30 females with history of infertility and repeated miscarriages. All were evaluated through 2D US and hystero-graphy in initial workup and then 3D US and MRI to compare results. It was found that evaluation was best done during the secretory phase of menstrual cycle.

One of the study conducted in 2009 included 108 women suspected to have MDA. The sensitivity and specificity for 3D US found to be significantly higher.

Another study involved 214 females with fertility issues which found 95% accuracy in diagnosing MDAs using 3D US.

A study conducted among 29 patients found 28 of them accurately diagnosed with 3D US examination. While MRI diagnosed 23 of them correctly. This found 3D US to be more accurate than MRI.

## PRISMA Flow Chart



## DISCUSSION

Different studies were reviewed to look for the accuracy of 3D ultrasound in identifying MDAs. A study done in Egyptian journal of radiology and nuclear medicine found that 3D US has sensitivity of 100%, specificity 96%, PPV 100% and NPV 100%. Also the 3D US study was less time consuming<sup>4</sup>. 3D US makes possible to create 3D images from the uterine volume acquisition. After this the data set can be manipulated to provide 3D images of uterus from virtually any angle<sup>5</sup>. This provides coronal images that are required for assessment of MDAs and detailed anatomical knowledge. In another study there was 93% sensitivity and 100% specificity with 3D US in expert hands. It also found the modality to be economical and less time taking. A pilot study done in China identified 27 out of 29 women (93.1%) on 3D ultrasound with confirmed MDAs. There was concordance between the pelvic ultrasonography and the surgically verified diagnosis. In comparison, only 24 out of 29 cases (82.8%) in this study had an accurate MRI diagnosis<sup>6</sup>. In addition to helping surgical practice, pelvic

ultrasonography greatly enhanced patient-doctor counseling. A study compared 3D US and MRI in diagnosing different MDAs in a cohort of patients. It found that 3D US had comparable accuracy to MRI in detecting septate uterus and bicornuate uterus but was less accurate for diagnosing complex anomalies like uterus didelphys. The study showed that while MRI remains superior for detailed assessment, 3D ultrasound is a reliable alternative for initial examination and follow up. It is found that despite some limitations in detailed anatomic delineation, 3D ultrasound was found more cost effective and efficient in outpatient settings. A study conducted in 2009 also found 3D US to be very accurate in diagnosis<sup>7</sup>. Another study demonstrated 93% sensitivity and 100% specificity with use of 3D US. The technique allows better delineation of the external uterine contour and uterine volume.<sup>8</sup> A study conducted in Greece, found Concordance between 3D US and hysteroscopy with laparoscopy about the type and the classification of uterine anomaly in 61 cases, including all those with septate uterus, dysmorphic uterus, bicornuate, hemi-uterus or unicornuate, and aplastic uterus and one out of two with normal uterus. For the diagnosis of septate uteri, which was the most common anomaly, the sensitivity of 3D US was 100%, the specificity was 92.3%, the PPV was 98% and the NPV was 100%, with kappa index 0.950. For bicornuate, dysmorphic uterus, hemi-uteri or unicornuate and aplastic uterus the sensitivity, specificity, PPV and NPV were all 100% with K=1.00. Overall, 3D US showed perfect diagnostic accuracy (Kappa index=0.945) in the detection of congenital uterine anomalies.<sup>9</sup> The advent of three-dimensional (3D) ultrasound is one of the most important advances in gynecological ultrasound recently. The ability to view the uterus and endometrium in virtually any plane, has added greater diagnostic confidence to ultrasound imaging. While 2D transvaginal ultrasonography is an excellent screening examination for uterine anomalies, it is not as effective as 3D ultrasound in distinguishing specific malformations. 3D ultrasound does not replace 2D ultrasound but, rather, complements it<sup>10</sup> A study conducted in 2013 found high accuracy in diagnosing MDAs excluding those patients with arcuate uterus and short septa<sup>11</sup>. One of the studies found 3D US to be more accurate than MRI.<sup>12</sup>

**CONCLUSION**

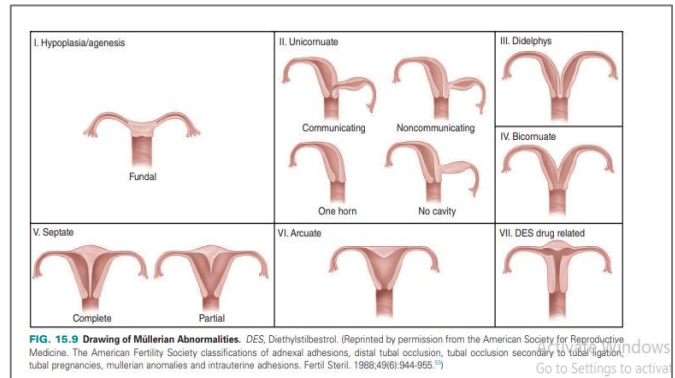
In conclusion, 3 D ultrasound is a valuable tool in diagnosis of mullerian duct anomalies offering good diagnostic accuracy comparable to MRI in many cases. Accessibility, lower cost and real time imaging capabilities are all its strengths. However MRI remains the main stay for cases requiring more detailed anatomical knowledge or surgical planning.

**LIMITATIONS AND RECOMMENDATIONS**

While 3D ultrasound shows promise it has certain limitations in visualizing fine details compared to MRI. Complex cases and cases requiring surgical intervention may still benefit from MRI. Operator skill and experience will also influence the accuracy of 3 D ultrasound in diagnosing MDAs. Future Research should focus on refining protocols and enhancing operator training to

maximize the potential of 3D ultrasound in diagnosing MDAs.

**Figure 1**  
*Mullerian Duct Anomalies*

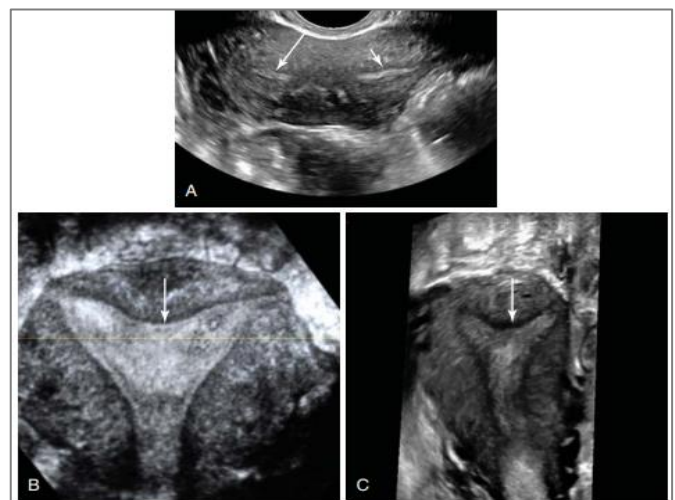


**FIG. 15.9** Drawing of Mullerian Abnormalities. DES: Diethylstilbestrol. (Reprinted by permission from the American Society for Reproductive Medicine. The American Fertility Society classifications of adnexal adhesions, distal tubal occlusion, tubal occlusion secondary to tubal ligation, tubal pregnancies, mullerian anomalies and intrauterine adhesions. Fertil Steril. 1988;49(6):944-955. \*)

**Figure 2**  
*Bicornuate Uterus*



**Figure 3**  
*Arcuate Uterus*



**Figure 4**

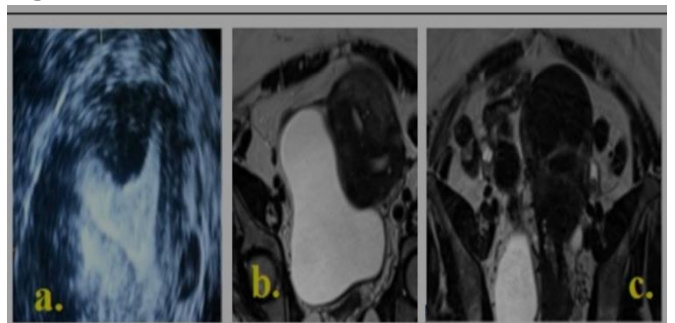


Figure 5

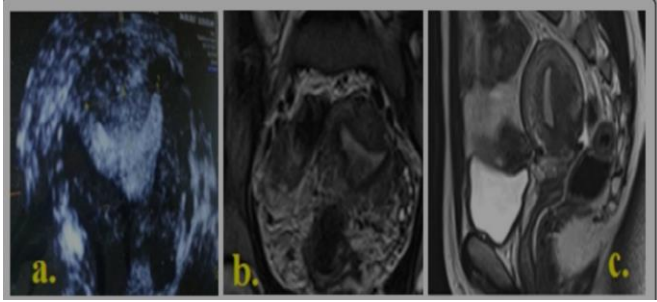
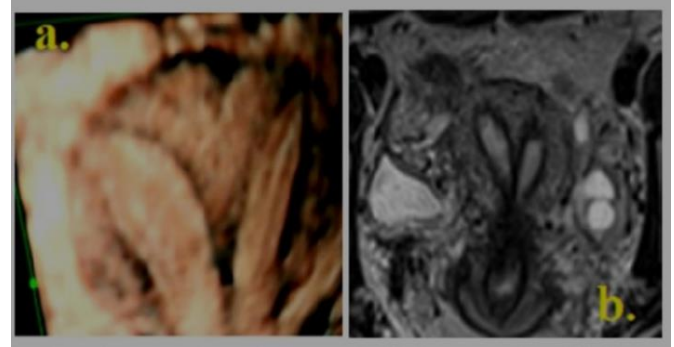


Figure 6



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