# Comparative Role of Ultrasonography and Magnetic Resonance Imaging in Female Infertility with Hysterolaparoscopy Correlation

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**Abstract:** In modern era of conservative therapies and minimal invasive surgeries, imaging plays an important role in diagnosis, treatment and determination of the prognosis of diseases. Male and female infertility are complex clinical conditions arising from variety of pathological conditions and diseases. Role of imaging in female infertility has been documented in variety of Medical literature but its clinical application has not been very aggressive. In this study, we aim to determine the role of ultrasonography and magnetic resonance imaging in determining variety of causes of female infertility using hysterolaparoscopy as a gold standard.

**Keywords:** Ultrasonography, magnetic resonance imaging, infertility.

## INTRODUCTION

Infertility is defined as an inability of a couple to achieve a pregnancy in spite of unprotected attempts over a period of twelve months [1]. Male and female infertility has nearly equal prevalence in modern era. Cause of female infertility are many and can be broadly divided in to organic and functional causes. Organic causes can be further subdivided in to congenital or acquired and infectious or noninfectious conditions affecting uterus, tubes and ovaries.

Imaging plays a major role in the evaluation of organic causes of female fertility. Ultrasonography (USG) is usually the first investigation that is performed on an infertile female following a thorough clinical examination. But in many instances, USG fails to answer the clinical question or answers its incompletely. Though, gynecologist consider hysterolaparoscopy (HLA) as a single-stop shop for diagnosing and treating organic causes of female infertility yet it has limitations due to its invasive nature. Magnetic resonance imaging (MRI) in the present era has been accepted for evaluating females with infertility not only due to its noninvasive nature but because of its higher accuracy, comparable with to that of HLA [2, 3]. In this article, we'll try to find out the comparative efficacy of USG and MRI in evaluating variety of causes of female infertility using HLA findings as gold standard.

### Aims of Study

1. To assess the relative role of Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) in detecting various causes of female infertility.
2. To compare the relative accuracy of USG and MRI in detecting various causes of female infertility using hysterolaparoscopy (HLA) as a gold standard technique.

## MATERIAL AND METHODS

1. Fifty-five females in reproductive age-group presenting with primary and secondary infertility were included in the study. Females with primary amenorrhea were excluded from the study.
2. All the patients included in the study underwent Endovaginal USG (EVS) and noncontrast MRI pelvis on the same day. Color Doppler Flow Imaging (CDFI) was used whenever indicated. Imaging was done after $8^{th}$-$10^{th}$ day of menstrual cycle and a minimum of 3-4 days after complete stoppage of menstrual blood flow. Pituitary imaging and Hormonal evaluation were not included in study.
3. Ovary was considered small when its volume was less than 2ml and it appeared completely hypoechoic on USG with no evidence of any follicle. Aplasia was considered on MRI, when there was no identifiable ovarian tissue in pelvis.
4. Vascular stroma with radiating vessels in central echogenic stroma of ovaries was taken as a sign of polycystic ovary.
5. All the patients who revealed positive imaging and clinical findings were taken for hysterolaparoscopy within one week of imaging.

### Protocol of Magnetic Resonance Imaging (MRI)

1. Optimal distension of urinary bladder was achieved.

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2. T2-weighted images (including fat-suppressed images) in axial and sagittal planes.

3. T1-weighted images (including fat-suppressed images) in axial and coronal planes.

## OBSERVATIONS AND ANALYSIS

### General Considerations

1. Age of the patients included in the study ranged from 20 years to 40 years.

2. Out of 55 patients, 33 patients had primary infertility while rest 22 patients has secondary infertility.

3. Evaluated patients revealed polycystic ovarian disease (unilateral or bilateral), tubal disease, variable degrees of pelvic inflammatory disease, endometrial disease, uterine leiomyoma and congenital anomalies.

4. Many patients had multiple findings and hence were included in multiple disease groups. In seven patients, polycystic ovaries coexisted with PID. In five patients, polycystic ovaries coexisted with endometrioma in ovaries. In five cases, tubal dilatation/damage coexisted with diffuse PID. These findings suggest that in many cases infertility is multifactorial.

### Polycystic Ovaries (PCO)

1. Table **1** shows the distribution of patients with polycystic ovaries detected by USG, MRI and HLA.

2. The findings reveal that USG and MRI are as accurate as HLA in detecting polycystic ovaries with positive predictive value, negative predictive value and accuracy reaching up to 100%.

3. Sixteen cases of polycystic ovaries revealed altered/reduced uterine perfusion. Two of 16 cases revealed reverse diastolic flow in uterine arteries.

4. In our study, out of 27 cases of polycystic ovaries, 17 patients (63%) had primary infertility and 10 patients (37%) had secondary infertility. This shows that PCO is a more common cause of primary infertility.

**Table 1: Distribution of Patients with PCO**

| USG | MRI | HLA |
|---|---|---|
| 27 | 27 | 27 |

### Tubal Disease (Hydrosalpinx / Pyosalpinx or Digested / Destroyed Tubes)

1. Table **2** shows the distribution of patients with tubal diseases detected by USG, MRI and HLA.

2. USG failed to detect 03 cases of hydro / pyosalpinx out of which two cases were detected by MRI.

3. USG diagnosed one false-positive case of pyosalpinx.

4. USG failed to detect 03 cases of tubal damage while MRI detected all of them. In one case, MRI detected damaged tube unilaterally but was bilateral on HLA.

5. The findings reveal that USG when compared with HLA has positive predictive value, negative predictive value and accuracy of 75%, 94% and 87.2% respectively for detection of tubal diseases while MRI has higher positive predictive value, negative predictive value and accuracy reaching up to 100%, 98% and 98.2% respectively.

6. In our study out of 10 patients with tubal dilatation or damage, 06 patients (60%) had primary infertility while 04 patients has secondary infertility suggesting common occurrence in primary infertility cases.

**Table 2: Distribution of Patients with Tubal Disease**

| Tubal Status | USG | MRI | HLA |
|---|---|---|---|
| Dilated | 4 | 6 | 7 |
| Damaged | 0 | 3 | 3 |
| Total | 4 | 9 | 10 |

### Pelvic Inflammatory Disease (PID)

1. Table **3** shows the distribution of patients with PID detected by USG, MRI and HLA.

2. Cases that were included in PID group were those with thickened tubes, tubo-ovarian masses, collection in endometrial or pelvic cavity, subendometrial calcification and infected broad ligament. Cases of tubal dilatation and damage were not included in this group as they formed a separate group in our study.

3. USG detected less than one-third cases of PID, those that revealed thickened tubes, tubo-ovarian masses, collection in endometrial / pelvic cavity and subendometrial calcification.

4. MRI failed to detect cases of early PID associated with infective adhesions and subendometrial calcification.

5. One case of PID, false negative on USG revealed mesenteric adenopathy while eight other false negative cases revealed altered or reduced uterine perfusion on CDFI.

6. These findings reveal that USG when compared with HLA has positive predictive value, negative predictive value and accuracy of 100%, 63.8% and 69% respectively for detection of PID while MRI has higher positive predictive value, negative predictive value and accuracy reaching up to 100%, 90.1% and 94.5% respectively.

7. In our study, out of 25 cases of PID, 11 patients (44%) had primary infertility while 14 patients (66%) had secondary infertility. This shows that PID is a commoner cause of secondary infertility.

**Table 3: Distribution of patients with PID**

| USG | MRI | HLA |
|---|---|---|
| 8 | 22 | 25 |

### Miscellaneous Factors

1. Table 4 shows the distribution of patients with other lesser common causes detected by USG, MRI and HLA.

2. USG is apparently not optimal for visualization of tubes and broad ligament. But MRI is superior to USG and parallels HLA in such cases.

3. The sole case of uterine anomaly detected in our study was of uterus subseptus.

4. Although USG and MRI were equally accurate in detecting hypoplasia / aplasia of ovary and uterine anomaly in our study, yet the diagnostic confidence was much higher on MRI.

5. One false positive case of endometrioma was detected by USG in a patient of adenomyosis that was identified as hydrosalpinx on MRI and HLA.

6. USG and MRI parallel HLA accuracy in detection of adenomyosis and leiomyoma. However, for delineating the exact location and their relationship to other lesions, MRI is superior to USG. 3D USG however could overcome some of the limitations.

7. These findings reveal that USG when compared with HLA has positive predictive value, negative predictive value and accuracy of 90.5%, 94.4% and 96.4% respectively for detection of miscellaneous causes while MRI has higher positive predictive value, negative predictive value and accuracy reaching up to 100%.

8. Endometrial hyperplasia was accurately detected by both USG and MRI but presence of cystic endometrial hyperplasia could be seen in one patient on USG while infective endometrial thickening was recognized only on HLA in one patient. The upper limit of normal endometrial thickness is 14mm on both USG and MRI.

9. As the number of cases having these pathologies is relatively low; hence their accuracies cannot be extrapolated to larger samples.

10. It may sometimes be difficult to differentiate leiomyoma and adenomyoma on imaging. In such cases, serial examinations may help.

11. The nature of endometrial hyperplasia (hormonal / infective) can be better assessed with HLA.

**Table 4: Distribution of Patients with Miscellaneous Causes of Infertility**

| Factor | USG | MRI | HLA |
|---|---|---|---|
| Anomaly of Tubes and Adnexa | 0 | 2 | 2 |
| Hypoplasia / Aplasia of Ovary | 5 | 5 | 5 |
| Uterine anomaly | 1 | 1 | 1 |
| Endometrioma | 3 | 3 | 3 |
| Adenomyosis | 1 | 1 | 1 |
| Leiomyoma | 6 | 6 | 6 |
| Endometrial hyperplasia | 3 | 3 | 3 |

## DISCUSSION

Female infertility is a complex clinical condition with multifactorial etiology. The causes may be broadly divided in to uterine, tubal and ovarian causes with subdivision in to infectious and noninfectious causes that include PID, endometriosis and tubal diseases. Variety of imaging methods can be utilized for evaluation of female infertility ranging from x-ray hysterosalpingography, ultrasonography including sonosalpingography, computed tomography and magnetic resonance imaging. However among all the imaging modalities, USG is the most popular and readily

available followed by MRI that has multiplanar imaging capability with high soft-tissue contrast, noninvasiveness and radiation-free nature.

Polycystic ovaries are one of the commonest cause of female infertility which manifests as round to ovoid, normal or bulky ovaries with multiple, tiny, immature follicles arranged at the periphery of ovary showing echogenic stroma on USG and hypointense stroma on MRI [4] (Figure **1**).

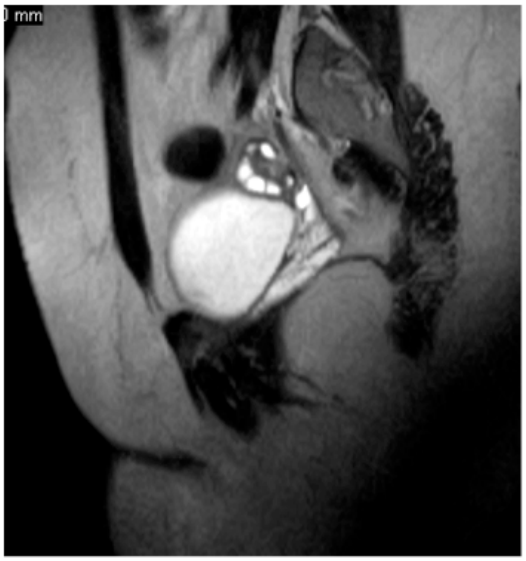

**Figure 1:** Sagittal T2W image through pelvis shows polycystic ovary.

Tubal diseases include dilatation secondary to obstruction caused by infection / adhesion resulting in hydrosalpinx or pyosalpinx. In extreme cases, tubes may be digested or destroyed. Dilated fallopian tubes are seen as fluid-filled, retort-shaped or fusiform shaped, tortuous structures in the adnexal region showing incomplete internal septations with mural nodules [5, 6] (Figure **2**).

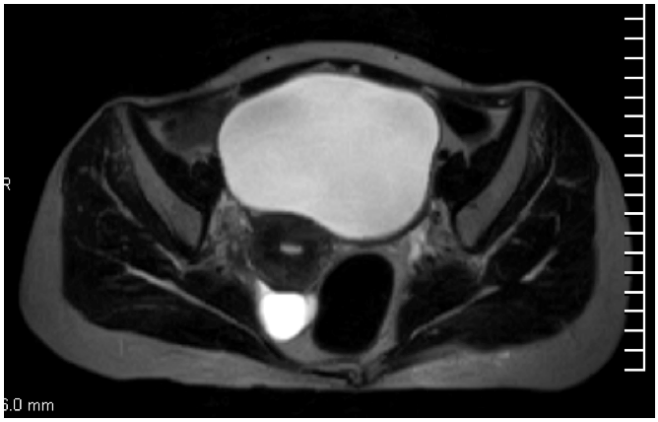

**Figure 2:** T2W axial image through pelvis shows hydrosalpinx on right side.

Pelvic inflammatory disease is an important cause of female infertility and includes pelvic collections, tubo-ovarian abscess and uterine / adnexal infections. USG besides probe tenderness, may reveal thickened tubes and endometrial abnormalities (thickening, collection or subendometrial calcification). MRI may show altered signal intensity of the uterine parenchyma and broad ligament [5]. Tubo-ovarian abscesses may reveal high-resistance, peripheral vascularity on CDFI and hyperintense inner rim on T1W images [7] (Figures **3-5**).

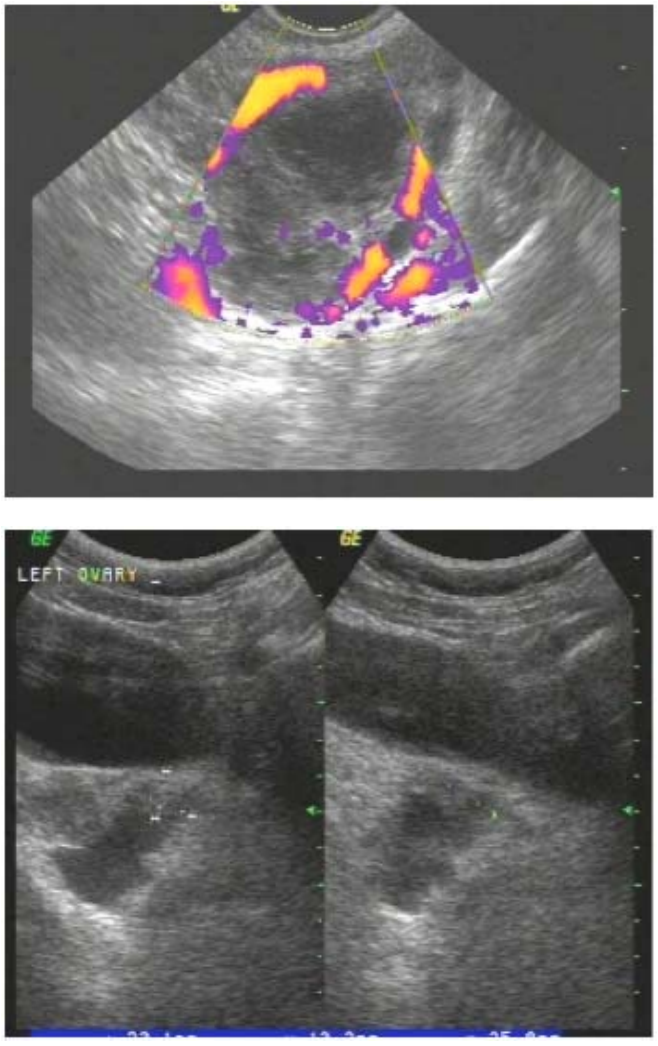


**Figure 3:** USG images showing tubo-ovarian mass (above) and pelvic collection (below).

Endometriosis is also an important cause of infertility in the young reproductive age-group. It may affect the uterus or adnexae. It may occur in the form of focal masses in the uterus (adenomyoma) or chocolate cysts in the broad-ligament / ovary or as diffuse involvement (adenomyosis uterus). Similar to PID, it also causes severe pelvic soft tissue inflammation

resulting in pelvic adhesions. USG may reveal the above findings with associated probe tenderness. MRI is superior to USG in determining the pelvic adhesions and following patients treated conservatively with medical therapy [8] (Figures **6, 7**).

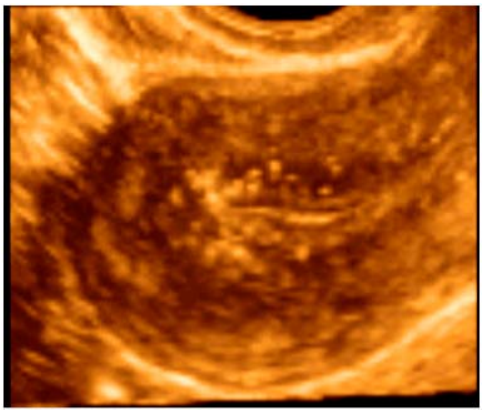

**Figure 4:** 3D USG image shows subendometrial calcification.

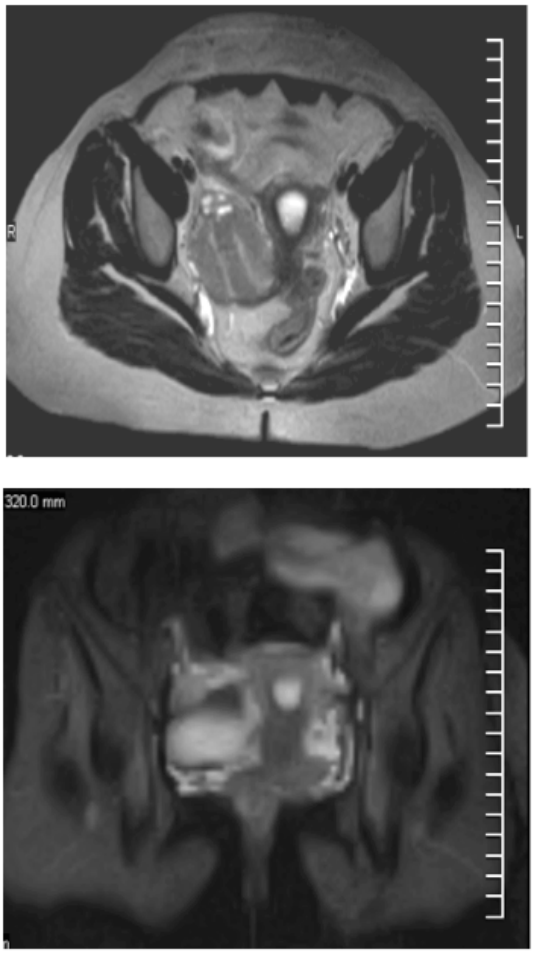


**Figure 5:** Axial T2W and coronal fat-suppressed T2W images show pelvic adhesions between bowel loops and minimal fluid in adnexae (above) and infected broad-ligament (below) in PID.

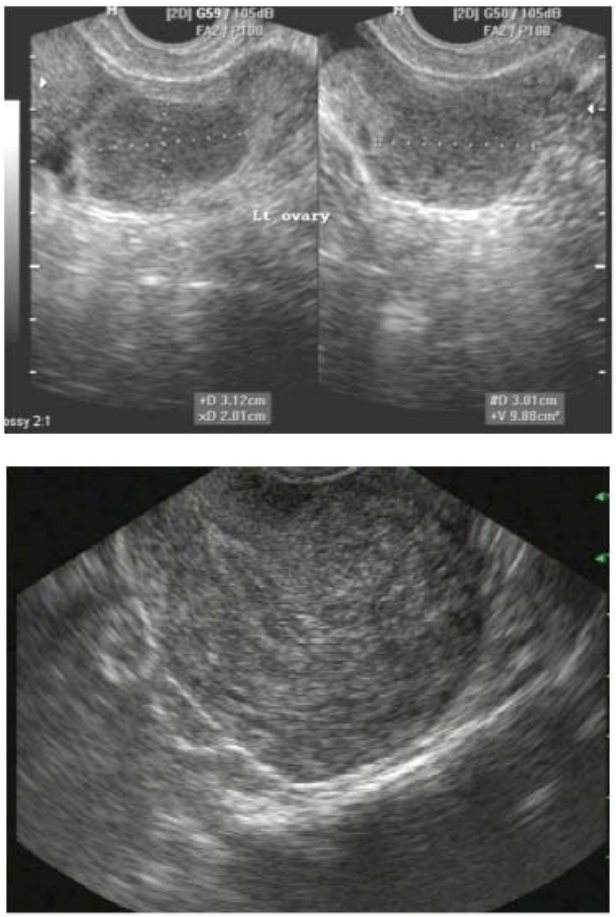


**Figure 6:** USG images show endometrioma ovary (above) and adenomyoma uterus (below).

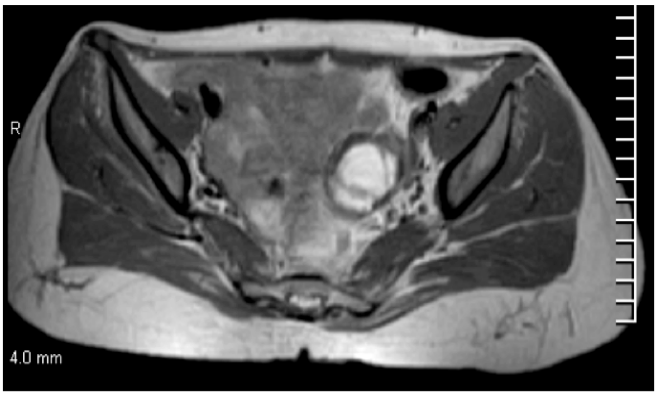


**Figure 7:** Axial T1W images shows hyperintense endometrioma in left ovary.

Uncommon cause of female infertility includes leiomyoma and uterine anomalies especially uterus subseptus. Though both of them can be diagnosed with sufficient confidence on 3D USG and MRI yet the latter is superior to former in the depicting the relationship between the leiomyoma and tubes / endometrium [9] (Figures **8, 9**).

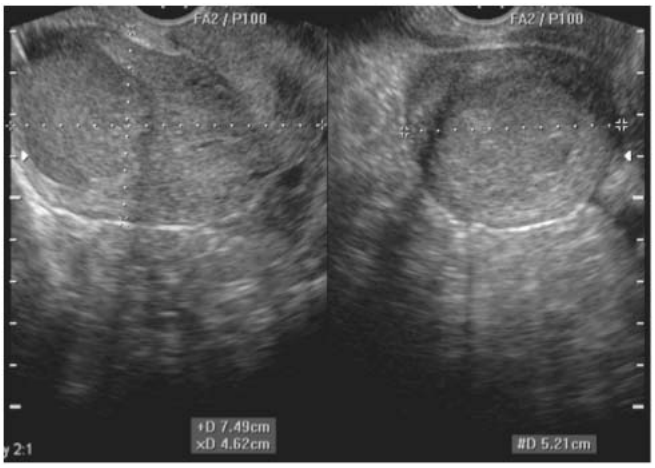


**Figure 8:** USG scan shows intramural fibroid uterus.

**Figure 9:** Coronal 3DUSG image shows uterus subseptus.

## CONCLUSION

1. USG should be first investigation of choice in all patients presenting with infertility as it is highly accurate in detecting polycystic ovaries, leio-myoma, endometriosis / adenomyosis, endometrial thickening and uterine and ovarian anomalies.

2. MRI should be used as a problem-solving tool in patients with complex clinical disease showing unremarkable or non-characteristic USG.

3. MR imaging can complement hysterolaparoscopy especially when tubal diseases or endometriosis are suspected causes of infertility.

4. MR imaging is highly accurate in noninvasive diagnosis of uterine anomalies, adenomyosis, leiomyoma and endometriosis.

5. MR imaging is useful in predicting the outcome in patients treated conservatively for adenomyosis, leiomyoma and endometriosis and may help in better treatment planning.

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