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The role of Transvaginal Ultrasound in the Diagnosis and Management of Female infertility: A Prospective Observational Study

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ABSTRACT

Female infertility is a multifaceted and emotionally challenging condition that affects millions of women worldwide. Prompt and accurate diagnosis is essential for developing effective strategies to manage fertility-related disorders. Transvaginal sonography, a non-invasive imaging technique that provides real-time visualization, plays a pivotal role in the diagnostic process. However, it is important to recognize that although transvaginal sonography is highly effective in identifying structural abnormalities, it may be less effective in detecting hormonal and lifestyle-related factors. This limitation underscores the importance of a comprehensive diagnostic approach that integrates additional clinical and laboratory methods to address the complex nature of female infertility.

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Keyword: Magnetic Resonance imaging (MRI), brain, tumor ، contrast

دور الموجات فوق الصوتية عبر المهبل في تشخيص وعلاج العقم عند النساء : دراسة رصدية مستقبلية

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الملخص:

يُعدّ العقم عند النساء حالةً معقدةً ومُرهقةً نفسيًا تُصيب ملايين النساء حول العالم. ويُعدّ التشخيص السريع والدقيق ضروريًا لوضع استراتيجيات فعّالة لإدارة اضطرابات الخصوبة. ويلعب التصوير بالموجات فوق الصوتية عبر المهبل، وهو تقنية تصوير غير جراحية تُتيح رؤيةً فوريةً، دورًا محوريًا في عملية التشخيص. ومع ذلك، من المهم إدراك أنه على الرغم من فعالية التصوير بالموجات فوق الصوتية عبر المهبل في تحديد التشوهات الهيكلية، إلا أنه قد يكون أقل فعاليةً في الكشف عن العوامل الهرمونية وعوامل نمط الحياة. ويُبرز هذا القصور أهمية اتباع نهج تشخيصي شامل يدمج أساليب سريرية ومخبرية إضافية لمعالجة الطبيعة المعقدة للعقم عند النساء.

الكلمات المفتاحية: الموجات فوق الصوتية عبر المهبل، العقم عند النساء، تشخيص العقم، التصوير التناسلي بالموجات فوق الصوتية للحوض، علاج العقم

INTRODUCTION

Infertility, concerning female reproductive health, denotes a woman's inability to conceive and maintain a pregnancy to term, despite participating in regular unprotected sexual intercourse for a prolonged duration, usually one year. It is estimated that this

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condition impacts approximately 8 to 12% of couples of reproductive age globally. This condition can cause significant emotional and psychological distress for individuals and couples desiring to have children. Female infertility may result from a range of factors, such as ovulatory disorders, structural abnormalities in the reproductive organs, endometrial complications, hormonal imbalances, and age-related issues. Understanding the definition of female infertility is crucial for addressing its profound effects on both individuals and society (Sarkar S & Gupta P, 2016).

The issue of female infertility is a significant global concern. Approximately 17.5% of the adult population, or about 1 in 6 individuals worldwide, face infertility, highlighting the pressing need to enhance access to affordable and high-quality fertility care for those affected (Greil AL & McQuillan J, 2010).

This condition impacts millions of women globally, emerging as a prevalent reproductive health challenge. The prevalence of infertility differs across various regions and populations, influenced by factors such as age, lifestyle choices, and existing medical conditions. In this detailed review, we will examine the multiple factors that contribute to female infertility and the importance of transvaginal ultrasound in its diagnosis (Carson SA & Kallen AN, 2021).

Imaging is essential for evaluating anatomical irregularities, tubal blockages, and ovarian reserve. This review emphasizes the use of ultrasound imaging to examine the uterus, ovaries, fallopian tubes, and pelvic cavity in relation to the identification of Müllerian duct anomalies, tubal structural abnormalities, intrauterine adhesions, uterine fibroids, and endometriosis. Ovarian abnormalities encompass: ovarian dysgenesis, premature ovarian failure, androgenic disorders, and polycystic ovarian syndrome. Uterine abnormalities consist of leiomyomas, Müllerian duct anomalies, endometrial polyps, intrauterine adhesions, and adenomyosis. Cervical abnormalities include factors contributing to infertility and cervical stenosis. Tubal abnormalities involve tubal occlusion, pelvic inflammatory disease (PID), and endometriosis (Carson SA & Kallen AN, 2021).

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The prompt and accurate identification of female infertility is crucial for various reasons. Firstly, it facilitates timely interventions and fertility treatments, thereby enhancing the likelihood of successful conception. Secondly, it aids in recognizing underlying medical conditions or reproductive health concerns that may necessitate medical or surgical intervention. Thirdly, an early diagnosis can mitigate emotional distress for individuals and couples by providing clarity regarding the causes of fertility challenges. Additionally, early diagnosis can conserve time and lessen the financial strain associated with extended infertility evaluations (Carson SA & Kallen AN, 2021).

Timely diagnosis is especially important due to the possible decline in female fertility associated with aging. As women grow older, both the quality and quantity of their eggs decrease, which can make conception more difficult. Consequently, an early and precise diagnosis allows healthcare professionals to tailor treatment options according to individual requirements, thereby potentially enhancing the likelihood of a successful pregnancy (Malawi S &Gari N, 2023). Ultrasound has emerged as a crucial instrument for diagnosing female infertility by visualizing pelvic organs, developing ovarian follicles, and the cyclical alterations in the endometrium throughout the menstrual cycle. This imaging technique is particularly effective in illustrating ovarian blood flow, resistance to flow, and various other factors that influence follicular development. In assisted reproductive technology (ART), ultrasound serves as an essential tool for monitoring ovarian follicles following hormone stimulation, during ovum retrieval, embryo transfer, and in the subsequent stages (Malawi S &Gari N, 2023).

The role of transvaginal sonography in diagnosing female infertility is significant. Follicular monitoring through transvaginal sonography serves as an essential method for evaluating follicular development, which is a crucial aspect of the ovulatory process. This monitoring entails carefully observing the growth and maturation of ovarian follicles during the menstrual cycle, usually starting in the early follicular phase. The benefits of utilizing

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transvaginal sonography for follicular monitoring are extensively recorded in existing literature (Malawi S &Gari N, 2023).

A key element is its ability to detect abnormal follicular development. Utilizing high-resolution imaging, transvaginal sonography can accurately identify irregularities in follicular growth, including the lack of dominant follicles or atypical growth patterns. This data is essential for diagnosing ovulatory disorders such as anovulation or oligo-ovulation (Bochenek M et al., 2015).

Transvaginal ultrasound is crucial for diagnosing PCOS as it highlights key features in the ovaries. During the procedure, numerous small follicular cysts, often compared to a "string of pearls," can be observed in the ovaries. These cysts arise from halted follicular development, which inhibits the release of mature eggs. By visualizing these distinctive cysts, transvaginal sonography assists in confirming the diagnosis of PCOS, directing treatment approaches, and evaluating the effectiveness of interventions (Bochenek M et al., 2015).

Transvaginal ultrasonography serves as an essential instrument for evaluating dysfunctions of the hypothalamic-pituitary-ovarian (HPO) axis, offering detailed information regarding ovarian activity, follicular maturation, and the process of ovulation. This data assists healthcare professionals in pinpointing the root causes of fertility challenges linked to HPO axis dysfunction, thereby enabling the formulation of precise and effective treatment strategies (Mikhael S et al.,2019).

This dysfunction affects female fertility and ovulation, highlighting the necessity of tracking follicular development and identifying ovulation when assessing ovarian reserve function. Key metrics, including ovarian volume, antral follicle count, peak flow rate of the ovarian interstitial artery, and peak end-diastolic flow velocity, serve as crucial indicators (Mikhael S et al.,2019).

Transvaginal sonography is vital in the diagnosis of endometriosis, as it allows for the visualization of endometrial implants, cysts (endometriomas), and pelvic adhesions. Early detection via transvaginal sonography is critical for timely intervention and management of the condition, which can enhance fertility outcomes for those affected. This imaging technique is also instrumental in

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evaluating the uterine cavity and detecting adhesions. By identifying these adhesions, transvaginal sonography aids in the diagnosis of Asherman's syndrome [2]. Furthermore, transvaginal sonography is important for assessing and comprehending fertility changes related to age (Alhassan A et al.,2023).

One of the key factors leading to age-related infertility is the reduction in both the quantity and quality of a woman's eggs. The ovaries house a limited number of eggs, and as a woman grows older, this ovarian reserve decreases. Transvaginal sonography is essential for assessing ovarian reserve by examining several important parameters: Antral follicle count: Transvaginal sonography. A diminished antral follicle count may suggest a smaller pool of available eggs, which can affect fertility potential (Afzal S et al.,2022).

Transvaginal sonography facilitates the evaluation of ovarian size and structure. Alterations in ovarian size, including a reduction in volume, may signify age-related changes in ovarian functionality (Afzal S et al.,2022).

Hormonal imbalances, including thyroid disorders like hypothyroidism or hyperthyroidism, as well as hyperprolactinemia (which is characterized by elevated prolactin levels), can interfere with the intricate hormonal balance necessary for the menstrual cycle and ovulation. Such imbalances may result in irregular or absent ovulation, thereby complicating the process of conception.

Transvaginal sonography can play a crucial role in identifying structural irregularities in the pituitary or thyroid glands that might lead to these hormonal imbalances (Dewald O & Khan YS, 2023).

Lifestyle elements, including high levels of stress, inadequate nutrition, tobacco use, excessive alcohol intake, and exposure to environmental pollutants, can significantly affect female fertility. Although transvaginal sonography does not directly identify lifestyle and environmental influences, it is instrumental in excluding structural and physiological reasons for infertility (Dewald O & Khan YS, 2023).

Ultrasound technology has significantly progressed in the field of reproductive medicine, particularly concerning female infertility. It serves as an essential instrument for diagnosing and managing a

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range of disorders. Specifically, transvaginal ultrasonography is crucial in infertility treatment, as it enables the assessment of both normal and stimulated ovarian cycles, the aspiration of follicles, and the subsequent transfer of embryos. Additionally, the application of color Doppler allows for the visualization of endometrial and intraovarian blood vessels, enhancing the understanding of both normal and abnormal physiological conditions of the uterus and ovaries (Dewald O & Khan YS, 2023).

Transvaginal ultrasound offers several benefits over transabdominal ultrasound, primarily due to its superior spatial resolution and the elimination of the requirement for a fully distended urinary bladder. In two-dimensional (2D) mode, ultrasound images are produced in sagittal and transverse planes. Conversely, three-dimensional (3D) ultrasound provides sagittal, transverse, and coronal views, resulting in a more comprehensive representation of the pelvic organs (Kontagora L et al.,2023).

The purpose of transvaginal ultrasound is to effectively evaluate pelvic anatomy, identify the underlying causes of infertility, and track the effectiveness of fertility treatments. Its importance in both scientific and clinical contexts is attributed to its safety, absence of radiation, and the high-resolution images it generates, all of which play a crucial role in accurate treatment planning (Kontagora L et al.,2023).

Materials and Methods

This study was designed as a prospective observational study to evaluate the role of transvaginal ultrasound in detecting and managing infertility in women.

Data Collection

The study was conducted over a period of three months at the gynecology and radiology departments of Tobruk Medical Center, Al-Shifa Center, and Al-Afiya Clinic.

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Plan of the Study

A total of 70 women of reproductive age (18–45 years), presenting with primary or secondary infertility, were included in this study. All participants provided informed consent before enrollment.

Methods

All patients underwent a detailed clinical evaluation, which included:

• Medical and gynecological history.

• Physical examination.

Transvaginal ultrasound examinations were performed using a high-frequency probe (5–9 MHz). The procedure was carried out during the early follicular phase of the menstrual cycle (days 2–5) unless otherwise indicated.

Ultrasound Assessment

The ultrasound assessment involved the following:

• Evaluation of the uterus (size, shape, and endometrial thickness).

• Detection of uterine abnormalities (fibroids, polyps, and congenital anomalies).

• Assessment of the ovaries (size, morphology, and the presence of cysts or polycystic ovaries).

• Follicular monitoring to assess ovulation.

• Detection of pelvic pathology (e.g., free fluid or visible adhesions).

Inclusion Criteria

• Women aged 18–45 years.

• Patients diagnosed with primary or secondary infertility.

• Patients willing to participate in the study.

Exclusion Criteria

• Pregnant women.

• Women with known malignancies.

• Patients who refused to participate.

Ethical Considerations: Strict adherence to ethical considerations was maintained throughout the study

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RESULTS AND DISCUSSION

A total of 70 women aged between 18 and 45 years were included in this study to evaluate the role of transvaginal ultrasound in detecting and managing infertility. The age distribution showed that the majority of cases were within the age group of 26–35 years (45%), followed by 36–45 years (30%), and 18–25 years (25%) as observed in Table :1

Table (1): Age cases and percentage

Age Group	Percentage
26-35 years	45%
36-45 years	30%
18-25 years	25%

Overall, this study confirms that transvaginal ultrasound is a crucial first-line investigation in infertile women. It provides valuable information that aids in early diagnosis, guides treatment decisions, and improves patient outcomes. Future studies with larger sample sizes are recommended to further validate these findings and explore additional diagnostic approaches.

This research underscores the crucial importance of transvaginal ultrasound in assessing and managing female infertility. The results indicate that ultrasound serves as a vital, non-invasive diagnostic instrument capable of identifying a broad spectrum of gynecological issues that could lead to infertility. The age distribution analysis showed that 45% of the participants fell within the 26–35 years age range, making it the most impacted demographic. This finding aligns with the peak reproductive age, during which women are more inclined to seek medical advice regarding infertility as in table: 1. In contrast, 30% of the participants were aged 36–45 years, suggesting a potential age-related decline in fertility, while only 25% belonged to the 18–25 years category, which may reflect lower awareness or a delay in seeking clinical evaluation (Kontagora L et al.,2023).

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To further evaluate the role of transvaginal ultrasound in the diagnosis and management of female infertility, ten cases of women with infertility were selected for detailed study. These cases were analyzed based on age, the presence of chronic medical conditions, and the type of infertility (primary or secondary). All participants provided informed consent, and follow-up was conducted over a period of three months, as shown in table 2.

Table (2): The ten cases of women with infertility

Ultrasound / Follow-up Findings	Infertility Type	Chronic Disease	Age	Case
Regular ovulation observed, mild ovarian cysts	Primary	Hypothyroidism	28	1
Endometrial thickness normal, fibroid detected	Secondary	None	35	2
Polycystic ovary morphology noted	Primary	Diabetes Mellitus	32	3
Irregular ovulation, uterine fibroids	Secondary	Hypertension	40	4
Normal findings, ovulation confirmed	Primary	None	25	5
Endometrial detected, ovulation irregular	Secondary	Hypothyroidism	37	6
Ovarian cysts detected, ovulation normal	Primary	None	30	7
Thin endometrium, irregular ovulation	Secondary	Diabetes Mellitus	42	8

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Ultrasound / Follow-up Findings	Infertility Type	Chronic Disease	Age	Case
Normal ultrasound findings, follicular growth monitored	Primary	None	29	9
Uterine fibroid and ovarian cysts detected	Secondary	Hypertension	38	10

Half of the participants were found to have chronic medical conditions, with hypothyroidism being the most common. Thyroid dysfunction is well known to affect menstrual cycles and ovulation, thereby contributing to infertility. Similarly, diabetes mellitus and hypertension can negatively impact reproductive health through hormonal imbalance and vascular changes. These results emphasize the importance of systemic health evaluation in infertile women. The most common conditions included: Hypothyroidism (20%), Diabetes Mellitus (15%), and Hypertension (15%).

In terms of infertility types, primary infertility was found to be more common, comprising 60% of the cases (n=42), whereas secondary infertility accounted for 40% (n=28). This study indicates that primary infertility is more prevalent than secondary infertility (60% compared to 40%) as shown in figure:1. This observation aligns with numerous regional and international studies, which suggest that a significant number of women face challenges in conceiving for the first time rather than following a previous pregnancy. Such difficulties may be attributed to underlying hormonal, ovarian, or structural issues that exist from the onset of reproductive life (Kontagora L et al.,2023).

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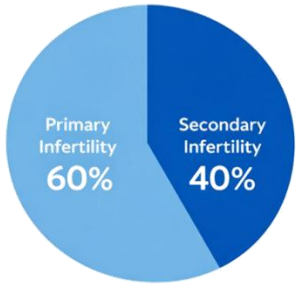

Figure 1: Difference between primary and secondary infertility.

Transvaginal ultrasound findings revealed various abnormalities, in Figure 2: Polycystic ovary morphology (PCOS) 25%, Ovarian cysts 20%, Uterine fibroids 18%, Endometrial abnormalities (polyps/thin endometrium) 17%, and Normal findings 20%. The ultrasound findings in this study revealed that polycystic ovary morphology (PCOS) was the most frequent abnormality (25%).

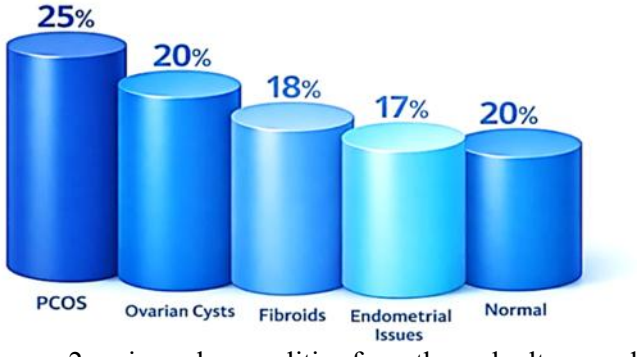

Figure :2 various abnormalities from through ultrasound

This is anticipated, as PCOS ranks among the primary causes of anovulation and infertility globally. Ovarian cysts, uterine fibroids, and endometrial irregularities were frequently identified. Each of these conditions has the potential to disrupt normal reproductive functions, including ovulation, fertilization, or implantation. Importantly, 20% of the participants exhibited normal ultrasound results. This figure is noteworthy, as it indicates that a significant number of infertility cases may stem from non-structural factors,

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such as hormonal imbalances, tubal issues, or male-related infertility, which are not identifiable through ultrasound alone (Malawi S & Gari N, 2023).

These results indicate that transvaginal ultrasound is essential for detecting both structural and functional factors contributing to infertility, facilitating timely diagnosis and suitable interventions. The findings of this research align with existing scientific literature and studies, which emphasize the significant role of transvaginal ultrasound in evaluating the reasons for infertility. Furthermore, these outcomes advocate for its application as a primary diagnostic instrument. This evidence enhances the credibility of the findings and helps prevent delayed diagnosis. In summary, the percentage-based outcomes of this study illustrate that transvaginal ultrasound serves as a highly effective diagnostic method for uncovering the root causes of infertility. The range of abnormalities identified further solidifies its position as a first-line assessment, promoting early diagnosis and informing appropriate clinical management (Malawi S & Gari N, 2023).

CONCLUSION

Ultrasound is a reliable tool in the diagnosis of many anatomical causes of female infertility and is comparable to gold standard investigations in many circumstances. Therefore, we recommend it as a primary investigation modality that could be complemented by other tools, such as MRI, HSG, and laparoscopy when needed. This comprehensive review highlighted the pivotal role of transvaginal sonography in diagnosing female infertility. Transvaginal ultrasound, a non-invasive and widely accessible imaging technique, has become a cornerstone in evaluating female reproductive health, providing a thorough understanding of the underlying anatomical factors.

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