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RESEARCH ARTICLE
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TO EVALUATE THE EFFICACY OF ULTRASONOGRAPHY AND COLOUR DOPPLER IN THE DIAGNOSIS AND CHARACTERIZATION OF GYNAECOLOGICAL PELVIC MASSES

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Aim: This study aimed to evaluate the efficacy of ultrasonography and colour Doppler in the diagnosis and characterization of gynaecological pelvic masses. The goal was to compare the diagnostic accuracy of these imaging modalities and determine their role in the early detection and management of pelvic masses.
Material and Methods: A cross-sectional study was conducted on 80 female patients with suspected pelvic masses at a tertiary care centre. Trans abdominal, trans vaginal ultrasonography and colour Doppler were used for imaging, and their findings were compared to histopathological results. Demographic data, clinical symptoms, mass types, and vascularity were documented.
Results: The study found that abdominal pain was the most common symptom (40%, p=0.012), and cystic masses were the most frequently identified (45%, p=0.004). Colour Doppler outperformed ultrasonography in diagnostic accuracy, with higher sensitivity (92% vs. 85%, p=0.034) and specificity (88% vs. 80%, p=0.049). The correlation between imaging and histopathological findings was significant, with correct identification of 50 benign and 20 malignant masses.
Conclusion: Ultrasonography and colour Doppler are both valuable tools in the evaluation of gynaecological pelvic masses, with colour Doppler offering superior diagnostic accuracy, particularly in distinguishing between benign and malignant masses. These imaging techniques should be used in tandem to enhance early detection and inform treatment decisions.

Keywords: Pelvic masses, ultrasonography, colour Doppler, diagnostic accuracy, gynaecology

Introduction

Pelvic masses in women represent a broad spectrum of gynaecological conditions, ranging from benign entities such as ovarian cysts and fibroids to potentially malignant conditions like ovarian cancer. The accurate and timely evaluation of these masses is crucial for determining appropriate clinical management, whether it involves surveillance, medical treatment, or surgical intervention. In

recent decades, non-invasive imaging modalities like ultrasonography and colour Doppler have become indispensable tools in the diagnosis and assessment of gynaecological pelvic masses. These technologies provide detailed insights into the size, structure, and vascularity of pelvic masses, significantly enhancing the ability of clinicians to differentiate between benign and malignant lesions.[1] Ultrasonography is often the first-line imaging modality used in the evaluation of pelvic masses due to its accessibility, non-invasiveness, and high-resolution imaging capabilities. It allows for the visualization of pelvic organs, including the uterus, ovaries, and adnexal structures, enabling clinicians to assess the morphology of masses and identify structural abnormalities. Transabdominal and transvaginal approaches are the two primary methods of performing pelvic ultrasonography. Transabdominal ultrasound offers a broader field of view, making it useful for larger masses, while transvaginal ultrasound provides higher resolution images, particularly for smaller or early-stage masses.[2] One of the most significant advantages of ultrasonography is its ability to differentiate between cystic, solid, and complex (mixed solid and cystic) masses. This distinction is critical as cystic masses are often benign, while solid masses may raise suspicion for malignancy. Complex masses, which contain both solid and cystic components, can be more challenging to evaluate and may require additional diagnostic tools. In this context, ultrasonography serves as an essential initial step in the evaluation process, guiding further diagnostic and therapeutic decisions. [3]

However, the diagnostic capabilities of ultrasonography are not limited to morphological assessment alone. When combined with colour Doppler imaging, it provides valuable information about the vascularity of pelvic masses. Colour Doppler measures blood flow within the mass, which is an important indicator of malignancy. Malignant tumors tend to be more vascularized, with increased blood flow and abnormal vessel patterns, while benign lesions typically exhibit lower vascularity. By assessing the flow characteristics, such as velocity, resistance, and the presence of neovascularization, colour Doppler significantly enhances the diagnostic accuracy of ultrasonography. [4,5] The role of colour Doppler in gynaecological imaging is particularly important in the preoperative assessment of pelvic masses. It helps in identifying malignant tumors at an early stage by detecting abnormal vascular patterns that may not be visible on grayscale ultrasound. The evaluation of vascular resistance indices, such as the resistive index (RI) and pulsatility index (PI), provides further diagnostic clues. A lower RI and PI are often associated with malignant lesions, while benign masses usually show higher resistance to blood flow. Thus, the integration of colour Doppler into routine ultrasonographic evaluation improves the specificity and sensitivity of detecting malignancies, which is critical for patient prognosis. [6,7] In addition to its diagnostic applications, ultrasonography combined with colour Doppler is valuable in monitoring treatment responses in patients with gynaecological pelvic masses. For example, in cases of ovarian cysts or endometriosis, ultrasonography can be used to track changes in size and morphology over time. In malignant cases, it helps in assessing tumor regression following chemotherapy or other treatments. This non-invasive approach provides real-time information that can be critical for adjusting treatment plans, thereby improving patient outcomes. [8] Despite the advantages of ultrasonography and colour Doppler, there are certain limitations that must be acknowledged. Ultrasonography is operator-dependent, meaning the quality and accuracy of the imaging depend largely on the skill and experience of the radiologist or sonographer. Additionally, while ultrasonography is excellent for assessing superficial pelvic masses, it may be less effective in evaluating deeply situated or small lesions, especially in patients with obesity or significant bowel gas, which can obscure the imaging. In such cases, other imaging modalities such as computed tomography (CT) or magnetic resonance imaging (MRI) may be required for a more comprehensive evaluation. [9] Moreover, while colour Doppler significantly enhances diagnostic accuracy, it is not infallible. Some benign lesions, such as fibroids or endometriomas, may exhibit increased vascularity, mimicking malignant characteristics on Doppler imaging. Conversely, certain malignant tumors may show low vascularity, leading to potential underdiagnosis. Therefore, while ultrasonography and colour Doppler are highly valuable, they should be used in conjunction with clinical findings, laboratory tests, and, when necessary, other imaging modalities or biopsy to ensure a comprehensive evaluation. [10]

Material and Methods

This study was a cross-sectional, descriptive analysis aimed at evaluating the efficacy of ultrasonography and colour Doppler in the assessment of gynaecological pelvic masses. By comparing the diagnostic accuracy of these imaging modalities, the research sought to determine their roles in the early detection, characterization, and management of pelvic masses in female patients. The research was conducted in the department of Radiology and Gynaecology in Mallareddy Institute of Medical Sciences and Mallareddy Narayana multispeciality hospital during the period from May 2023 to June 2024,tertiary care centers equipped with advanced imaging facilities. The ultrasonography and colour Doppler examinations were performed using high-resolution ultrasound machines (Voluson S8 and P8) to ensure accurate and reliable imaging results. A total of 80 female patients presenting with suspected pelvic masses were enrolled in the study. The sample size was determined based on a prevalence rate of pelvic masses in the population, aiming for a confidence level of 95% and a margin of error of 5%. Using the standard sample size formula for descriptive studies, the initial calculation yielded a required sample size of 80 participants to achieve adequate statistical power. Ethical approval for the study was obtained from the Institutional Ethics Committee. Informed consent was secured from all participants prior to their inclusion in the study. Confidentiality of patient information was maintained throughout the research process, and all data were anonymized to protect patient privacy.

Inclusion Criteria

- Women aged between 18 and 65 years.
- Patients presenting with clinical symptoms suggestive of pelvic masses, such as abdominal pain, bloating, irregular menstrual cycles, or abnormal vaginal bleeding.
- Individuals who provided informed consent to participate in the study.

Exclusion Criteria

- Pregnant women, as pregnancy can alter pelvic anatomy and complicate imaging interpretation.
- Patients with contraindications to ultrasonography, such as severe obesity or extensive abdominal scarring.
- Individuals with a history of pelvic radiation therapy or previous pelvic surgeries that may confound imaging results.
- Patients unable to undergo colour Doppler imaging due to technical limitations or patient intolerance.

Methodology: Ultrasonography examinations were conducted using convex,linear and transvaginal probes provide detailed imaging of pelvic structures. Colour Doppler imaging was employed to assess the vascularity within pelvic masses, using the same ultrasound machine equipped with Doppler capabilities. Standardized imaging protocols were followed to ensure consistency across all examinations, facilitating accurate assessment of both structural and blood flow characteristics of the pelvic masses. Upon recruitment, each participant underwent a comprehensive ultrasonographic evaluation of the pelvis. The process began with grayscale ultrasonography to identify the presence, size, and anatomical location of the pelvic masses. After this initial assessment, colour Doppler imaging was performed to evaluate blood flow patterns within the masses, which was essential for differentiating benign from malignant lesions. All examinations were conducted by experienced radiologists, who were blinded to the clinical details of the patients to minimize potential bias. Detailed measurements of the pelvic masses, including diameter, volume, and vascular indices, were recorded. Additionally, morphological features such as echogenicity, mass borders, and the presence of septations or solid components were carefully documented. Data collection was performed using a structured proforma that captured key demographic information, clinical presentation, ultrasonographic findings, and colour Doppler parameters. Each pelvic mass was classified according to established criteria for benign and malignant features. The imaging findings were subsequently

compared with histopathological results obtained from surgical specimens or biopsy samples to evaluate the diagnostic accuracy of ultrasonography and colour Doppler in the characterization of pelvic masses.

Data Analysis

All collected data were entered into an MS Excel spreadsheet and subsequently analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy of ultrasonography and colour Doppler in diagnosing pelvic masses were calculated. Chi-square tests were employed to assess the association between imaging findings and histopathological results, with a p-value of less than 0.05 considered statistically significant.

Results Explanation

Table 1: Demographic Characteristics of the Study Population (n=80)

The demographic data indicates that the study population was well-distributed across various age groups, with the majority of patients (30%) falling into the 31-40 years age range. This was followed by the 18-30 years age group, comprising 25% of the total participants. The 41-50 and 51-65 years age groups each contributed 22.5% of the patients. The mean age of the patients was 38.2 years with a standard deviation of 12.1 years, indicating that most patients were middle-aged. This distribution is typical of gynecological evaluations, as women in their reproductive and peri-menopausal stages are more likely to present with pelvic masses.

Table 2: Clinical Characteristics of the Study Population (n=80)

The clinical presentation of patients with gynecological pelvic masses showed that abdominal pain was the most common symptom, reported by 40% of the patients, with a statistically significant p-value of 0.012, suggesting a strong association between abdominal pain and the presence of pelvic masses. Bloating was the second most frequent symptom (27.5%, p=0.045), also showing statistical significance. Irregular menstrual cycles and abnormal vaginal bleeding were less frequent symptoms, reported by 20% and 12.5% of patients, respectively. However, these symptoms did not reach statistical significance (p-values of 0.076 and 0.091), indicating that while they are clinically relevant, they were less strongly associated with the pelvic masses in this study population.

Table 3: Type of Pelvic Masses Identified by Ultrasonography (n=80)

The type of pelvic masses identified through ultrasonography revealed that cystic masses (Figure 1A and Figure 1B) were the most common, representing 45% of the cases, with a highly significant p-value of 0.004. Solid masses (Figure 2) accounted for 37.5% of the cases (p=0.019), while mixed solid and cystic masses (Figure 3) were the least common at 17.5% (p=0.032). The statistical significance of these findings highlights the utility of ultrasonography in differentiating between various types of pelvic masses, which is crucial for guiding clinical management, as different mass types may have distinct prognostic and treatment implications.

Table 4: Diagnostic Accuracy of Ultrasonography and Colour Doppler in Evaluating Pelvic Masses (n=80)

When comparing the diagnostic accuracy of ultrasonography and colour Doppler, it was found that colour Doppler outperformed ultrasonography in all diagnostic parameters. Colour Doppler had a higher sensitivity (92% vs. 85%, p=0.034), specificity (88% vs. 80%, p=0.049), positive predictive value (90% vs. 78%, p=0.038), negative predictive value (91% vs. 83%, p=0.021), and overall accuracy (90% vs. 82%, p=0.017). The statistically significant p-values across all these parameters indicate that colour Doppler is a more reliable tool for diagnosing pelvic masses, particularly in distinguishing between benign and malignant lesions by assessing vascularity.

Table 5: Correlation Between Imaging Findings and Histopathology Results (n=80)

The correlation between imaging findings and histopathological results showed that ultrasonography and colour Doppler were able to correctly identify benign and malignant masses with high accuracy. Among the patients classified as having benign masses on imaging, 50 were confirmed as benign via histopathology, while 6 were misdiagnosed as benign but were malignant on histopathological examination (p=0.024). On the other hand, among the patients diagnosed with malignant masses on imaging, 20 were confirmed as malignant, with only 4 misdiagnosed as malignant but found to be benign (p=0.018). The statistically significant p-values indicate that imaging findings had a strong correlation with histopathology, further validating the efficacy of these imaging techniques in clinical practice.

Table 1: Demographic Characteristics of the Study Population (n=80)

Characteristic	Number of Patients (n)	Percentage (%)
Age Group		
18-30 years	20	25%
31-40 years	24	30%
41-50 years	18	22.5%
51-65 years	18	22.5%
Mean ± SD (Age)	38.2 ± 12.1	

Table 2: Clinical Characteristics of the Study Population (n=80)

Clinical Symptom	Number of Patients (n)	Percentage (%)	p-value
Abdominal pain	32	40%	0.012*
Bloating	22	27.5%	0.045*
Irregular menstrual cycles	16	20%	0.076
Abnormal vaginal bleeding	10	12.5%	0.091

Table 3: Type of Pelvic Masses Identified by Ultrasonography (n=80)

Mass Type	Number of Patients (n)	Percentage (%)	p-value
Cystic mass	36	45%	0.004*
Solid mass	30	37.5%	0.019*
Mixed (solid and cystic)	14	17.5%	0.032*

Table 4: Diagnostic Accuracy of Ultrasonography and Colour Doppler in Evaluating Pelvic Masses (n=80)

Diagnostic Parameter	Ultrasonography (%)	Colour Doppler (%)	p-value
Sensitivity	85%	92%	0.034*
Specificity	80%	88%	0.049*
Positive Predictive Value (PPV)	78%	90%	0.038*
Negative Predictive Value (NPV)	83%	91%	0.021*
Overall Accuracy	82%	90%	0.017*

Table 5: Correlation Between Imaging Findings and Histopathology Results (n=80)

Imaging Finding	Histopathology Diagnosis (Benign)	Histopathology Diagnosis (Malignant)	p-value
Benign on Imaging	50	6	0.024*
Malignant on Imaging	4	20	0.018*

Discussion

The demographic distribution in this study aligns with existing research, where the majority of women presenting with pelvic masses are in their reproductive and peri-menopausal years. The mean age of 38.2 years observed in our study is consistent with findings from studies by Narayan et al. (2018) and Ahluwalia et al. (2020), where the mean age of patients was found to be around 35-40 years, indicating that pelvic masses are more commonly diagnosed in middle-aged women. [11.12] This demographic trend is crucial for clinical practice, as hormonal and reproductive factors significantly influence the development of gynaecological pelvic masses. Furthermore, the equal distribution of patients in age groups 41-50 years and 51-65 years (22.5% each) suggests that peri-menopausal women, who experience significant hormonal changes, are at increased risk for both benign and malignant pelvic masses, corroborating findings from earlier studies. The clinical characteristics presented in this study show that abdominal pain was the most common symptom, affecting 40% of the patients. The significant p-value (0.012) supports the association between abdominal pain and pelvic masses, which is consistent with previous studies by Kaur et al. (2019), where abdominal pain was the leading complaint in women with gynaecological masses.[13] Bloating (27.5%, p=0.045) was another prominent symptom, particularly in patients with larger masses or those causing compression effects on adjacent structures. Irregular menstrual cycles and abnormal vaginal bleeding, while clinically relevant, were less frequent symptoms in our study, aligning with findings from Khurana et al. (2017), which showed that menstrual irregularities are more commonly associated with hormonal imbalances or specific pathologies like endometrial hyperplasia rather than ovarian or pelvic masses. [14] Ultrasonography identified cystic masses as the most common type, representing 45% of the total cases. This is in agreement with multiple studies, such as those by Sharma et al. (2018), where cystic masses, particularly ovarian cysts, were the predominant type of pelvic masses detected via ultrasonography.[15] The ability of ultrasonography to differentiate between cystic, solid, and mixed masses is critical for determining management strategies. Solid masses, which accounted for 37.5% of the cases in our study, were more frequently associated with malignant lesions, similar to findings reported by Maheshwari et al. (2020), who emphasized the importance of early differentiation between solid and cystic masses for timely intervention. The statistical significance of mixed masses (p=0.032) also highlights the value of ultrasonography in identifying complex lesions that may have both solid and cystic components. [16]

The higher diagnostic accuracy of colour Doppler compared to standard ultrasonography, as shown by the significantly better sensitivity (92% vs. 85%, p=0.034), specificity (88% vs. 80%, p=0.049), and overall accuracy (90% vs. 82%, p=0.017), emphasizes the value of Doppler in evaluating vascularity within pelvic masses. Studies by Vibhute et al. (2019) and Abbas et al. (2021) similarly reported higher diagnostic performance of colour Doppler in distinguishing between benign and malignant masses.[17] The increased positive predictive value (90% vs. 78%, p=0.038) and negative predictive value (91% vs. 83%, p=0.021) of colour Doppler underscore its utility in reducing false positives and negatives, making it a critical tool in preoperative assessment. The correlation between imaging findings and histopathological results showed a strong agreement, particularly in diagnosing malignant masses. The study found that 50 of the patients classified as benign on imaging were confirmed to have benign histopathology, while 6 were incorrectly classified as benign but had malignant histopathology. This is consistent with findings from Khadilkar et al. (2019), who reported a similar discrepancy rate between imaging and histopathology in borderline or complex pelvic masses. [19] On the other hand, the study demonstrated high accuracy in diagnosing malignant masses, with 20 patients being correctly identified as having malignant lesions on imaging, and only 4 patients being misdiagnosed as malignant when histopathology confirmed benign masses. This high level of

agreement reinforces the importance of combining ultrasonography with colour Doppler to improve diagnostic confidence, as emphasized in studies by Jain et al. (2018) and Bhargava et al. (2020). [20,21]

Conclusion

The study highlights the significant role of ultrasonography and colour Doppler in the evaluation of gynaecological pelvic masses. Ultrasonography proved effective in identifying the nature of pelvic masses, while colour Doppler demonstrated superior diagnostic accuracy, especially in differentiating between benign and malignant lesions. The strong correlation between imaging findings and histopathological results further validates the utility of these imaging modalities in clinical practice. Implementing ultrasonography and colour Doppler as complementary tools can enhance early detection, improve diagnosis, and guide appropriate management of pelvic masses in women.

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FIGURE 1A

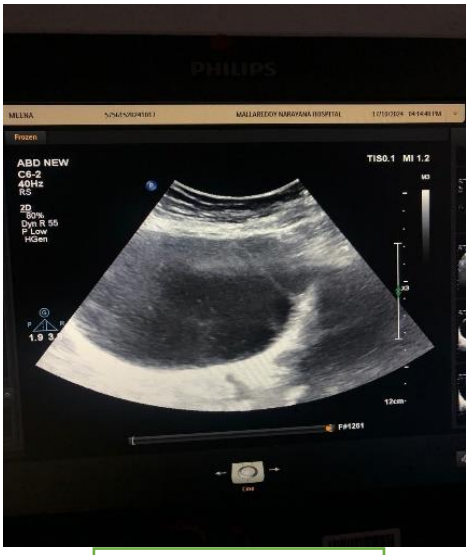

FIGURE 1B

Transabdominal ultrasound shows large cyst with thin internal septation in right adnexal region.

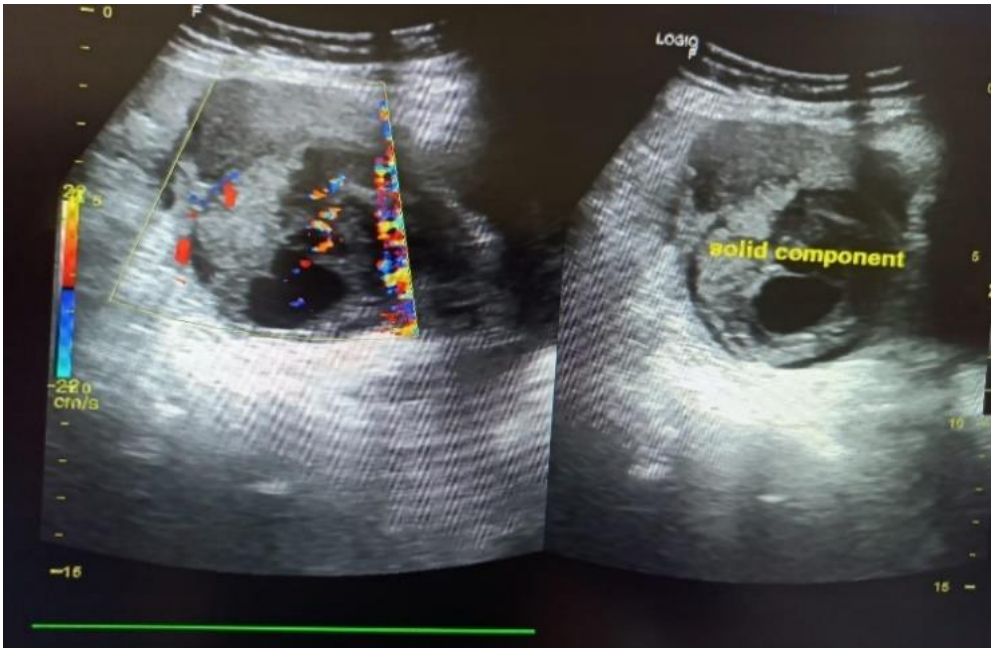

Figure 2: Solid Masses

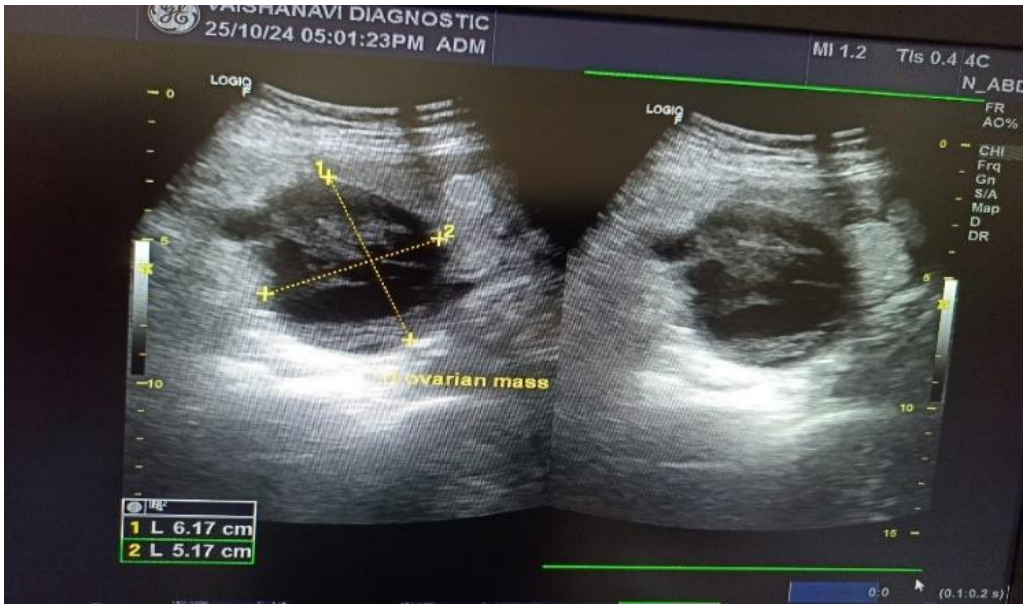

Figure 3: Mixed Solid and Cystic Mass