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Maryam Ahmadzai

SU91-MAHSW-S23-208

FAHS

The Diagnostic Utility of Ultrasound in Pelvic Inflammatory Disease (PID)

SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

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Session: 2023-2025

Faculty of Allied Health Sciences

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This is to certify that the research work presented in this thesis, titled **"The Diagnostic Utility of Ultrasound in Pelvic Inflammatory Disease (PID)"** was conducted by **"Maryam Ahmadzai"** under the supervision of **"Dr. Rida Fatima"**

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of "**Allied Health Sciences"** in Faculty of Allied Health Sciences at The Superior University, Lahore.

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DEDICATION

We extend our deepest and heartfelt gratitude to our parents, teachers, supervisor and Co- supervisor, whose unwavering guidance, support, and assistance have been instrumental in our journey throughout the degree program. Their selfless dedication, constant encouragement, and endless patience provided us with the strength and motivation to persevere through challenges and celebrate our successes. Our parents, with their unconditional love and prayers, have been the cornerstone of our achievements, always believing in our potential even when we doubt ourselves. Similarly, our teachers and supervisors, with their expertise and mentoring, have imparted not only knowledge but also values that will guide us throughout our professional lives. All thanks to their support and care to ensure we got to this point. Most of all, we are grateful to Allah Almighty for showering upon us such kind and loving parents and for helping us to complete this work. This testifies that it is by His grace that one has been able to achieve all that one has in one's lifetime.

Maryam Ahamdzai

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In the name of Allah, the most Gracious, the most Merciful.

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In the end, I would like to extend my deepest gratitude to my family members. Without their encouragement, I would not have been able to complete this endeavor.

Maryam Ahamdzai

TABLE OF CONTENTS

LIST OF TABLES

Table No. **Description** **Page**

LIST OF FIGURES

Figure No. Description Page

LIST OF ABBREVIATIONS

3D US	Three-Dimensional Ultrasound
IUD	Intrauterine Device
CT	Computed Tomography
CTA	Computed Tomography Angiography
D&C	Dilation and Curettage
Doppler US	Doppler Ultrasound
E.coli	Escherichia coli
HSG	Hysterosalpingography
MRI	Magnetic Imaging Resonance
PID	Pelvic Inflammatory Disease
PCO	Polycystic ovary syndrome
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
TOA	Tubo-Ovarian Abscess
TVS	Transvaginal Ultrasound
US	Ultrasound

Abstract

Introduction:

Pelvic Inflammatory Disease refers to the acute or chronic infection of the female upper genital tract, primarily involving the uterus, fallopian tubes, ovaries, and adjacent pelvic structures. The pathogenesis of PID is complex and can result from ascending infections, typically following vaginal or cervical infections. Infections caused by Chlamydia trachomatis and Neisseria gonorrhoeae are the most common etiologies, although other pathogens such as Escherichia coli, Mycoplasma genitalium, and anaerobic bacteria may also contribute.

Aim of the study:

The aim of this study was to evaluate the diagnostic efficacy of ultrasound in identifying Pelvic Inflammatory Disease (PID), This investigation seeks to establish ultrasound as a practical, non-invasive imaging alternative that can improve diagnostic accuracy, patient outcomes and decreased healthcare cost in cases of Pelvic Inflammatory Disease (PID).

Methodology:

This cross-sectional investigation was carried out at Popular Diagnostic Center, Peshawar. 139 people were chosen as the sample size using a practical sampling approach. Women between the ages of 18 years and 45 years who had been clinically diagnosed with pelvic inflammatory disease (PID) and had completed initial diagnostic testing were included in the research. Patients who are pregnant, had recent pelvic surgery, have persistent pelvic discomfort unrelated to acute PID, or do not provide their consent are excluded. A Toshiba Aplio 200 equipped with a convex probe operating at 3-5 MHz was be used to gather data. Following the rules set forth by Superior University in Lahore ensured informed permission, patient privacy, confidentiality and voluntary

involvement.

Results:

The study analyzed 139 female patients with pelvic inflammatory disease (PID), with a mean age of 34.64 years. Most patients were aged 26-45 years. Among them, 56.1% were married. The study found that 33.1% experienced severe pelvic pain, 53.2% had abnormal menstruation, and 56.1% reported vaginal discharge. Ultrasonographic results showed an average endometrium thickness of 10.47 mm, with 51.1% having homogeneous uterine echogenicity. This data underscores the significant prevalence of severe pain, abnormal menstruation, and vaginal discharge in PID patients.

Conclusion:

This research assessed the role of ultrasound in diagnosing Pelvic Inflammatory Disease (PID), focusing on key markers such as endometrial thickening, uterine echogenicity, and cul-de-sac free fluid. The findings confirmed that ultrasound is an effective and accessible imaging tool for identifying complications associated with PID.

Chapter 1

INTRODUCTION

Pelvic Inflammatory Disease (PID) refers to the acute or chronic infection of the female upper genital tract, primarily involving the uterus, fallopian tubes, ovaries, and adjacent pelvic structures. The pathogenesis of PID is complex and can result from ascending infections, typically following vaginal or cervical infections (1). Infections caused by Chlamydia trachomatis and Neisseria gonorrhoeae are the most common etiologies, although other pathogens such as Escherichia coli, Mycoplasma genitalium, and anaerobic bacteria may also contribute (2).

PID can present in different forms, ranging from mild cases with nonspecific symptoms to severe infections resulting in life-threatening complications. The clinical presentation often includes pelvic pain, fever, abnormal vaginal discharge, and dyspareunia (pain during intercourse). However, these symptoms can also be seen in other conditions such as ectopic pregnancy, ovarian cysts, and other gynecological disorders, making the diagnosis of PID challenging (3).

The early diagnosis and treatment of PID are critical to preventing long-term sequelae, including infertility, chronic pelvic pain, ectopic pregnancy, and tubal factor infertility, which accounts for a significant proportion of infertility cases worldwide (Figure 1.1). PID is also a risk factor for the acquisition of HIV, as untreated infections may facilitate the transmission of the virus. Moreover, the financial and emotional costs of PID-related complications make effective diagnosis and management essential for improving public health outcomes (1, 4). The specificity of the diagnosis is increased by adding more diagnostic signs, but the sensitivity may be lowered and PID cases may be missed as a result (5). Table 2 presents findings that support the PID diagnosis (Table 1.1).

Given the potentially shocking consequences of missed or delayed diagnosis, it is essential to have a reliable, accessible, and accurate method for diagnosing PID. Although clinical diagnosis remains the cornerstone of PID detection, imaging modalities such as ultrasound have become increasingly important for confirming the

diagnosis, particularly in cases where clinical findings are ambiguous or when there is a need to assess the extent of the disease (6).

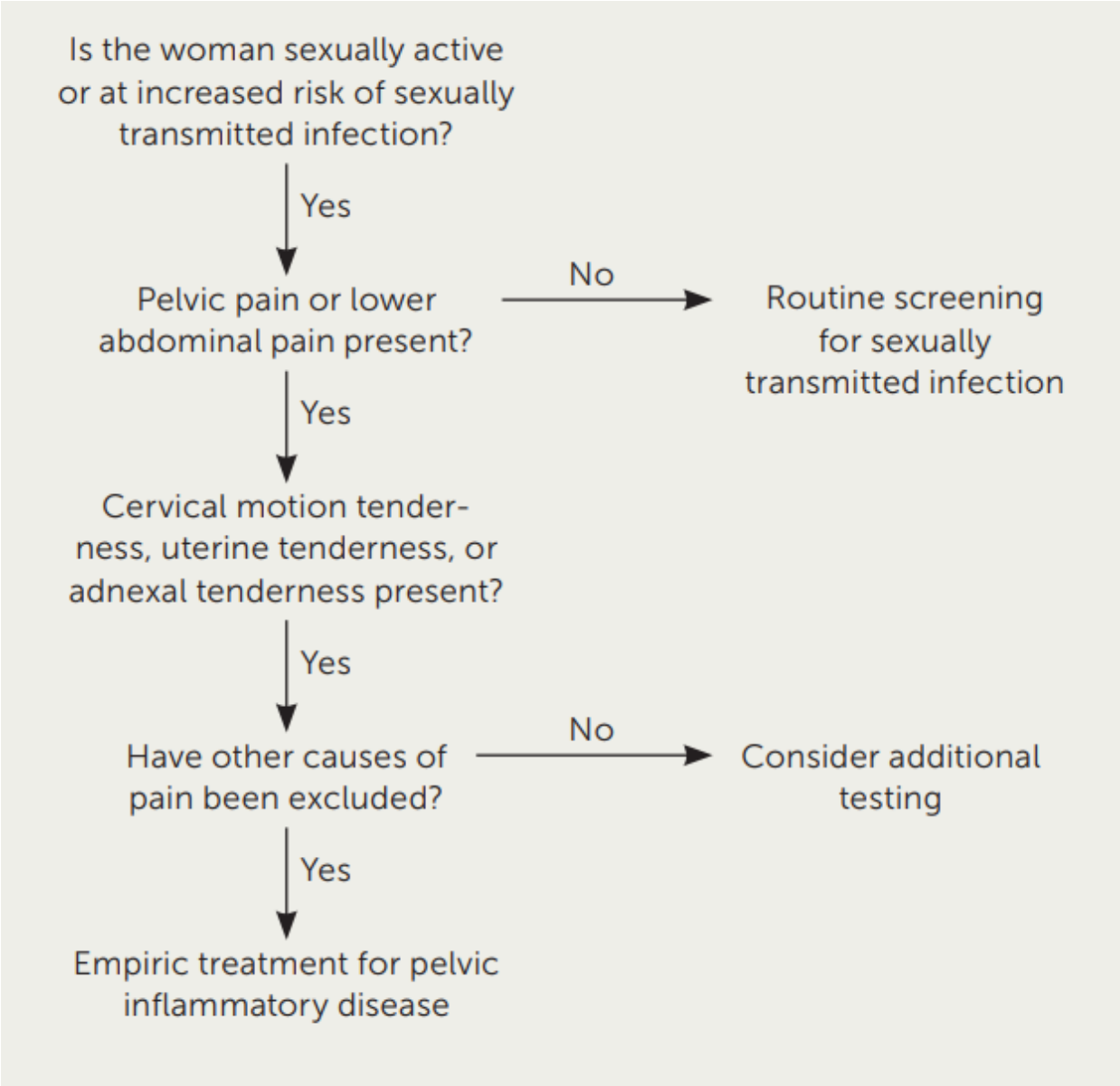

Figure 1.1: Steps for determining treatment for pelvic inflammatory disease.

Table 1.1: Alternative Diagnostic Testing for Pelvic Pain

Diagnosis	Clinical findings	Diagnostic testing
Appendicitis	Peritoneal signs Periumbilical or right lower quadrant pain Vomiting/anorexia	Computed tomography or ultrasonography
Ectopic pregnancy or rupture	Hypotension or anemia Missed menses Positive pregnancy test Unilateral pelvic pain	Transvaginal ultrasonography
Endometriosis	Dyschezia Dysmenorrhea, intermenstrual bleeding Dyspareunia	Definitive testing is laparoscopy with histologic confirmation after biopsy
Endometritis	Acute: fever, pelvic pain, vaginal discharge Chronic: pelvic discomfort, vaginal spotting, leukorrhea	Endometrial biopsy
Ovarian cyst, rupture, or torsion	Acute onset of severe unilateral pain	Transvaginal ultrasonography
Tubo-ovarian abscess	Fever Pelvic/adnexal mass on bimanual examination Unilateral pelvic pain	Transvaginal ultrasonography
Ureteral calculus	Dysuria Fever, nausea, vomiting, hematuria Pain (flank, pelvic, or abdominal)	Computed tomography, plain radiography, ultrasonography, urinalysis
Urinary tract infection	Increased urinary frequency, dysuria, or hematuria Mid- or bilateral pelvic pain	Urinalysis with microscopic examination, urine culture

Female Pelvic Anatomy

The uterus is located in the pelvis between the urinary bladder and the rectum. The body of the uterus lies between the layers of the broad ligament and is freely movable. The peritoneal reflections covering the uterus and bladder form the vesicouterine pouch, and those covering the uterus and rectum form the rectouterine pouch. The broad ligament assists in fixing the uterus in place and represents a double layer of peritoneum (mesentery) that extends from the sides of the uterus to the lateral walls and floor of the pelvis (7). The portion of the broad ligament that forms the mesentery of the uterine tube (fallopian tube) is termed the mesosalpinx. The ovaries lie close to the fimbriae, the distal ends of the fallopian tubes. The superolateral margin of the broad ligament forms the suspensory ligament of the ovary, which extends over the ovarian vessels. The ligament of the ovary (proper ligament of the ovary) attaches to the uterus posteroinferior to the uterotubal junction (7, 8). The round ligament of the uterus attaches anteroinferior to the uterotubal junction and extends into the bilateral inguinal canals. The uterosacral ligaments course posterosuperior from the lateral margins of the cervix to the midportion of the sacrum. These ligaments provide both passive and active support, allowing the uterus to maintain its central position in the pelvic cavity (Fig 1.2, 1.3, 1.4 and 1.5). All the aforementioned structures may be involved in pelvic infectious or inflammatory processes, which usually result in thickening and hyperemia of the structures (6).

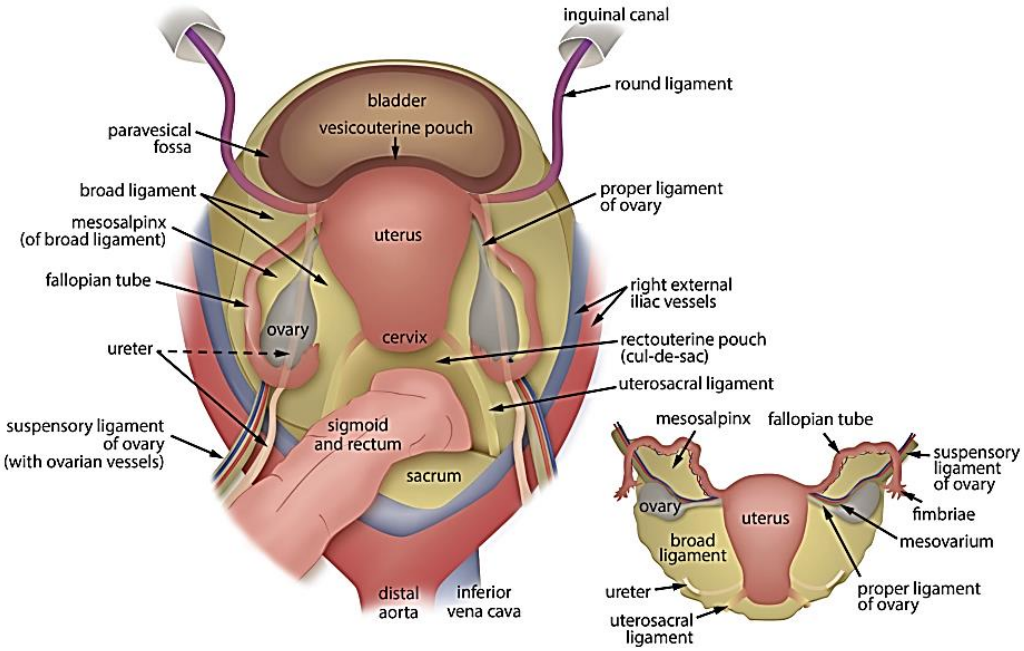

Figure 1.2: Female pelvic anatomy adopted form Ujaddughe O et al., 2024

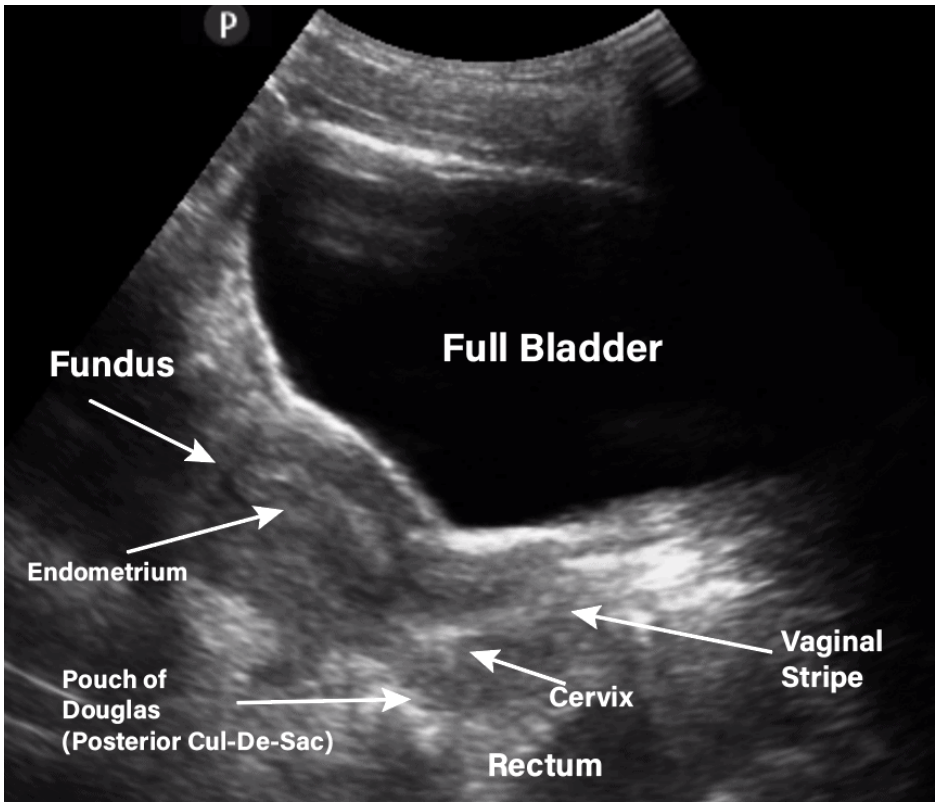

Figure 1.3: Transabdominal Pelvic Ultrasound a Longitudinal View of Female Pelvic Anatomy adopted form Ujaddughe O et al., 2024

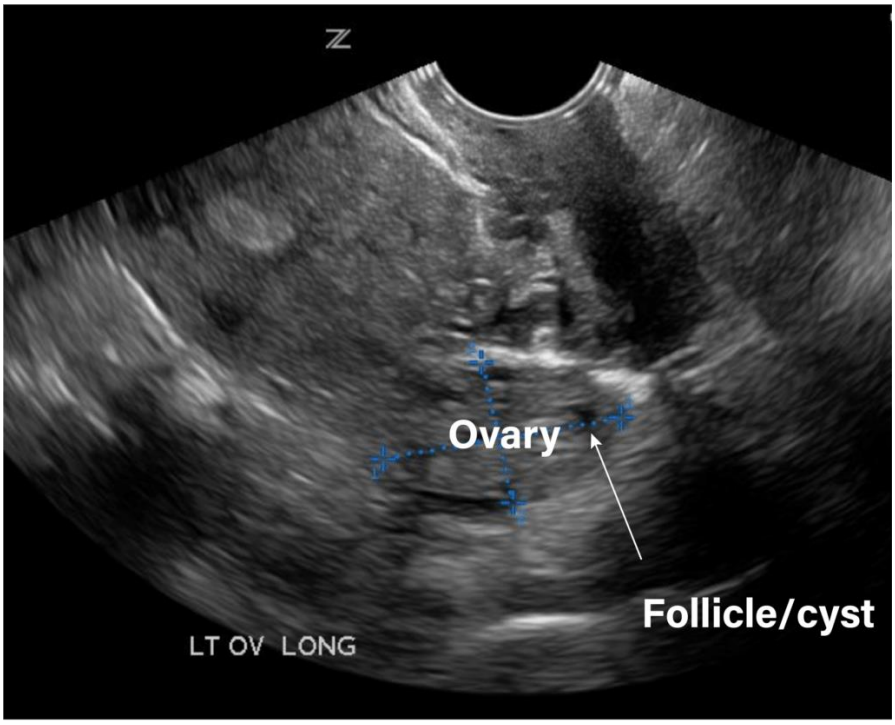

Figure 1.4: Normal ovary with follicle/cyst; transvaginal ultrasound adopted form Ujaddughe O et al., 2024

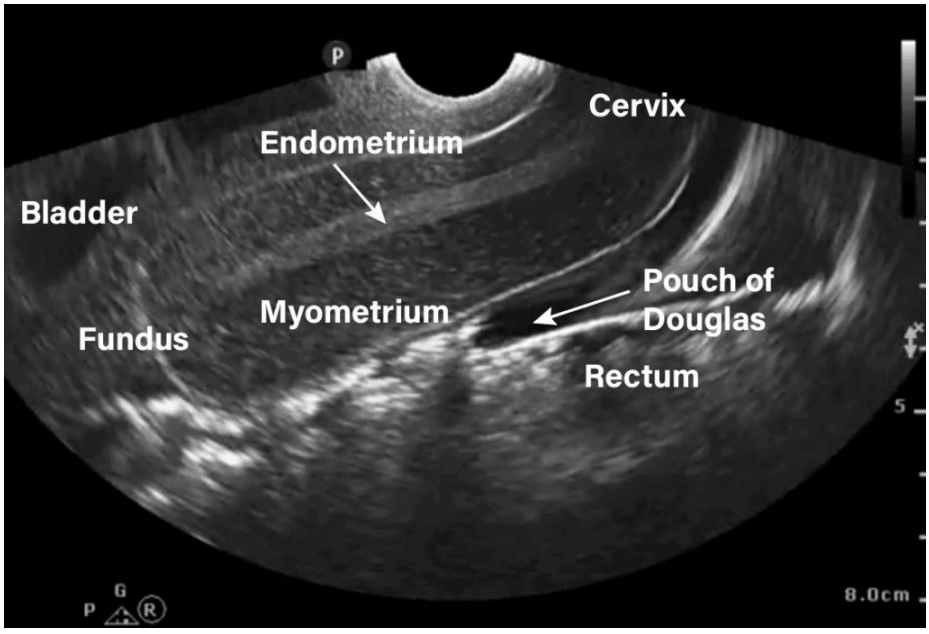

Figure 1.5: Sagittal transvaginal Ultrasound with free fluid in pouch of Douglas adopted form Ujaddughe O et al., 2024

Clinical Diagnosis of PID

The clinical diagnosis of PID is primarily based on a combination of symptoms, physical examination findings, and laboratory tests. However, there is no single definitive test for PID, which often results in diagnostic uncertainty. The diagnosis can be made through a combination of factors, such as History of pelvic pain, abnormal vaginal discharge or bleeding, fever and tenderness on pelvic examination (e.g., cervical motion tenderness) (9).

Despite these indicators, many patients may not present with the typical signs of PID. For example, up to 50% of women with asymptomatic or subclinical PID may not show signs of significant inflammation or infection, which makes clinical diagnosis particularly difficult in these cases. Furthermore, the absence of laboratory confirmation or microbiological testing (often due to delayed testing or lack of access to resources) adds to the complexity (9).

Role of Laboratory Tests in PID Diagnosis

Laboratory tests are integral to diagnosing PID but often fall short in providing immediate, definitive answers. Microbiological cultures, polymerase chain reaction (PCR) tests, and serological tests for sexually transmitted infections (STIs) can help identify the causative pathogens, but these tests can be time-consuming, costly, and unavailable in resource-limited settings. In addition, some forms of PID may be caused by non-chlamydial, non-gonococcal bacteria, which may not be detected by routine STI testing (10).

The Role of Computed Tomography in PID Diagnosis

A CT examination is frequently performed in patients with nonspecific symptoms, as well as in patients with suspected pelvic pathologic conditions and equivocal US findings. CT of the abdomen and pelvis is usually performed on a 64-section CT scanner, with the scan obtained from the level of the dome of the diaphragm to the level of the pubic symphysis (10, 11).

Administration of diluted oral barium contrast material is helpful in the distinction of the gastrointestinal tract from adnexal structures. However, a new trend is to eliminate the routine use of oral contrast material for CT in the emergency department, because investigators have shown that its elimination does not compromise diagnosis in the acutely ill patient and successfully decreases the length of stay in the emergency department (12). Intravenous contrast material administration is preferred because it allows better delineation of the uterus and adnexal structures, as well as assessment of endometrial, cervical, and tubal perfusion. At our institution, the examinations were performed with CT scanners (LightSpeed VCT or Discovery CT750 HD; GE Healthcare) (13). All examinations are performed in the portal venous phase. The portal venous phase images were acquired by using a scanning delay of 70 seconds after the injection of 85 mL of iohexol (Omnipaque 300; GE Healthcare) at a rate of 2–3 mL/sec. The CT parameters were as follows: section thickness, 5 mm; reconstruction interval, 0.625 mm; pitch, 0.6; voltage, 120 kVp with automatic exposure control (Auto or Smart mA; GE Healthcare); and noise index, 22. The data were reconstructed by using a standard algorithm. Coronal and sagittal multiplanar reconstructions, which are useful for evaluating complex female pelvic anatomy, are created by using source data obtained in the axial plane. Oral contrast material was prepared with 25 mL of iohexol (Omnipaque 350; GE Healthcare) diluted in 875 mL of water. Oral contrast material was administered starting 90 minutes before the examination. It is important to note that a patient's pregnancy status must be determined before performing CT in any premenopausal female (14).

General CT Findings of PID

PID represents a clinical continuum of the infectious conditions that affect the upper genital tract. Because there is a gradual progression from one condition to the next, no true separation exists between each entity, and therefore considerable overlap exists in the general imaging features of each of these infectious processes. After a review of the general imaging features encountered with PID, specific entities was reviewed individually (15, 16).

The most common general CT findings of PID described in the literature are thickening of the uterosacral ligaments, obliteration of fascial planes, free fluid in the cul-de-sac, loss of definition of the uterine border, pelvic fat infiltration or haziness and pelvic edema, reactive lymphadenopathy, and signs of peritonitis (17). The uterosacral ligaments are paired structures that extend from the lower uterine segment to the mid sacrum and are best seen on axial cross-sectional images. The normal thickness of the uterosacral ligaments is subjective and has not yet been established on CT images (Figure 1.5). Posterior extension of inflammatory adnexal or tubal disease often causes thickening of the uterosacral ligaments and increased haziness of the presacral and perirectal fat planes (18). Pelvic fat haziness refers to increased attenuation of the pelvic fat when compared with retroperitoneal fat. Pelvic fat haziness is one of the most sensitive findings of acute PID and is seen in as many as 65% of patients. Pelvic peritonitis refers to increased attenuation and marked stranding of the pelvic fat with peritoneal enhancement (19).

PID often is accompanied by reactive lymphadenopathy affecting the paraaortic lymphatic chain at the level of the renal hila. This lymph adenopathy is caused by the course of drainage of the ovarian and salpingian lymphatic vessels along the gonadal veins (20).

Additional imaging findings predictive of PID are *(a)* hepatic capsular enhancement on the late arterial phase images and *(b)* fallopian tube thickening of more than 5 mm. The combination of these two findings had a sensitivity of 71.9%, specificity of 81.3%, and accuracy of 76.6% (10). The specificity of the tubal thickening sign alone has been reported to be as high as 95% (21).

Normal pelvic anatomy. Axial contrast-enhanced CT image shows a normal appearance of the uterosacral ligaments (long arrows), round ligaments (short arrows), clear fat in the rectouterine pouch (★), and anterior pelvic fat (*), as well as normal size of the uterus *(U)*.

a.

b.

Figure 1.5 Early PID: general CT findings in two different patients. **(a)** Axial contrast-enhanced CT image of a 32-year-old woman presenting with pelvic pain and low-grade fever shows thickened and edematous uterosacral ligaments (arrows). **(b)** Axial contrast-enhanced CT image of a 25-year-old woman with cervical motion tenderness shows marked anterior pelvic fat stranding (long arrow) and thickening of the left fallopian tube (short arrow). PID was confirmed clinically on the basis of the patient's microbiologic results.

The Role of Ultrasound in PID Diagnosis

Principles of Ultrasound Imaging

Ultrasound uses high-frequency sound waves to produce images of the inside of the body. The sound waves are transmitted into the body and reflected back by various tissues, which are then converted into an image. Ultrasound is widely used in clinical practice for imaging the abdominal and pelvic organs due to its ability to visualize soft tissues, detect fluid collections, and assess organ morphology in real-time (22). There are two main types of ultrasound techniques used in the diagnosis of PID:

- **Transabdominal ultrasound**: Performed by placing a probe on the abdomen, it allows for the visualization of the larger pelvic structures and organs, but may not provide sufficient detail for detecting smaller structures such as the fallopian tubes (23).

- **Transvaginal ultrasound**: This method involves inserting a probe into the vagina and is typically used to obtain more detailed images of the pelvic organs, including the uterus, ovaries, and fallopian tubes. It is more sensitive than transabdominal ultrasound for detecting inflammatory changes and abscesses (24).

Ultrasound Findings in PID

Ultrasound plays a crucial role in the diagnosis of PID, helping to identify both direct and indirect signs of the disease. Key ultrasound findings in PID include:

- **Pelvic free fluid**: The presence of fluid in the pelvic cavity can indicate inflammation or infection, such as in the case of a tubo-ovarian abscess or an inflamed uterus.

- **Tubo-ovarian abscess (TOA)**: A hallmark complication of severe PID, TOAs are visualized as complex, cystic structures with both solid and fluid components, often located near the ovaries or fallopian tubes.

- **Endometrial thickening**: Inflammatory changes in the endometrium can cause it to appear thicker than usual on ultrasound, which can be a sign of endometritis.
- **Ovarian and fallopian tube enlargement**: Inflammation in the fallopian tubes or ovaries can lead to enlargement, which is often visible on ultrasound.

Advantages of Ultrasound

Ultrasound has several advantages in diagnosing PID, including:

- Non-invasive and relatively low cost compared to other imaging modalities like CT or MRI.
- Real-time imaging that can assist in guiding clinical management decisions.
- The ability to detect complications such as abscesses, hydro salpinges, and other anatomical abnormalities.

Limitations of Ultrasound

Despite its advantages, ultrasound also has certain limitations in the diagnosis of PID:

- **Sensitivity and specificity**: Ultrasound may miss early or mild cases of PID, particularly those without complications such as abscesses.
- **Operator dependence**: The accuracy of ultrasound depends on the skill and experience of the operator, which can vary widely.
- **Inability to diagnose infection**: While ultrasound can identify anatomic changes, it cannot identify the causative pathogens of PID.

Ultrasound in Comparison to Other Diagnostic Modalities

Comparison with Clinical Diagnosis

While clinical diagnosis remains the first-line method for identifying PID, ultrasound can complement clinical findings by providing anatomical confirmation and visualizing

complications. However, ultrasound alone may not always suffice for an early or definitive diagnosis, especially in cases where clinical findings are ambiguous (25).

Comparison with Laparoscopy

Laparoscopy, considered the gold standard for diagnosing PID, allows direct visualization of the pelvic organs and can provide a definitive diagnosis. However, it is invasive, costly, and requires specialized expertise and equipment (26). Laparoscopy is typically reserved for cases where the diagnosis is unclear or when there is a need to evaluate the severity of the disease or its complications (such as abscesses or adhesions). In comparison, ultrasound is non-invasive, more accessible, and does not require general anesthesia, making it a preferred first-line diagnostic tool in many settings, especially in resource-limited environments. However, the sensitivity of ultrasound in detecting subtle or early stages of PID may be lower than that of laparoscopy, which allows direct visualization of the pelvic organs (27).

Comparison with MRI and CT Scanning

Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are advanced imaging modalities that can provide detailed images of pelvic anatomy and help assess complex cases of PID, particularly when there is concern about other conditions like tumors or abscesses (25). MRI, in particular, can offer high-resolution imaging of soft tissues and is highly effective in detecting complicated PID presentations, such as tubo-ovarian abscesses (25). However, both MRI and CT scans are more expensive, less accessible, and involve longer wait times compared to ultrasound.

In clinical practice, ultrasound often serves as the first-line imaging modality due to its superior cost-effectiveness, rapid turnaround, and ease of use. MRI and CT scans are generally reserved for cases where ultrasound findings are inconclusive, or when there is a need for more detailed anatomical assessment (3, 28).

Advances in Ultrasound Technology for PID Diagnosis

Doppler Ultrasound

One important advancement in ultrasound technology is the use of Doppler ultrasound, which can assess blood flow within pelvic organs. In the context of PID, Doppler ultrasound can help evaluate the extent of vascular changes due to inflammation or infection. Increased blood flow, as indicated by color Doppler imaging, can be a sign of active inflammation in the pelvic organs, such as the uterus, ovaries, or fallopian tubes. This technology is particularly useful in detecting complications like tubo-ovarian abscesses, where increased vascularity may be present (24).

3D Ultrasound Imaging

Three-dimensional (3D) ultrasound is another emerging technology that provides more detailed and comprehensive imaging of the pelvic organs. This advanced technique allows for the creation of volumetric images, which can offer a more thorough assessment of anatomical structures and facilitate the detection of subtle pathological changes that may not be visible on standard 2D ultrasound. For PID, 3D ultrasound could potentially enhance the detection of uterine abnormalities, fallopian tube pathologies, and the presence of abscesses or free fluid, offering additional diagnostic value (22, 23).

Elastography in PID

Elastography, a relatively new technique in ultrasound imaging, measures tissue stiffness by assessing the propagation of sound waves through tissue. In PID, elastography could potentially be used to assess the degree of inflammation or fibrosis in the pelvic organs, such as the uterus or fallopian tubes. While this technique is still in the experimental stages, it may eventually play a role in improving the diagnostic accuracy and monitoring the progression of PID over time (8).

Artificial Intelligence and Ultrasound

The integration of artificial intelligence (AI) in ultrasound imaging is another frontier in the diagnostic field. AI algorithms can assist in the interpretation of ultrasound images, potentially improving diagnostic accuracy and reducing human error. AI could help automate the detection of common PID findings, such as fluid collections, abscesses, or tubal dilation, thereby reducing the burden on radiologists and increasing the speed of diagnosis. As AI technology continues to evolve, it holds promise for improving the precision and reliability of ultrasound in diagnosing PID (25).

Clinical Implications and Future Directions

Enhancing Diagnostic Accuracy

The use of ultrasound in diagnosing PID offers significant potential to improve clinical outcomes, particularly when combined with clinical examination and laboratory testing. However, improving the diagnostic accuracy of ultrasound in PID requires further research and refinement in imaging techniques, as well as the development of standardized criteria for interpreting ultrasound findings in the context of PID. Collaborative efforts between clinicians, radiologists, and researchers was be crucial in establishing more robust guidelines for the use of ultrasound in PID diagnosis (25).

One of the critical challenges in the use of ultrasound for PID is its variable sensitivity, especially for detecting early or mild cases of the disease. To address this, future studies should focus on refining imaging protocols and exploring the integration of complementary diagnostic tools, such as PCR-based pathogen detection or advanced biomarkers, to increase the overall diagnostic accuracy (29).

Role of Ultrasound in Monitoring Treatment Response

In addition to its role in diagnosing PID, ultrasound can also be useful in monitoring the treatment response in patients with PID. Serial ultrasound examinations can help track changes in the size of tubo-ovarian abscesses, the resolution of pelvic free fluid, and the normalization of anatomical structures, providing valuable information about the

effectiveness of medical or surgical treatment. Furthermore, ultrasound can be used to guide interventions, such as the drainage of abscesses or the placement of a catheter, when necessary (30).

One of the key advantages of ultrasound is its accessibility, particularly in low-resource settings where more expensive imaging modalities like MRI and CT may not be readily available. Expanding access to ultrasound in these regions, especially in primary care or remote settings, could significantly improve the early diagnosis of PID and reduce the incidence of complications such as infertility and chronic pelvic pain. Training healthcare providers in the proper use and interpretation of ultrasound is critical to ensuring its effective deployment in diverse healthcare environments (31).

Scope and Focus

The scope of this thesis was to examine the diagnostic value of ultrasound for pelvic inflammatory disease (PID) in women aged 18-45. It focused on patients who came in with symptoms of PID, such as pelvic pain, abnormal vaginal discharge, and fever. Ultrasound was used as the main tool to examine key structures like the uterus and fallopian tubes, looking for signs of PID, including abscesses, thickened endometrium, and fluid in the pelvic area. The research was completed over a four-month period, allowing enough time to gather data and assess the accuracy of ultrasound in diagnosing PID (32).

Importance and Relevance

The main goal of this research was to help improve the diagnosis of PID, which is common but hard to diagnose because its symptoms are similar to those of other gynecological issues. PID can lead to serious health problems, such as infertility, ectopic pregnancies, and ongoing pelvic pain, if not treated. Typically, doctors use clinical exams and lab tests to diagnose PID, but ultrasound has shown promise as a non-invasive, widely accessible option without radiation. This study aimed to show how ultrasound could help detect important signs of PID, providing healthcare workers with a reliable tool for faster and more accurate diagnoses (33).

The results from this study may encourage the use of ultrasound as a first-choice test for PID, which could help healthcare providers make quicker, more accurate diagnoses. This could improve patient outcomes and offer a cost-effective solution for PID management.

AIM AND OBJECTIVES

The aim of this study was to evaluate the diagnostic efficacy of ultrasound in identifying pelvic inflammatory disease (PID), This investigation seeks to establish ultrasound as a practical, non-invasive imaging alternative that can improve diagnostic accuracy, patient outcomes and decreased healthcare cost in cases of PID.

Chapter 2

LITERATURE REVIEW

Research was published in 2021 by Sharon et al., where the author state that the pelvic inflammatory disease (PID) is a significant health concern for women, often resulting in chronic pelvic pain and infertility. The article explores the evolving causes of PID, including sexually transmitted infections (STIs) like gonorrhea and chlamydia, as well as other pathogens such as Mycoplasma genitalium and bacteria linked to bacterial vaginosis. It underscores the need for improved diagnostic tools and noninvasive tests to accurately detect PID. Additionally, the article highlights the importance of developing vaccines against STIs to prevent PID and calls for further research to fill the gaps in understanding the disease's epidemiology and pathogenesis. Furthermore, in 2019, the age-standardized rate (ASR) of PID prevalence was 53.19 per 100,000 population globally. Western Sub-Saharan Africa, Australasia, and Central Sub-Saharan Africa had the highest ASR of PID prevalence1. In the United States, around 4% of females aged 18 to 44 years report having had PID. In Europe, the notification rates for chlamydia, a common cause of PID, ranged between 0.1 and 709 cases per 100,000 population in 20223. These statistics highlight the global burden of PID and the need for effective interventions and strategies to address this public health issue (34).

A study conducted by Indian researcher Farah Naaz et al., she concluded tht the pelvic inflammatory disease (PID) is a significant health concern for young, sexually active women, particularly those in their reproductive years. This study, conducted over a year with 200 women diagnosed with PID, provides valuable insights into the demographic and epidemiological factors associated with the disease. The highest incidence of PID was observed in women aged 25-29 years, highlighting the vulnerability of this age group. Education level appeared to be a critical factor, with 30% of the affected women being illiterate. This suggests that higher education levels may contribute to better awareness and prevention of the disease. Socio-economic status also played a role, with the majority of women affected by PID belonging to the middle-income group. This finding aligns with previous research indicating that socio-economic factors can

influence health outcomes. Contraceptive use among the study subjects revealed that barrier methods were the most common form of contraception, used by 35.5% of the women, followed by intrauterine devices (IUDs) at 18.5%. Interestingly, 27.5% of the women did not use any form of contraception. The study also found that all the women reported having a single sexual partner, but 28.5% of their husbands admitted to having multiple partners. This discrepancy underscores the importance of considering partner behavior in the epidemiology of PID. The study further revealed that 43.5% of the women were married before the age of 20, which may increase the risk of PID due to biological and behavioral factors. Additionally, the prevalence of PID was higher among Muslim women (71.5%), likely reflecting the demographic composition of the study population rather than a specific religious predisposition. Overall, the findings of this study emphasize the complex interplay of demographic, educational, socio-economic, and behavioral factors in the prevalence of PID. Addressing these factors through targeted public health interventions could help reduce the incidence and impact of PID among women in their reproductive years (11).

Another research was conducted by Uzma Eram et al. (2022) delves into the risk factors associated with pelvic inflammatory disease (PID) among women. The study reveals that women using intrauterine devices (IUDs) for contraception are significantly more likely to develop PID, with a risk increase of 2-4 times compared to non-users. Additionally, women with a history of PID are twice as likely to experience recurrent infections. The research highlights that poor personal hygiene, such as the use of any cloth during menstruation, and a history of sexually transmitted infections (STIs) are major contributing factors. The study emphasizes the importance of proper hygiene practices and careful consideration of contraceptive methods to mitigate the risk of PID. The findings underscore the need for targeted public health interventions to address these risk factors and improve women's reproductive health outcomes (35).

According to the Author Amy Curry et al., Pelvic Inflammatory Disease (PID) is primarily caused by sexually transmitted infections (STIs) like Chlamydia trachomatis and Neisseria gonorrhoeae, but other bacteria can also be involved. Risk factors include being younger than 25, having multiple sex partners, and a history of STIs. Symptoms

include lower abdominal pain, abnormal uterine bleeding, and increased urinary frequency. Diagnosis is often based on clinical suspicion, especially in sexually active young women with unexplained pelvic pain, and empiric treatment is recommended for those at risk. Mild to moderate PID can be treated with a single intramuscular injection of a recommended cephalosporin followed by oral doxycycline for 14 days, while severe cases may require hospitalization and parenteral antibiotics. Prevention includes screening for C. trachomatis and N. gonorrhoeae in women younger than 25 and those at risk, along with intensive behavioral counseling for those at increased risk of STIs. Emerging issues include the routine use of quinolones no longer being recommended due to resistance, and intrauterine devices not needing to be removed if the patient is clinically improving within 48 to 72 hours of antibiotic initiation. Early diagnosis and treatment are crucial to prevent complications such as infertility, ectopic pregnancy, and chronic pelvic pain (36).

According to the author Breanne B Das et al., Pelvic inflammatory disease (PID) is a prevalent condition affecting the reproductive system, often going undiagnosed or improperly treated. This can result in serious issues like infertility, ectopic pregnancies, and chronic pelvic pain. The article stresses the necessity of STI screening and timely treatment for those with STIs and PID to avert these complications. It points out the disproportionately high rates of negative outcomes in women with PID, especially among young minority women, and underscores the need for healthcare providers to follow national screening and treatment guidelines more closely. Additionally, the article advocates for new, evidence-based clinical and public health strategies to lower PID rates and enhance outcomes for women who are affected (37).

Recently the research article was published by the author Hasiya Yusuf et al., where author explain the management and clinical practice for PID and states that PID is a prevalent condition affecting the reproductive system, often going undiagnosed or improperly treated. This can result in serious issues like infertility, ectopic pregnancies, and chronic pelvic pain. The article stresses the necessity of STI screening and timely treatment for those with STIs and PID to avert these complications. It points out the disproportionately high rates of negative outcomes in women with PID, especially

among young minority women, and underscores the need for healthcare providers to follow national screening and treatment guidelines more closely. Additionally, the article advocates for new, evidence-based clinical and public health strategies to lower PID rates and enhance outcomes for women who are affected (38).

Research conducted in Pakistan by Fareeha Asghar et al. (2019) explores the relationship between pelvic inflammatory disease (PID) and intrauterine contraceptive devices (IUCDs) in women attending outpatient departments in Rawalpindi. The study reveals that IUCDs are significantly associated with an increased risk of PID, with an odds ratio of 2.36, indicating that women using IUCDs are more likely to develop PID compared to non-users. The findings also highlight that the majority of PID cases were among women aged 26-36 years, and the use of IUCDs was more prevalent in this group. Additionally, the study identifies various factors contributing to the discontinuation of IUCDs, with PID being the most common reason. The research underscores the need for careful consideration of IUCD use and its potential risks, particularly in settings with limited healthcare resources and varying levels of aseptic techniques (39).

Research conducted by Raisham Saleem et al. (2022) investigates the frequency of pelvic inflammatory disease (PID) in women presenting with infertility. The study reveals that PID is a common infection among non-pregnant women of reproductive age, with a significant impact on fertility. The findings indicate that 27% of the women in the study had PID, with primary infertility being more prevalent than secondary infertility. The study highlights that tubal damage before and during PID episodes is strongly correlated with infertility. Additionally, the research underscores the importance of understanding the etiology, pathogenesis, and treatment of acute PID to improve reproductive health outcomes. The study emphasizes the need for targeted public health interventions to address the risk factors associated with PID and infertility (40).

Research conducted by Margarita V. Revzin et al. (2016) delves into the complexities of diagnosing and managing pelvic inflammatory disease (PID) using multimodality

imaging techniques. The study reveals that PID, a prevalent condition with nearly one million cases annually, often presents diagnostic challenges due to its nonspecific clinical manifestations that can mimic other pelvic and abdominal conditions. As highlighted by the authors, computed tomography (CT) is frequently the initial imaging modality used, revealing early-stage PID through signs such as thickening of the uterosacral ligaments, pelvic fat stranding, and reactive lymphadenopathy. The study underscores the importance of recognizing these imaging findings to ensure prompt and accurate diagnosis. Furthermore, the research identifies late-stage complications of PID, including tubal damage leading to infertility, peritonitis from abscess rupture, and the development of peritoneal adhesions causing bowel obstruction. The study emphasizes the critical role of CT in differentiating PID from other conditions like endometriosis, adnexal torsion, and appendicitis, thereby aiding in proper patient management and reducing the risk of unnecessary surgeries. The findings underscore the need for comprehensive imaging approaches to effectively diagnose and treat PID, ultimately improving patient outcomes (41).

Research conducted by Sheza Waseem et al. (2020) investigates the sonographic findings in females of reproductive age presenting with acute pelvic pain. The study reveals that uterine fibroids are the most common cause of acute pelvic pain, observed in 30.1% of cases. Simple ovarian cysts were the second most frequent finding, accounting for 20.2% of cases, followed by hemorrhagic cysts at 14.1%. Interestingly, 8.6% of the patients showed no abnormal sonographic findings. Other notable findings include adenomyosis, pelvic inflammatory disease (PID), and endometrial polyps, each constituting 4.3% of cases. The study underscores the effectiveness of ultrasound as a primary imaging modality for diagnosing and characterizing the causes of acute pelvic pain due to its wide availability, cost-effectiveness, and lack of radiation exposure. The research highlights the importance of ultrasound in the initial evaluation of acute pelvic pain, providing critical insights into the underlying gynecological conditions (14).

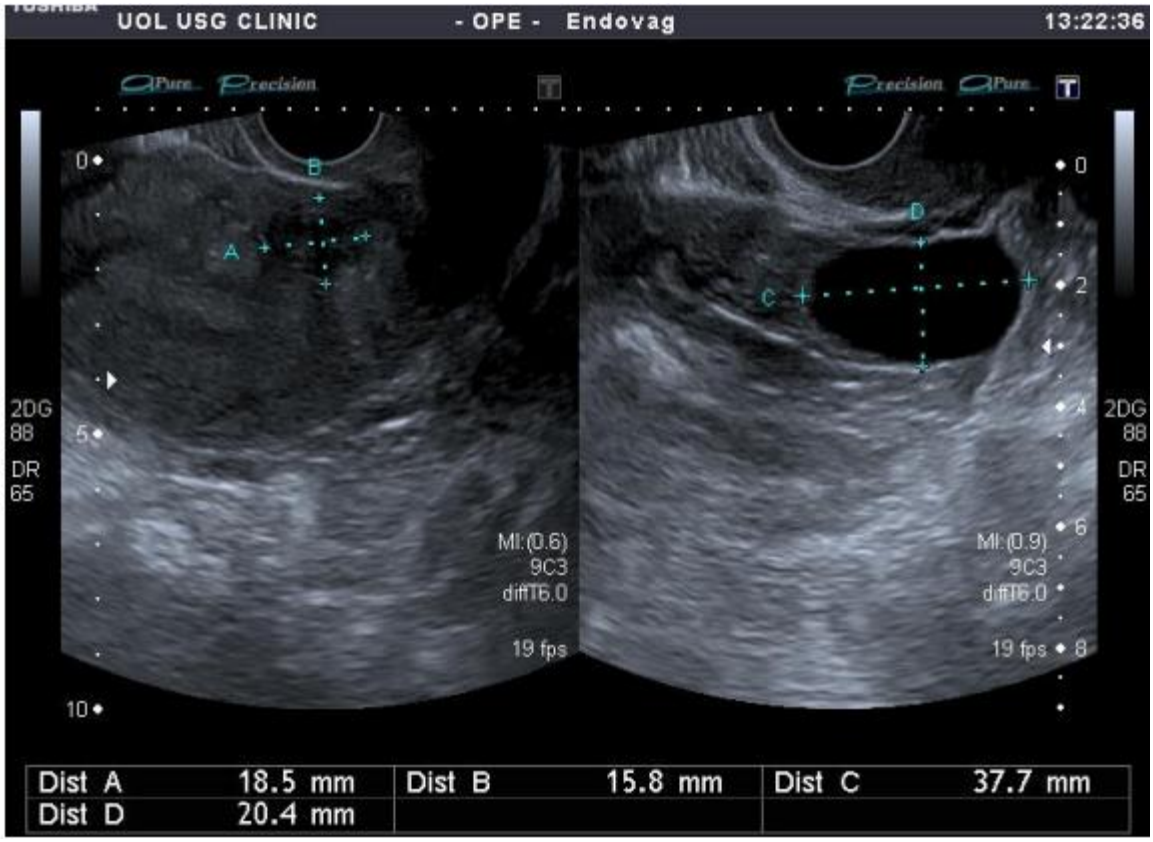

Figure 0.1: Transvaginal grey scale image showing, uterine fibroid measuring 18.5x 15.8mm and simple adnexal cyst measuring 37.7x 20.4mm - Sheza Waseem et al. (2020)

Research conducted by Marijana Basta Nikolic et al. (2021) delves into the diagnostic challenges and imaging strategies for acute pelvic pain (APP) in females. As highlighted by the authors, APP requires urgent medical evaluation due to its broad differential diagnosis, encompassing gynecologic, urinary, gastrointestinal, and vascular causes. The study reveals that ultrasonography is the first-line imaging modality, favored for its high sensitivity, specificity, and lack of ionizing radiation. However, when ultrasound findings are inconclusive, computed tomography (CT) is often employed, especially in emergency settings, due to its rapid acquisition and diagnostic accuracy. Magnetic resonance imaging (MRI) is reserved for specific cases, particularly in young and pregnant patients, to avoid radiation exposure. The findings underscore the importance of recognizing the diverse imaging features of APP to ensure prompt and accurate diagnosis. The study emphasizes the critical role of imaging in differentiating APP from

other conditions, thereby aiding in appropriate patient management and reducing the risk of unnecessary surgeries. Overall, the research underscores the need for a comprehensive imaging approach to effectively diagnose and treat APP, ultimately improving patient outcomes (42).

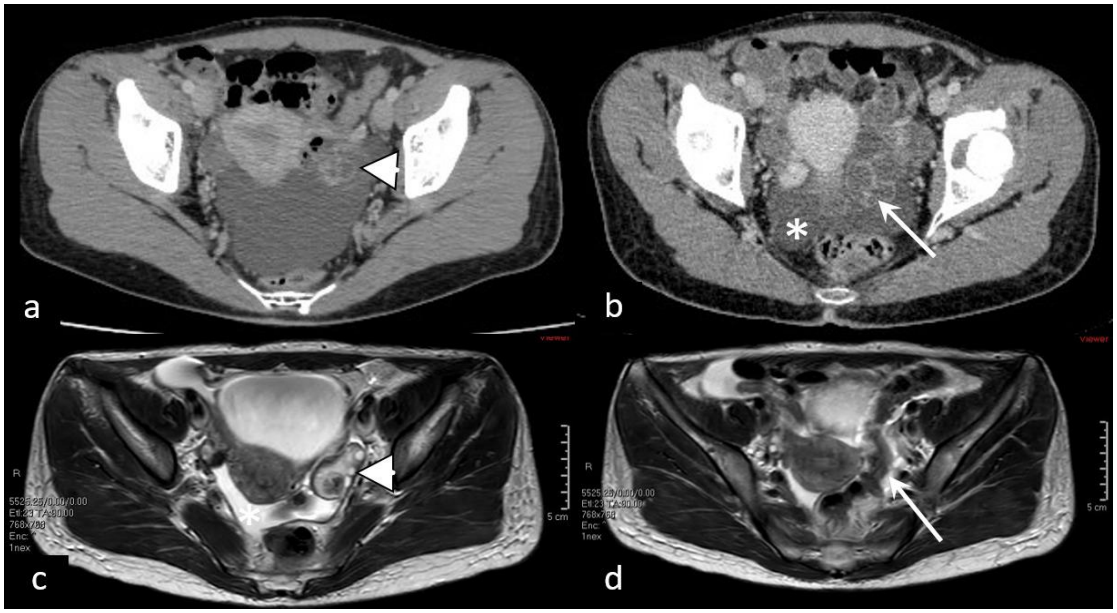

Figure 0.2: Contrast-enhanced CT (a, b) shows slightly enlarged, in homogenous left ovary - Jean-Luc Brun et al. (2020

Research conducted by Yuji Okazaki et al. (2022) investigates the diagnostic accuracy of pelvic imaging for acute pelvic inflammatory disease (PID) in an emergency care setting. The study reveals that contrast-enhanced computed tomography (CT) and magnetic resonance imaging (MRI) are valuable tools for diagnosing acute PID, especially when gynecological examinations are not readily available. As highlighted by the authors, CT demonstrated a pooled sensitivity of 0.79 and specificity of 0.99, while MRI showed a sensitivity of 0.95 and specificity of 0.89. These findings suggest that CT and MRI can effectively identify acute PID, although the evidence for MRI remains uncertain due to limited data. The study emphasizes the importance of early and

accurate diagnosis to prevent long-term complications such as infertility and chronic pelvic pain. The research underscores the potential of pelvic imaging to serve as an alternative diagnostic method in emergency settings, particularly in rural areas or during night-time emergencies when gynecological consultations may be delayed (18).

Research conducted by Ferenc Czeyda-Pommersheim et al. (2016) delves into the diagnostic and therapeutic complexities of pelvic inflammatory disease (PID) using magnetic resonance imaging (MRI). As highlighted by the authors, PID is an ascending infection of the female genital tract, often caused by sexually transmitted bacteria, leading to significant morbidity among reproductive-age women. The study reveals that MRI is particularly effective in evaluating PID due to its superior soft tissue contrast and high sensitivity for detecting inflammation. Acute PID can manifest as cervicitis, endometritis, salpingitis, and inflammation in the pelvic soft tissues, with complications such as pyosalpinx, tubo-ovarian abscess, peritonitis, and perihepatitis. Chronic sequelae include hydrosalpinx, pelvic inclusion cysts, and ureteral obstruction. The study underscores the importance of MRI in diagnosing PID and its complications, providing detailed imaging findings that aid in the accurate diagnosis and management of this condition. The research emphasizes the need for early and accurate diagnosis to prevent long-term complications such as infertility and chronic pelvic pain, highlighting the critical role of MRI in the comprehensive evaluation of PID (43).

Research conducted by Pietro Valerio Foti et al. (2019) delves into the diagnostic complexities of acute gynecologic disorders using cross-sectional imaging techniques like CT and MRI. As highlighted by the authors, the increasing use of these imaging modalities in emergency departments has led to more frequent diagnoses of acute gynecologic conditions, often initially suspected to be other abdominal or pelvic issues. The study reveals that MRI, with its superior soft-tissue contrast and multiplanar capabilities, is particularly effective in characterizing abnormal or inconclusive findings, making it preferable over CT when available and feasible. The findings emphasize the importance of recognizing the imaging features of various gynecologic emergencies, including endometrial polyps, degenerated leiomyomas, uterine inversion, and the spectrum of pelvic inflammatory disease (PID). The study underscores the critical role

of imaging in ensuring timely and accurate diagnosis, which is essential for appropriate treatment and management of these conditions. By providing detailed imaging examples and differential diagnoses, the research aims to enhance radiologists' familiarity with these emergencies, ultimately improving patient outcomes (44).

Research conducted by Hiroyoshi Iwata et al. (2022) delves into the diagnostic accuracy of pelvic examinations for pelvic inflammatory disease (PID). As highlighted by the authors, PID is a significant health concern that can lead to chronic pain, ectopic pregnancy, and infertility. The study reveals that pelvic tenderness, cervical motion tenderness, and adnexal tenderness are key indicators for diagnosing PID, with pelvic tenderness showing a sensitivity of 0.81 and specificity of 0.40. Cervical motion tenderness had a sensitivity of 0.72 and specificity of 0.50, while adnexal tenderness demonstrated a sensitivity of 0.87 and specificity of 0.27. These findings suggest that while pelvic examinations are useful for screening PID due to their moderate-to-high sensitivity, their low specificity means that a negative result does not conclusively rule out the disease. The study emphasizes the importance of early and accurate diagnosis to prevent long-term complications and underscores the need for comprehensive diagnostic criteria that include pelvic examinations as a crucial component (45).

Research conducted by Myriam Safrai et al. (2020) investigates the risk factors associated with recurrent pelvic inflammatory disease (PID). As highlighted by the authors, PID is a prevalent infection that can lead to severe long-term complications such as chronic pelvic pain and infertility. The study reveals that women with a history of pelvic surgery are more likely to experience recurrent PID, with an adjusted odds ratio (OR) of 2.2. Additionally, the presence of intrauterine devices (IUDs) significantly increases the risk of recurrence, with an OR of 7.2. The findings also indicate that antibiotic regimens and invasive treatments are independently associated with recurrent PID, emphasizing the need for careful management and prevention strategies. The study underscores the importance of identifying high-risk groups and implementing targeted interventions to reduce the incidence of recurrent PID and its associated morbidity (46).

Research conducted by Jeffrey Dee Olpin et al. (2020) delves into the diagnostic

challenges and imaging protocols for acute pelvic pain in nonpregnant women. As highlighted by the authors, acute pelvic pain, defined as pain lasting less than three months, poses a diagnostic dilemma due to its broad differential diagnosis, encompassing both gynecologic and nongynecologic etiologies. The study reveals that ultrasound is the primary imaging modality for evaluating acute pelvic pain, given its effectiveness in identifying common gynecologic conditions such as functional cysts, hemorrhagic cysts, ovarian torsion, and pelvic inflammatory disease (PID). The findings emphasize the importance of detailed patient history and clinical examination in guiding the selection of appropriate imaging techniques. Additionally, the study underscores the role of computed tomography (CT) and magnetic resonance imaging (MRI) in cases where ultrasound results are inconclusive or when nongynecologic conditions are suspected. The research highlights the critical role of imaging in ensuring timely and accurate diagnosis, which is essential for appropriate clinical management and improving patient outcomes. The comprehensive approach to imaging, as detailed in the study, aims to enhance the diagnostic accuracy and treatment of acute pelvic pain, ultimately benefiting women's health (47).

Research conducted by Marco Di Serafino et al. (2022) delves into the diagnostic challenges of pelvic pain in women of reproductive age, emphasizing the importance of ultrasound (US) as a primary diagnostic tool. As highlighted by the authors, pelvic pain can stem from a variety of causes, including gynecological, entero-colic, and urological disorders, making accurate diagnosis crucial. The study reveals that US, particularly transabdominal (TSA-US) and transvaginal (TSV-US) approaches, is highly effective in diagnosing conditions such as adnexal torsion, ruptured ovarian cysts, and pelvic inflammatory disease (PID). The findings underscore the significance of US in identifying adnexal torsion, characterized by the "whirl sign" of a twisted vascular peduncle, and the presence of hemorrhagic cysts with distinctive reticular structures. Additionally, the study emphasizes the role of US in detecting PID, which often presents with thickened, hyperaemic fallopian tubes and tubo-ovarian abscesses. The research also highlights the utility of US in diagnosing other conditions like endometritis, endometriosis, and peritoneal inclusion cysts, each with unique sonographic features. Overall, the study underscores the critical role of US in the initial evaluation and

management of pelvic pain, providing detailed insights into the most frequent adnexal, uterine, and vascular causes, and advocating for its use as a first-line diagnostic modality in reproductive-age women (48).

Research conducted by Donald E. Greydanus et al. (2019) delves into the complexities of pelvic inflammatory disease (PID), a significant sexually transmitted infection affecting adolescent and young adult females. As highlighted by the authors, PID is primarily caused by pathogens such as Chlamydia trachomatis and Neisseria gonorrhoeae, which ascend from the lower genital tract to infect the upper genital organs, leading to conditions like acute salpingitis, perihepatitis, and tubo-ovarian abscesses. The study reveals that PID is a polymicrobial infection, often exacerbated by local genital tract flora, and is associated with various risk factors including young age, multiple sexual partners, and ineffective condom use. The findings emphasize the importance of early diagnosis and adherence to treatment protocols established by the CDC and WHO to prevent severe complications such as chronic pelvic pain, ectopic pregnancy, and infertility. The research underscores the need for comprehensive sexuality education and robust public health interventions to mitigate the prevalence of PID and improve reproductive health outcomes among young women (49).

Research conducted by Julio Daniel Egusquiza et al. (2017) delves into the diagnostic challenges and imaging characteristics of acute pelvic pain in reproductive-age women. As highlighted by the authors, acute pelvic pain can arise from multiple organ systems, making it difficult to determine the exact etiology. The study reveals that a thorough history and physical examination, along with basic laboratory analyses, are crucial in narrowing down the differential diagnosis. The first-line imaging test usually obtained is pelvic ultrasound (US), followed by selective use of computed tomography (CT) based on sonographic findings. The findings emphasize the importance of recognizing the varied imaging appearances of conditions such as ectopic pregnancy, ruptured ovarian cysts, ovarian torsion, and pelvic inflammatory disease (PID). The study underscores the critical role of imaging in the emergency department to ensure timely and accurate diagnosis, which is essential for appropriate clinical management and improving patient outcomes. The research provides detailed insights into the imaging features of common

obstetric and gynecologic causes of acute pelvic pain, advocating for the use of US and CT as primary diagnostic tools in reproductive-age women (50).

Research conducted by Jean-Luc Brun et al. (2020) delves into the updated French guidelines for diagnosing and managing pelvic inflammatory disease (PID). As highlighted by the authors, PID encompasses infections of the upper genital tract, including endometritis, salpingitis, and pelvic peritonitis, which can lead to serious long-term complications. The study reveals that spontaneous pelvic pain, coupled with induced adnexal or uterine pain, is a key indicator of PID. Pelvic ultrasonography is recommended to rule out tubo-ovarian abscesses (TOA), and microbiological diagnosis requires endocervical and TOA sampling for molecular and bacteriological analysis. The guidelines recommend a combination of ceftriaxone, doxycycline, and metronidazole for treating uncomplicated PID, while complicated cases may require additional interventions such as drainage of pelvic fluid collections. The study emphasizes the importance of follow-up in women with sexually transmitted infections (STIs) and the use of condoms to prevent recurrence. The research underscores the need for targeted public health interventions and comprehensive management strategies to reduce the incidence and impact of PID among women (51).

Research conducted by James Spain et al. (2016) delves into the pathophysiology, imaging findings, and treatment of pelvic inflammatory disease (PID). As highlighted by the authors, PID is a significant cause of emergency visits and hospitalizations among young and adult female patients, primarily due to sexually transmitted infections like Neisseria gonorrhoeae and Chlamydia trachomatis. The study reveals that multidetector computed tomography (MDCT) is often used as the initial imaging modality due to the vague clinical presentation of PID. Early imaging features include pelvic edema, hyperemia, and thickening of the salpinges, while advanced stages may show tubo-ovarian abscesses and perihepatitis, also known as Fitz-Hugh-Curtis syndrome. The findings emphasize the importance of prompt and accurate diagnosis to prevent long-term complications such as infertility, ectopic pregnancy, and chronic pelvic pain. The research underscores the critical role of MDCT in detecting early inflammatory changes and guiding appropriate patient care, thereby minimizing the risk

of secondary complications. The study also discusses the performance metrics of MDCT, highlighting its sensitivity and specificity in diagnosing PID compared to other imaging modalities (52).

Research conducted by Hasiya Yusuf et al. (2023) delves into the management of pelvic inflammatory disease (PID) in clinical practice. As highlighted by the authors, PID is a common reproductive health disorder among women of reproductive age, with more than one million cases diagnosed annually in the United States alone. The study reveals that PID is a polymicrobial infection affecting the upper genital tract, often leading to complications such as infertility, chronic pelvic pain, and ectopic pregnancy if left untreated. The findings emphasize the importance of prompt and accurate diagnosis, which involves a comprehensive history, physical examination, and laboratory investigations. The study underscores the role of novel organisms like Mycoplasma genitalium in the pathogenesis of PID, noting that current treatment guidelines may not provide adequate coverage against this pathogen. The research also highlights the evolving nature of PID treatment, reflecting changes in antibiotic susceptibility and advancements in therapeutics. The authors advocate for the use of point-of-care testing, adherence support, and optimized self-management strategies to improve treatment outcomes and reduce the burden of PID. Overall, the study provides valuable insights into the complexities of PID management and the need for ongoing research and innovation in this field (10).

Research conducted by Dheeraj Reddy Gopireddy et al. (2022) delves into the diagnostic utility of magnetic resonance imaging (MRI) for acute pelvic pain, particularly in uterine emergencies. As highlighted by the authors, MRI is emerging as a crucial imaging modality due to its superior soft-tissue resolution, lack of ionizing radiation, and ability to provide multiplanar imaging. The study reveals that MRI is particularly effective in diagnosing conditions such as pelvic inflammatory disease (PID), endometritis, salpingitis, pyosalpinx, and tubo-ovarian abscesses. The findings emphasize that while ultrasound (US) is often the first-line imaging modality due to its accessibility, MRI offers significant advantages in cases where US and computed tomography (CT) are inconclusive. MRI's high sensitivity (96.6%) in identifying acute

uterine pathologies makes it an invaluable tool in emergency settings. The research underscores the importance of understanding the various MRI techniques and sequences, such as T1-weighted imaging (T1WI), T2-weighted imaging (T2WI), and diffusion-weighted imaging (DWI), to accurately diagnose and manage uterine emergencies. The study also highlights the role of MRI in differentiating between benign and malignant conditions, thereby aiding in appropriate clinical management and improving patient outcomes. Overall, the research advocates for the increased use of MRI in the evaluation of acute pelvic pain to enhance diagnostic accuracy and patient care (53).

Chapter 3

METHODOLOGY

Research Design

This study adopted a cross-sectional design to assess the effectiveness of diagnostic ultrasound in identifying pelvic inflammatory disease (PID).

Clinical Settings

Data for this research was gathered from Popular Diagnostic Center, Peshawar. This center was selected due to its high patient volume and advanced ultrasound equipment.

Sample Size

The sample size calculation follows the formula: $n = (DEFF \times N \times p(1 - p)) / [(d^2 / Z^2(1 - \alpha/2) \times (N - 1)) + p(1 - p)]$ where (n) is the sample size, (Z) is the confidence level (95%) with (Z = 1.96), (N) was the population size (100,000), and (p) is the proportion (10%) (54). The calculated sample size was 139 participants.

This calculation assumes that 10% of the population was present with symptoms suggestive of PID, based on previous epidemiological studies. The 95% confidence level ensures statistical significance with a 5% margin of error. The design effect (DEFF) accounts for potential data clustering within the clinical settings, ensuring the sample size is sufficient to detect meaningful differences in diagnostic accuracy. A sample size of 139 participants was deemed adequate for this study, providing enough power to detect differences in ultrasound findings and their correlation with clinical and laboratory results.

Sampling Technique

A convenient sampling technique was employed to select participants.

Duration of Study

The study was conducted over four months after the approval of the synopsis.

Selection Criteria

Inclusion Criteria:

- Women aged 18–45 years who presented with symptoms indicative of PID. This age range was chosen because PID primarily affects women of reproductive age.
- Patients clinically diagnosed with PID based on symptoms such as lower abdominal pain, fever, abnormal vaginal discharge, and tenderness upon pelvic examination. These symptoms were consistent with the clinical presentation of PID and were used to identify potential participants.
- Patients who had undergone preliminary diagnostic tests, including high vaginal swab (HVS) and urine microscopy, culture, and sensitivity (m/c/s), prior to ultrasound assessment. These tests provided additional diagnostic information and helped confirm the clinical diagnosis of PID.

Exclusion Criteria:

- Pregnant women, due to potential confounding factors in ultrasound findings and differential diagnosis. Pregnancy could alter pelvic anatomy and may present symptoms similar to PID, making it difficult to distinguish between the two conditions.
- Patients with chronic pelvic pain unrelated to acute PID episodes. Chronic pelvic pain could have multiple etiologies, and including these patients might have confounded the study results.

- Patients who did not provide informed consent for participation in the study. Informed consent was essential for ethical research practices.

- Patients with a history of recent pelvic surgery within the last six months, as postoperative changes could have affected ultrasound findings. Surgical interventions could cause alterations in pelvic anatomy and might mimic or mask PID findings.

Equipment

The study utilized a Toshiba Aplio 200 ultrasound machine with a convex probe operating at 3–5 MHz. This equipment was chosen for its high-resolution imaging capabilities and versatility in assessing pelvic structures. The convex probe provided a broad field of view, allowing for comprehensive visualization of the uterus, ovaries, and surrounding pelvic anatomy.

The Toshiba Aplio 200 was equipped with advanced imaging features, including color Doppler and power Doppler, which were essential for evaluating blood flow and vascularity in the pelvic region. These features enhanced the diagnostic accuracy of ultrasound by providing additional information on inflammatory processes and vascular changes associated with PID.

Ethical Considerations

The research adhered to the ethical guidelines set by Superior University, Lahore. Key ethical considerations included:

- Obtaining written informed consent from all participants: Participants were provided with detailed information about the study, including its purpose, procedures, potential risks, and benefits. They had the opportunity to ask questions and withdraw from the study at any time without penalty.

- Ensuring patient privacy and confidentiality: All personal and medical information was kept confidential, and participants were assigned unique

identifiers to protect their identities. Data was stored securely, and access was restricted to authorized research personnel.

- Seeking patient permission before any exposure: Participants were informed about the ultrasound procedure and its purpose. Their consent was obtained before performing the ultrasound examination.

- Keeping all collected data confidential and ensuring participants remained anonymous: Data was anonymized, and any identifying information was removed before analysis. Results were reported in aggregate form to prevent the identification of individual participants.

- Informing participants that there were no risks or disadvantages associated with the study procedures: The ultrasound examination was non-invasive and posed minimal risk to participants. They were reassured that their participation would not affect their medical care.

- Allowing participants to withdraw from the study at any time without any penalty: Participants were informed of their right to withdraw from the study at any point without any consequences. Their decision to withdraw was respected, and their data was excluded from the analysis if they chose to do so.

- Protecting participant privacy and ensuring their identity was not revealed in any publications resulting from the study: The study findings were published in a manner that ensured participant anonymity. No identifying information was included in any reports or publications.

Data Collection Procedure

Data was collected by the researcher using structured data collection tools. The procedure included:

- Obtaining informed written consent from participants: Participants were provided with a consent form outlining the study details, and their written consent was obtained before any data collection began.

- Collecting data according to the defined variables: Data was collected on demographic variables (age, marital status), clinical symptoms (pelvic pain, menstrual abnormalities, vaginal discharge), and ultrasound findings (endometrial thickness, uterine echogenicity, presence of free pelvic fluid, hydrosalpinx).

- Performing longitudinal and transverse sweeps with the transducer placed on the lower abdomen to visualize the uterus, adnexa (ovaries and fallopian tubes), and surrounding pelvic structures: The ultrasound examination was conducted by trained radiologists following standardized protocols to ensure consistency and accuracy.

- Noting any free fluid or abnormal masses in the pelvic cavity: The presence of free fluid, complex masses, or other abnormal findings was documented and measured.

- Identifying key features such as tubo-ovarian abscesses, endometrial thickening, free pelvic fluid, and pelvic adhesions: These features were indicative of PID and were carefully assessed.

Chapter 4

RESULTS

Demographics Results

In our study we analyzed the data of 139 female patients, which were conformed pelvic inflammatory disease. The patient had a mean age of 34.64 ± 9.14 standard deviation, where the minimum age was 18 years and maximum were 49 years (Table 1). We classified the patients into five age groups where there are 10 patients in age group between 18 to 20 years, 21 patients in age group between 21 to 25 years old, 40 patients were in age group between 26 to 35 years old, 49 patients were in age group between 36 to 45 years old and 19 patients were in age group between 46 to 49 years old (Figure). This table proved that pelvic inflammatory diseases are most common in those group whose age between 26 to 45 years old (Table 2). According to our demographics data 78 (56.1%) patients were married and 61 (43.9%) were single (Table 3 & Figure 10).

Table 0.1: Descriptive Statistics of Age and Endometrium Thickness

	N	Minimum	Maximum	Mean	Std. Deviation
Age	139	18	49	34.64	9.143
Endometrium Thickness (mm)	139	5.11	15.00	10.4726	3.08137

Table 0.2: Age group of pelvic inflammatory disease patients

Age Group	Frequency (Freq.)	Percent (%)	Cumulative (%)
18 to 20	10	7.19	7.19
21 to 25	21	15.11	22.30
26 to 35	40	28.78	51.08
36 to 45	49	35.25	86.33
46 to 49	19	13.67	100.00
Total	**139**	**100.00**	

Table 0.3: Marital status data

Marital Status	Frequency	Percent	Valid Percent	Cumulative Percent
Married	78	56.1%	56.1%	56.1%
Unmarried	61	43.9%	43.9%	100.0%

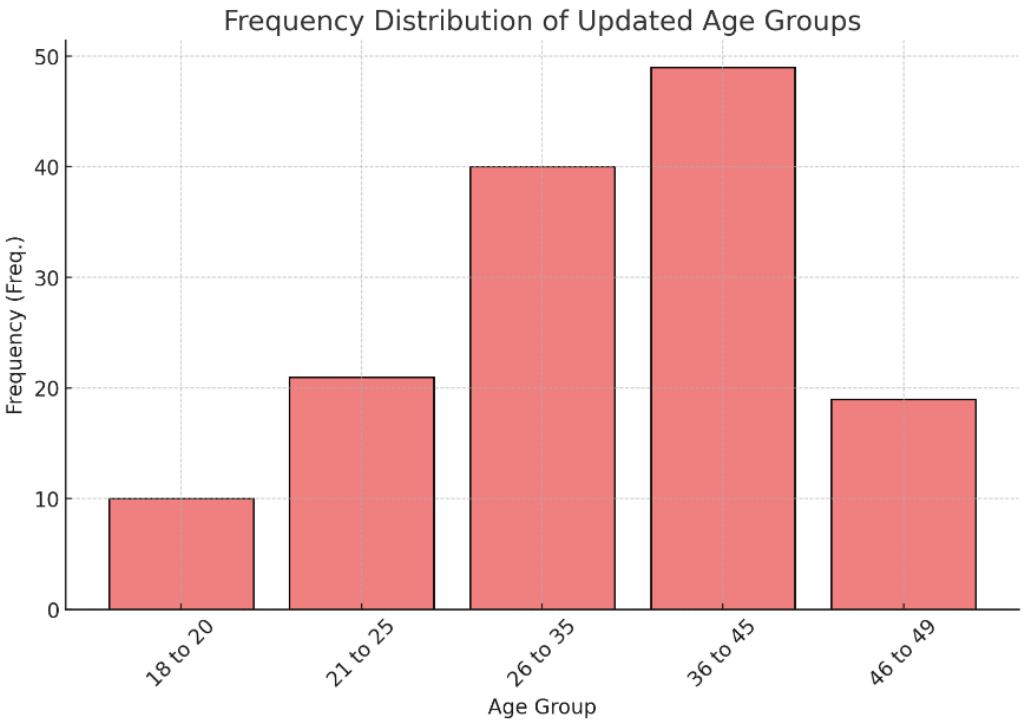

Figure 0.1

Figure 0.2: Age group represented in bar chart

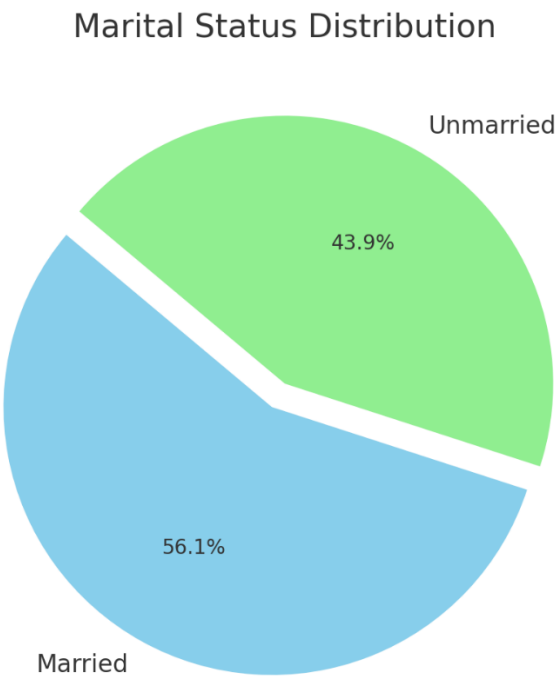

Figure 0.3: Marital Status distribution

The table provides information on the intensity of pelvic discomfort experienced by a group of people. It classifies the pain into four categories: no pain, mild pain, moderate pain, and severe pain. The data includes the number and proportion of individuals who reported each level of pain. Of the total participants, 32 patients (23.0%) said they felt no pain. 27 patients (19.4%) reported mild pain, and 34 patients (24.5%) experienced moderate pain. The patient's group with the largest number were those who felt severe pain, with 46 individuals (33.1%) reporting this level of discomfort (Table 4).

This data shows that a large number of people suffer from moderate to intense pelvic discomfort, with intense pain being the most frequent. This knowledge can be vital for medical professionals in focusing on pain control and treatment approaches (Figure 11).

Table 0.4: Table displaying the pelvic pain data

Pelvic Pain Level	Frequency	Percent	Valid Percent	Cumulative Percent
No Pain	32	23.0%	23.0%	23.0%
Mild Pain	27	19.4%	19.4%	42.4%
Moderate Pain	34	24.5%	24.5%	66.9%
Severe Pain	46	33.1%	33.1%	100.0%

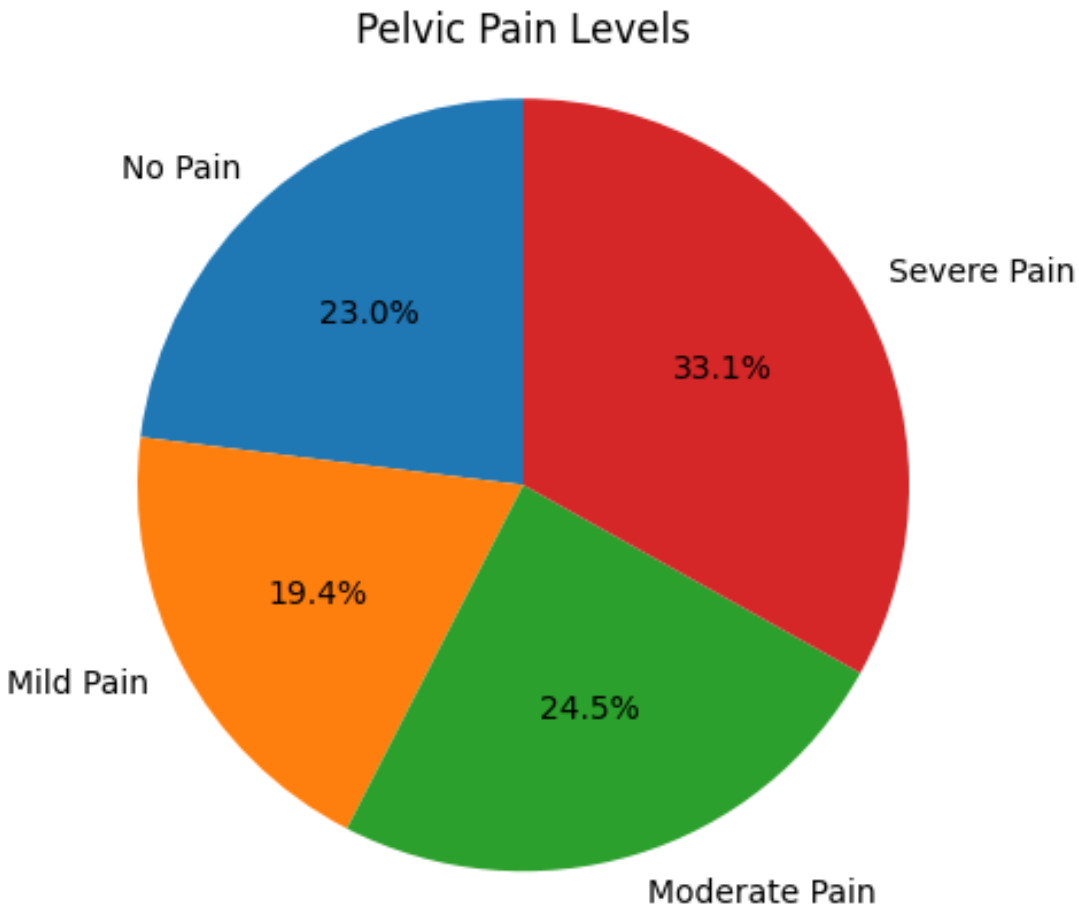

Figure 0.4: Pie chart representing the pelvic pain levels based on the demographic data

The table 5 and pie chart figure 12, shows the different people have their periods in a group of 139 individuals. The information is divided into two groups: Normal and Abnormal periods. Regular Menstruation: 65 people (46. 8%) said they have regular periods. Unusual Menstruation: 74 people (53. 2%) said they had unusual periods.

Table 0.5: Menstruation Status of Patients

Menstruation	Frequency	Percent	Valid Percent	Cumulative Percent
Normal	65	46.8%	46.8%	46.8%
Abnormal	74	53.2%	53.2%	100.0%
Total	**139**	**100.0%**	**100.0%**	**100.0%**

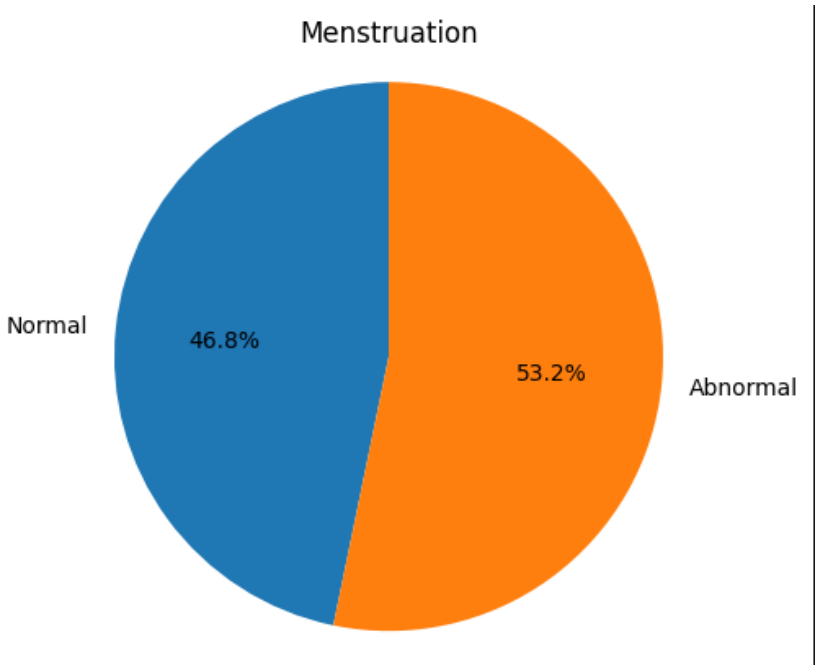

Figure 0.5: Menstruation Status of Patients

Table 6 and pie chart figure 13, illustrate the distribution of vaginal discharge among a group of 139 individuals. The data is categorized into two groups: those who reported no vaginal discharge and those who reported experiencing vaginal discharge. No Vaginal Discharge: 61 individuals (43.9%) reported not experiencing vaginal discharge. Yes, Vaginal Discharge: 78 individuals (56.1%) reported experiencing vaginal discharge.

Table 0.6: Vaginal Discharge

Vaginal Discharge	Frequency	Percent	Valid Percent	Cumulative Percent
No	61	43.9%	43.9%	43.9%
Yes	78	56.1%	56.1%	100.0%
Total	**139**	**100.0%**	**100.0%**	**100.0%**

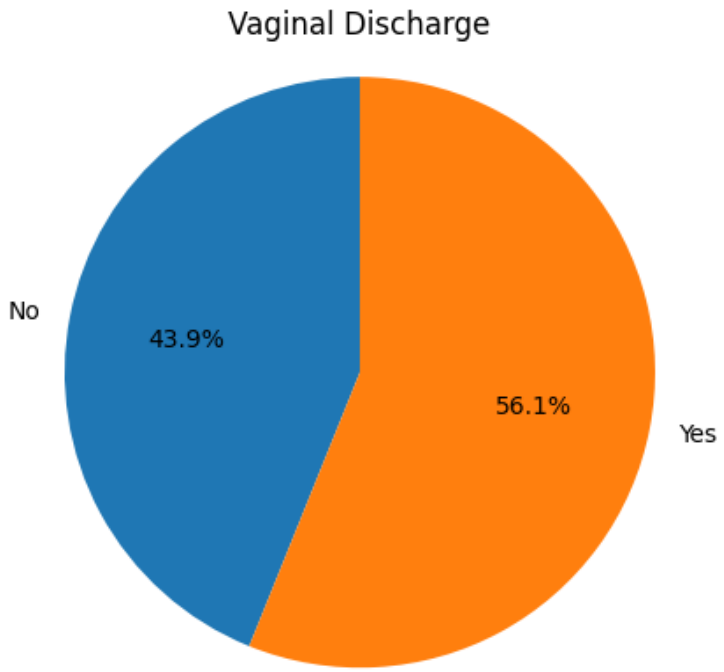

Figure 0.6: Pie Chart indicates Vaginal Discharge

The table 7 and pie chart figure 14, illustrate the distribution of discharge fluid smell among a group of 139 individuals. The data is categorized into two groups: those who reported an odor and those who reported odorless discharge. Odor: 73 individuals (52.5%) reported experiencing discharge with an odor. Odorless: 66 individuals (47.5%) reported experiencing odorless discharge.

Table 0.7: Frequency of Discharge Fluid Smell

Discharge Fluid Smell	Frequency	Percent	Valid Percent	Cumulative Percent
Odor	73	52.5%	52.5%	52.5%
Odorless	66	47.5%	47.5%	100.0%
Total	**139**	**100.0%**	**100.0%**	**100.0%**

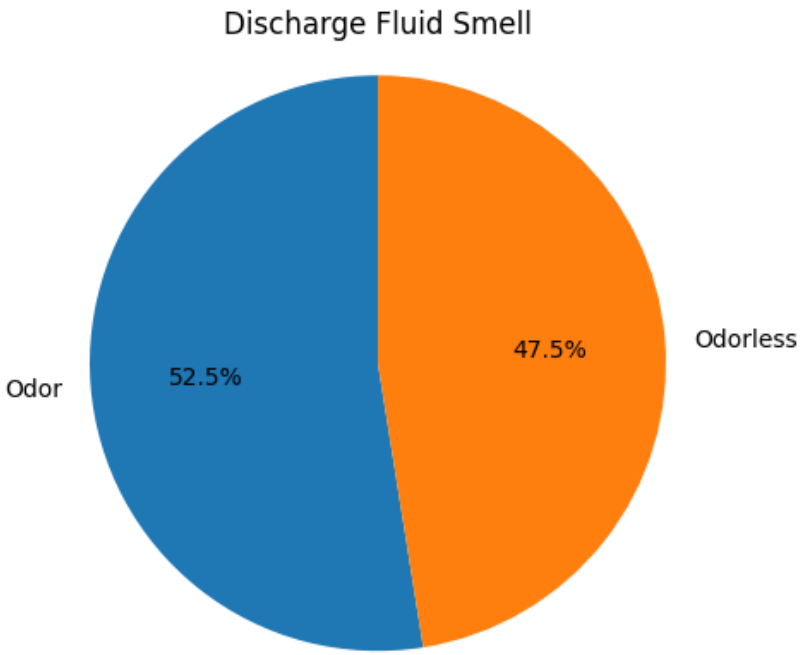

Figure 0.7: Pie Chart indicates Discharge Fluid Smell

Ultrasonographic Results

The table1, presents detailed descriptive statistics of the ultrasound findings for the endometrium thickness, measured in millimeters, among a sample of 139 individuals. This information provides valuable insights into the distribution and characteristics of endometrium thickness within the study population.

The first statistic reported is the number of valid observations, which is 139. This indicates that the analysis was conducted on a sample size of 139 individuals, ensuring a robust and representative dataset.

The minimum value observed for endometrium thickness is 5.11 mm, representing the smallest measurement recorded in the sample. Conversely, the maximum value is 15.00 mm, indicating the largest endometrium thickness observed among the participants.

The mean, or average, endometrium thickness is calculated to be 10.4726 mm. This central tendency measure provides an overall representation of the typical endometrium thickness within the sample. It suggests that, on average, the participants in the study had an endometrium thickness of approximately 10.47 mm.

To further understand the variability in endometrium thickness, the standard deviation is reported as 3.08137 mm. This statistic quantifies the amount of dispersion or spread in the thickness values around the mean. A higher standard deviation suggests a greater degree of variation in the endometrium thickness measurements, while a lower standard deviation indicates a more compact and homogeneous distribution.

The combination of the minimum, maximum, mean, and standard deviation statistics provides a comprehensive overview of the endometrium thickness characteristics within the study sample. This information can be valuable for understanding the normal range of endometrium thickness, identifying potential outliers or extreme values, and evaluating the overall distribution of the variable within the population.

The table 8, provide a detailed analysis of the distribution of uterine echogenicity among a group of 139 individuals. Uterine echogenicity, a measure of the ultrasound reflectivity of the uterine tissue, is an important factor in gynecological examinations and can provide valuable insights into the overall health and condition of the uterus.

The data presented in the table and chart is categorized into two distinct groups: Homogeneous Echogenicity and Heterogeneous Echogenicity. Homogeneous Echogenicity refers to a uniform echogenic pattern throughout the uterine tissue, while Heterogeneous Echogenicity indicates a varied or uneven echogenic pattern.

The results show that 71 individuals, or 51.1% of the total group, reported having homogeneous uterine echogenicity. This suggests that the majority of the individuals in the study group had a consistent and uniform echogenic pattern in their uterine tissue, which can be indicative of a healthy and normal uterine structure.

On the other hand, 68 individuals, or 48.9% of the group, reported having heterogeneous uterine echogenicity. This heterogeneous pattern can be associated with various uterine conditions, such as fibroids, adenomyosis, or other structural abnormalities. The presence of a heterogeneous echogenic pattern may warrant further medical investigation and evaluation to determine the underlying cause and any potential health implications.

Table 0.8: Uterine Echogenicity

	Frequency	Percent	Valid Percent	Cumulative Percent
Homogeneous	71	51.1	51.1	51.1
Heterogeneous	68	48.9	48.9	100.0
Total	139	100.0	100.0	

The pie chart (Figure 15) provides a visual representation of the relative distribution of the two echogenicity groups, making it easier to understand the overall proportions and the balance between homogeneous and heterogeneous echogenicity within the study population. This information can be valuable for healthcare professionals in understanding the prevalence of different uterine conditions and guiding their diagnostic and treatment approaches.

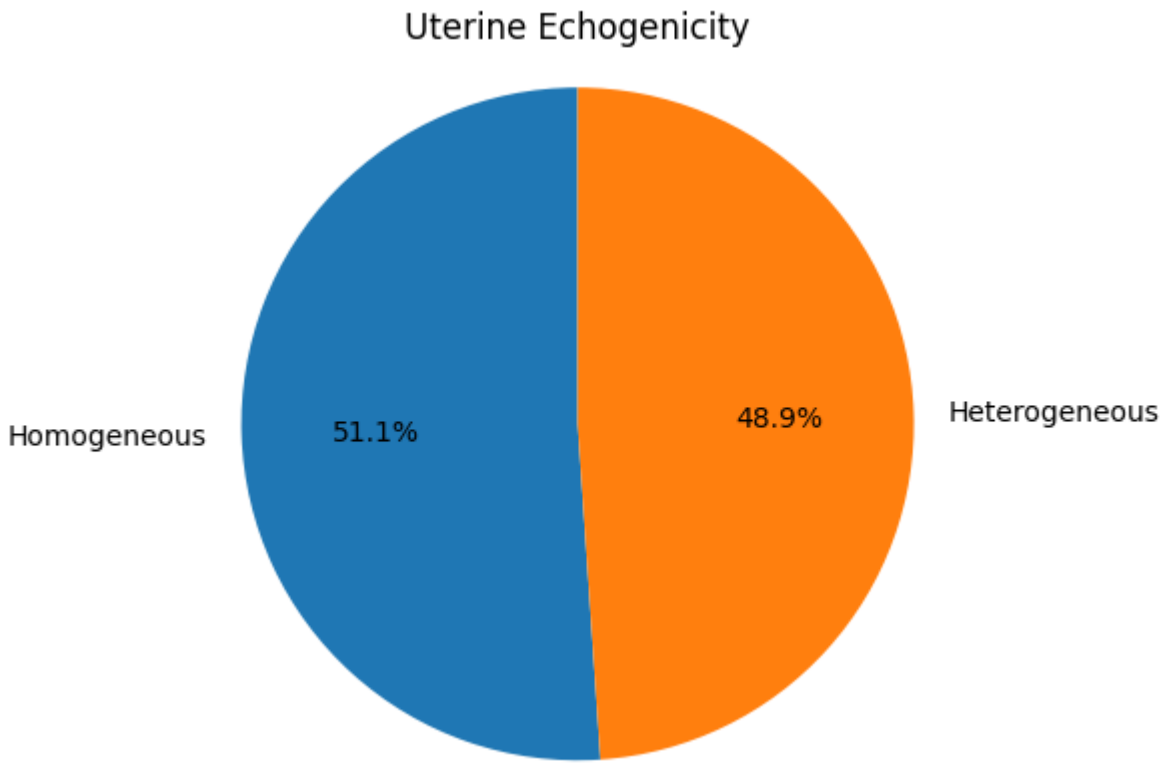

Figure 0.8: Pie Chart Indicates the Uterine Echogenicity

Table 9 provide a detailed analysis of the frequency of cul-de-sac free fluid among a group of 139 individuals. This medical data is an important tool for healthcare professionals to better understand the prevalence of this condition within the studied population.

The data is neatly organized into two distinct categories: "Present" and "Absent." The "Present" category indicates that 68 individuals, or 48.9% of the total, reported the presence of cul-de-sac free fluid. Conversely, the "Absent" category shows that 71 individuals, or 51.1%, reported the absence of this condition.

The cumulative percentage breakdown offers valuable insights. The data reveals that nearly half of the individuals (48.9%) have cul-de-sac free fluid, while the remaining 51.1% do not. This suggests that the distribution of this medical condition is almost evenly split within the study group, with a slight majority reporting its absence.

Table 0.9: Frequency of Cul-de-Sac Free Fluid

	Frequency	Percent	Valid Percent	Cumulative Percent
Present	68	48.9	48.9	48.9
Absent	71	51.1	51.1	100.0
Total	139	100.0	100.0	

pie chart (Figure 16) provide a comprehensive analysis of the frequency of cul-de-sac free fluid among the 139 individuals. This data can be invaluable for healthcare professionals, as it offers insights into the prevalence and distribution of this medical condition within the studied population, ultimately supporting more effective patient care and treatment strategies.

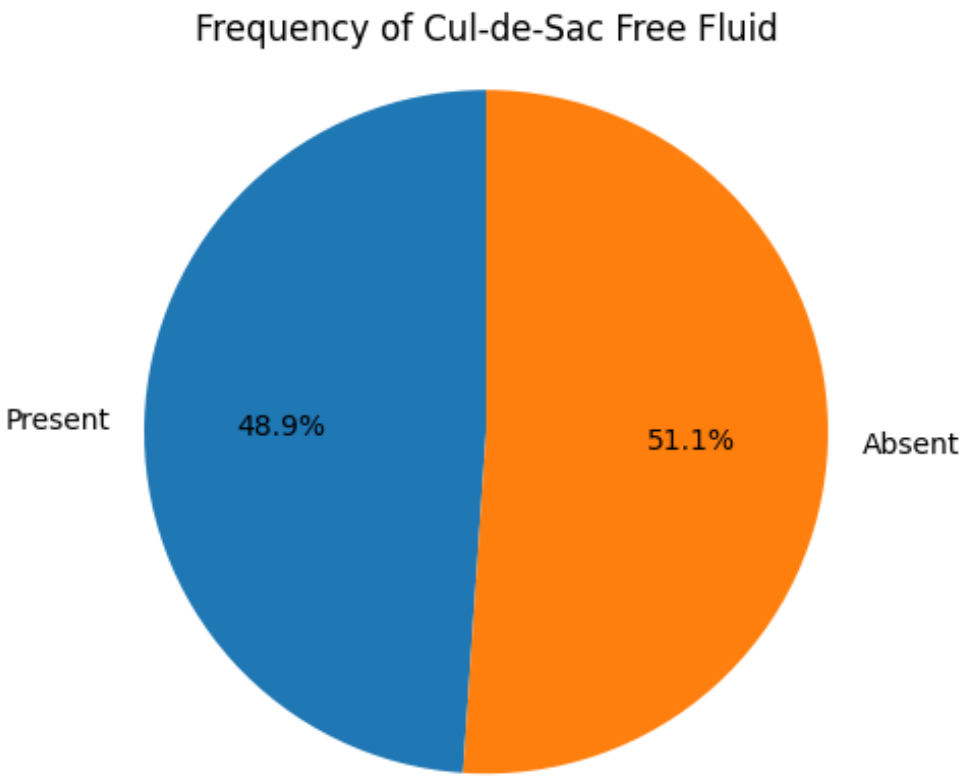

Figure 0.9: Cul-de-Sac Free Fluid

Table 10 chart presented provide a detailed analysis of the prevalence of hydrosalpinx, a medical condition characterized by the blockage or dilation of the fallopian tube, within a group of 139 individuals. Hydrosalpinx is a significant concern in the field of reproductive health, as it can contribute to infertility and other gynecological complications.

The data is clearly categorized into two distinct groups: "Present" and "Absent," indicating the presence or absence of hydrosalpinx among the study participants. The results reveal that a substantial proportion, 76 individuals or 54.7% of the total sample, reported the presence of hydrosalpinx. Conversely, 63 individuals, or 45.3%, reported the absence of this condition.

The cumulative percentage breakdown highlights the predominance of hydrosalpinx within this population. With over half of the individuals (54.7%) experiencing the

condition, it suggests that hydrosalpinx is a prevalent issue among this group. When combined with the 45.3% who do not have hydrosalpinx, the total percentage reaches 100%, providing a comprehensive overview of the distribution of this medical condition.

Table 0.10: Frequency of Hydrosalpinx

	Frequency	Percent	Valid Percent	Cumulative Percent
Present	76	54.7	54.7	54.7
Absent	63	45.3	45.3	100.0
Total	139	100.0	100.0	

Furthermore, the data presented in the pie chart (figure 17) can serve as a valuable resource for further research and comparative analyses. Examining the demographic characteristics, risk factors, and potential underlying causes of hydrosalpinx within this population could provide deeper insights into the epidemiology and etiology of the condition. This knowledge can then be leveraged to develop more targeted interventions and educational campaigns to promote reproductive health and address the challenges faced by individuals with hydrosalpinx.

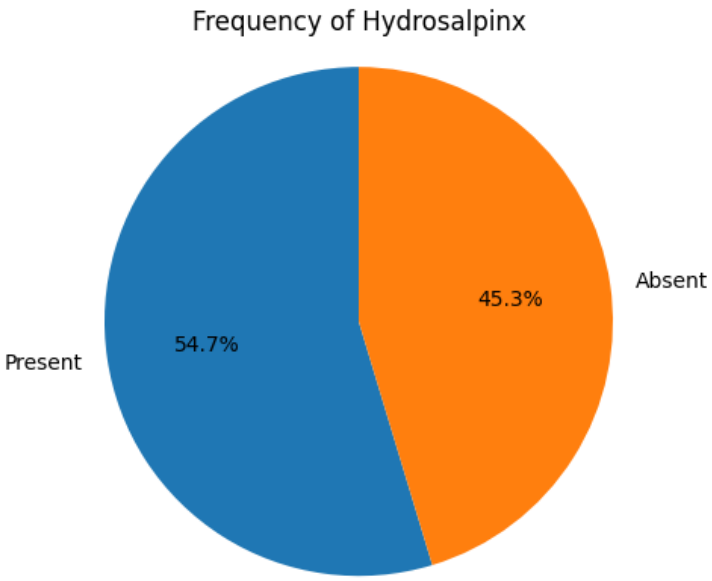

Figure 0.10: Pie Chart indicates Frequency of Hydrosalpinx

The study explored the association between marital status and uterine echogenicity, which can have important implications for women's reproductive health. Uterine echogenicity is a useful indicator of various uterine conditions, such as adenomyosis, endometrial polyps, and uterine fibroids, which can impact fertility, pregnancy outcomes, and overall gynecological well-being.

The crosstabulation (table 11) and pie chart (Figure 18) presented in the original passage offer a clear visual representation of the observed patterns. The data reveals that married individuals were more likely to have heterogeneous uterine echogenicity, which may suggest a higher prevalence of certain uterine pathologies in this group. Conversely, unmarried individuals were more likely to have homogeneous uterine echogenicity, potentially indicating a lower risk of uterine abnormalities.

These findings are particularly relevant for healthcare providers, as they can inform clinical decision-making and patient education. Understanding the potential relationship between marital status and uterine echogenicity can help physicians tailor their screening, diagnostic, and treatment approaches for their patients. For instance, married individuals may benefit from more frequent or targeted uterine imaging and monitoring, while unmarried individuals may require less intensive surveillance.

Table 0.11: Crosstabulation for Marital Status and Uterine Echogenicity

		Uterine Echogenicity		Total
		Homogeneous	Heterogeneous	
Marital Status	Married	35	43	78
	Unmarried	36	25	61
Total		71	68	139

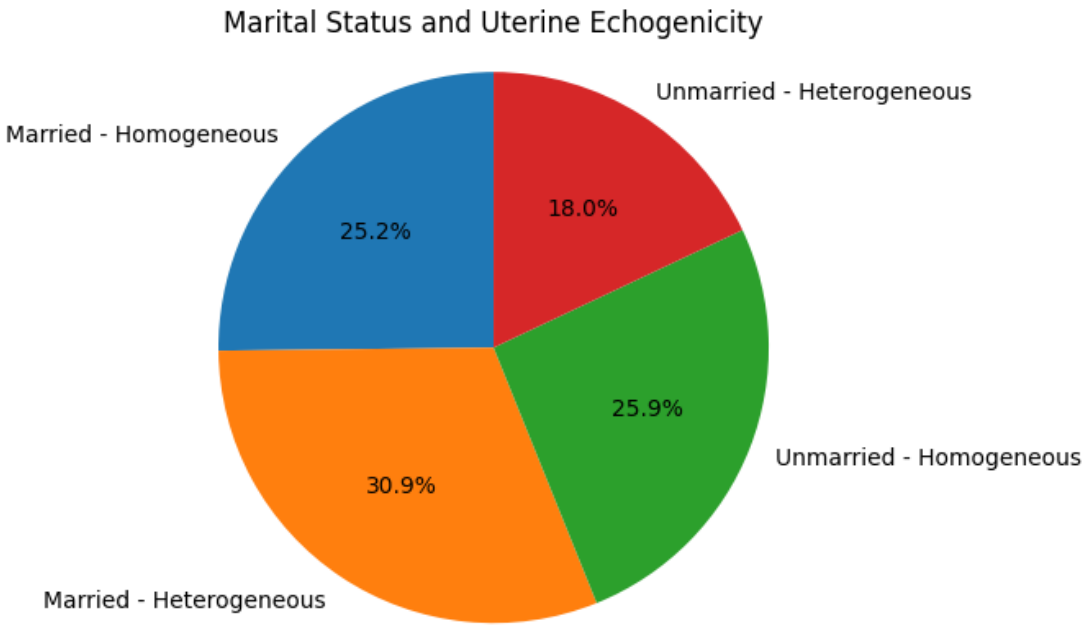

Figure 0.11: Marital Status and Uterine Echogenicity

The statistical analysis of the correlations between age, marital status, and endometrium thickness reveals some interesting insights (Table 12). The correlation between age and marital status is very weak and negative (-0.083), indicating that as age increases, marital status does not significantly change. This is supported by a p-value of 0.332, which is greater than the 0.05 threshold for statistical significance, suggesting that the

observed relationship is likely due to chance. Similarly, the correlation between age and endometrium thickness is very weak and positive (0.080), with a p-value of 0.347, suggesting no significant relationship between these two variables.

It's important to note that endometrium thickness is a crucial factor in various gynecological conditions, including pelvic inflammatory disease (PID). PID is a serious infection of the female reproductive organs, which can occur at any stage of a woman's life, regardless of age or marital status. While the data in this study does not indicate a significant relationship between the analyzed variables, it does not imply that PID is an independent variable unaffected by these factors.

Lastly, the correlation between marital status and endometrium thickness is weak and positive (0.145), with a p-value of 0.089. Although this p-value is closer to the significance threshold, it still does not indicate a statistically significant relationship. In summary, the data does not provide strong evidence of meaningful relationships between these variables, but it is essential to consider the broader context and potential risk factors associated with gynecological conditions like PID.

Table 0.12: Correlation between Age, Marital Status and Endometrium Thickness

		Age	Marital Status	Endometrium Thickness (mm)
Age	Pearson Correlation	1	-.083	.080
	Sig. (2-tailed)		.332	.347
	N	139	139	139
Marital Status	Pearson Correlation	-.083	1	.145
	Sig. (2-tailed)	.332		.089
	N	139	139	139
Endometrium Thickness (mm)	Pearson Correlation	.080	.145	1
	Sig. (2-tailed)	.347	.089	
	N	139	139	139

Chapter 5

DISCUSSION

This research evaluated the role of ultrasound in diagnosing Pelvic Inflammatory Disease (PID), focusing on its ability to detect critical indicators such as endometrial thickening, uterine echogenicity, and cul-de-sac free fluid. The study revealed that 48.9% of participants exhibited heterogeneous uterine echogenicity, and had cul-de-sac free fluid, both of which are strongly indicative of PID. These findings align with existing studies, reinforcing the effectiveness of ultrasound in clinical settings.

The age distribution observed in this study, with the highest prevalence of PID in women aged 26–45 years, is consistent with findings by Farah Naaz et al. Their work highlighted that the highest incidence of PID occurred in women aged 25–29 years, emphasizing the vulnerability of this demographic. While our study did not explore socioeconomic or educational factors, their observations about these influencing variables support the need for comprehensive public health strategies.

Endometrial thickening, a key diagnostic feature identified in our research, resonates with findings by Sharon et al., who highlighted its association with endometritis—a common aspect of PID. Sharon et al. also emphasized the growing reliance on ultrasound for detecting inflammatory changes, findings mirrored in this study's outcomes.

The detection of cul-de-sac free fluid in nearly half of the participants aligns with the work of Uzma Eram et al., who recognized its significance in diagnosing PID. Their study also stressed the role of ultrasound in differentiating PID from other pelvic conditions, an essential capability demonstrated by our findings.

Heterogeneous uterine echogenicity, noted in 48.9% of cases in this research, was similarly highlighted by Sheza Waseem et al., who reported its diagnostic relevance in conditions such as PID and adenomyosis. Their observations validate the capability of ultrasound to provide detailed imaging that facilitates early and accurate diagnosis.

The findings also echo the research of Revzin et al., who advocated for a multimodal imaging approach to PID. While their study focused on the complementary roles of CT and MRI, our research confirms ultrasound as a practical and efficient first-line diagnostic tool, particularly valuable in resource-constrained environments. The similarities in identifying features like free fluid and altered echogenicity across these studies underscore the reliability of ultrasound in initial diagnostic efforts.

Moreover, our findings support the conclusions of Breanne B. Das et al., who underscored the importance of prompt diagnosis to prevent long-term complications such as infertility and chronic pelvic pain. By documenting changes such as endometrial thickening and pelvic fluid, ultrasound proves to be an indispensable tool for timely intervention, aligning with the clinical practices they recommend.

The accessibility and non-invasive nature of ultrasound, as highlighted in this research, echo the findings of Amy Curry et al. and Hasiya Yusuf et al. Both studies emphasized the need for cost-effective and widely available diagnostic options to address the significant burden of PID, especially in underserved regions.

However, as Okazaki et al. observed, the sensitivity of ultrasound in detecting asymptomatic or early-stage PID can be a limitation. To overcome this, future studies might consider combining ultrasound with advanced imaging modalities or molecular diagnostic tools to improve overall accuracy.

In conclusion, this study reinforces the diagnostic value of ultrasound in PID by correlating its findings with extensive literature. The consistent alignment of our results with prior research underscores ultrasound’s reliability as a first-line imaging modality for diagnosing and managing PID.

CONCLUSIONS

This research assessed the role of ultrasound in diagnosing Pelvic Inflammatory Disease (PID), focusing on key markers such as endometrial thickening, uterine echogenicity, and cul-de-sac free fluid. The findings confirmed that ultrasound is an effective and accessible imaging tool for identifying complications associated with PID. Approximately half of the participants displayed heterogeneous uterine echogenicity and cul-de-sac free fluid, emphasizing the reliability of ultrasound in detecting these indicators. These results align with prior studies and highlight the utility of ultrasound in early diagnosis, timely treatment initiation, and improved outcomes in reproductive health, particularly in settings with limited resources.

Recommendations

1. **Enhancing Diagnostic Accuracy**
   Incorporating ultrasound alongside clinical assessments and laboratory testing can significantly enhance the diagnostic accuracy for PID, especially in patients with nonspecific symptoms.

2. **Skill Development for Healthcare Professionals**
   Training programs should be established to improve healthcare providers' expertise in recognizing and interpreting ultrasound findings indicative of PID.

3. **Exploration of Advanced Technologies**
   Research should focus on leveraging advanced ultrasound techniques, including Doppler imaging and 3D ultrasound, to improve diagnostic precision in PID cases.

4. **Community Education and Awareness**
   Efforts to educate women of reproductive age about PID’s symptoms and the importance of early detection can empower individuals and reduce the disease burden.

5. **Improved Accessibility to Ultrasound Services**
   Policymakers should invest in making ultrasound technology more widely available and affordable in underprivileged regions, addressing disparities in reproductive healthcare access.

ADVANCES IN KNOWLEDGE

1. **Validation of Ultrasound Markers**
   This study provides evidence that ultrasound is a dependable diagnostic tool for PID, with findings such as heterogeneous uterine echogenicity and pelvic free fluid serving as consistent indicators of the disease.

2. **Insights into Age-Related Risk**
   The research highlights that women between the ages of 26 and 45 are most commonly affected by PID, contributing valuable epidemiological insights.

3. **Promoting Non-Invasive Diagnostics**
   By showcasing ultrasound's advantages as a non-invasive and accessible diagnostic option, the study underlines its potential as a first-line imaging technique in both primary care and emergency settings.

4. **Encouraging Future Research**
   These findings underscore the importance of investigating emerging technologies, such as artificial intelligence integration in ultrasound imaging, to enhance diagnostic efficiency and reduce reliance on operator expertise.

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APPENDICES

ENGLISH CONSENT FORM

Description of Research and Your Participation

You are invited to participate in a research study conducted by Maryam Ahmad Zai on topic of "The Diagnostic Utility of Ultrasound in Pelvic Inflammatory Disease (PID)".

Risks and Discomforts

There was no risk and discomfort to the participants.

Protection of Confidentiality

We will do everything we could to protect your privacy. Your identity will not be revealed in any publication resulting from this study.

Voluntary Participation

Your participation in this research study is voluntary. You may choose not to participate, and you may withdraw your consent to participate any time. You will not be penalized in any way should you decide not you participate or to withdraw from this study.

CONSENT

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's Signature: _____ Date: _____

URDU CONSENT FORM

عنوان شرونیی سوزش کی بیماری (PID) کے مریضوں میں ایڈوانسڈ الٹراساؤنڈ تشخیص.

رفاقت

نقصانات اور تکلیف: اس تحقیق سے کسی قسم کے نقصان یا تکلیف کا اندیشہ نہیں ہے ۔

ممکنہ فوائد: آپکو ایک اہم تحقیق میں حصہ لینے کا موقعہ دیا جائے گا۔

رازداری کا تحفظ: ہم آپ کی معلومات کے تحفظ کے لیے وہ سب کچھ کریں گے جو ہم کر سکتے ہیں۔ تحقیق کے متعلق اکٹھی کی گیی تمام معلومات کو انتہا ئی خفیہ رکھا جاے گا۔ ڈیٹا انٹری اور تجزیے کے دوران آپ کے متعلق وہ تمام معلومات جن سے آپ کی شناخت ہو سکتی ہو کو ختم کر دیا جاے گا۔ اس تحقیق کے نتیجے میں شائع ہونے والی کسی بھی اشاعت میں آپ کی شناخت کو ظاہر نہیں کیا جاے گا۔

رضاکارانہ شمولیت: اس تحقیقی مطالعہ میں آپ کی شرکت رضاکارانہ ہے ۔ آپ کو شرکت نہ کرنے اور کسی بھی وقت بغیر وجہ بتاۓ اس تحقیق میں شمولیت کو چھوڑنے کا اختیار ہے ۔ شرکت نہ کرنے یا اس میں شمولیت کو چھوڑنے کی صورت میں آپ کے خلاف کوئی کاروایی نہیں کی جاے گی

درجذیل معلومات تحقیق میں شامل ہونے والوں کے لیے پڑھیں اور ان کا جواب دیے گیے خانوں میں درج کریں

☐ میں نے معلوماتی شیٹ جو کہ تحقیق کی وضاحت کر رہی ہے کو سمجھ لیا ہےاورمجھے تحققیق کے سوالات کرنے کا موقع دیا گیا تھا۔

☐ میں سمجھ گیا/گیی ہوں کہ میری شرکت رضاکارانہ ہے اور یہ کہ میں کسی بھی وقت اپنا ارادہ بدل سکتا/سکتی ہوں اور تحقیق سے دستبردار ہو سکتا/سکتی

☐ میں سمجھ گیا/گیی ہوں کہ میرے جوابات خفیہ رکھے جاءیں گے۔ میں محقیقیین کو اس بات کی اجازت دیتا/دیتی ہوں کے وہ جوابات کو جانچ سکیں۔

☐ میں سممجھ گیا/گی ہوں کے معلومات میرے نام کے بجاے نمبر کی صورت میں محفوظ کی جائیں گی۔ تا کہ میں نتائج کی اشاعت کے دوران کسی بھی طرح سے شناخت نہ کیا جا سکوں۔ میں اس بات سے رضامند ہوں کے جو معلومات مجھ سے لی جائیں گی وہ تحقیق میں استعمال ہوں گی۔

☐ میں اوپر بتایی گی تحقیق میں شامل ہونے کے لیے رضامند ہوں اور محقیقین کو اپنا پتہ تبدیل ہونے کی صورت میں مطلع کروں گا/گی۔

رضا مندی:میں نے یہ اجازت نامہ پڑھا ہے اور مجھے سوال پوچھنے کا موقع دیا گیا ہے۔ میں اس سٹڈی میں شرکت کے راضی ہوں۔

شرکت کنندہ کا نام _____ دستخط_____ تاریخ _____

اجازت لینے والے کا نام _____ دستخط _____تاریخ _____

اس اجازت نامہ کی ایک نقل آپکو دی جانی چاہیے

DEMOGRAPHICS FORM & QUESTIONNAIRES

Patient Demographics:
1. Patient ID: _____ 2.Age: _____ 3. Gender: _____
Clinical Information:4. Symptoms (Check all that apply):
□Cyanosis □Dyspnea □ Fatigue
□ Others (specify): _____

Transthoracic Echocardiography (TTE) Data:5. Date of TTE: _____
6. Heart Chambers (Check all that are abnormal): -
□Right Atrium □Right Ventricle – □Left Atrium – □Left Ventricle
7.. Shunts (Specify): _____

13. Additional Findings: _____

Multidetector Computed Tomography Angiography Data:
14. Date of MDCTA: _____
15. Cardiac Morphology: - Normal - Abnormal (Specify): _____
16. Right Ventricular Outflow Tract (RVOT) Obstruction: - □Yes - □No
17. Pulmonary Artery Anomalies: - □Yes (Specify): _____ - No
18. Aortic Arch Anomalies: - □Yes (Specify): _____ - □No
19. Coronary Artery Anomalies: - □Yes (Specify): _____ - □No
21. Valve Diameter (mm): _____
23. Additional Findings: _____

Correlation Data:
27. Correlation of Shunts (TTE vs. MDCTA): _____
28. Correlation of sepal defects (ASD, VSD)
29. double outlet right ventric.

PERMISSION LETTER

POPULAR

Ref. No. 514 /Rad/20 Date: 03/08/024

APPROVAL LETTER FOR DATA COLLECTION

This certificate acknowledges that **MARYAM AHMAD ZAI** is authorized to conduct a research project titled " **THE DIAGNOSTIC UTILITY OF ULTRASOUND IN PELVIC INFLAMMATORY DISEASE** "

Permission is granted for the collection of data from the Department of Radiology MMC General Hospital, Peshawar over a period of three months from the letter issuing date.

MANAGER
Popular Diagnostic Centre
Khyber Pakhtunkhwa
Ph: 091-2552890

Head of Radiology Department

POPULAR DIAGNOSTIC CENTER, SUEKARNO CHOWK PESHAWAR
Ph: 091-2552890 , Fax: 091-2593235

ETHICS COMMITTEE LETTER

SUPERIOR UNIVERSITY

OFFICE OF THE DEAN-FAHS

Ref.: IRB /FAHS/Allied-HS/10/24/MS/RS-3585

Date: 29th October 2024

Name: Maryam Ahmad Zai (MS Allied Health Sciences)

Registration: SU91-MAHSW-S23-208

Subject: Ethical Approval Letter

The Research Ethical Committee convened on Dated: **17th October, 2024** to discuss your protocol titled "**The diagnostic utility of ultrasound in pelvic inflammatory disease (PID)**"

No further corrections and recommendations were suggested. The above-mentioned protocol has been approved after considering various research issues including ethical concerns with condition that the researcher will submit completion report at the end of his/her research.

Prof. Dr. Muhammad Naveed Babur
Dean/Convener REC
Faculty of Allied Health Sciences
Superior University, Lahore

17-KM, Main Raiwind Road, Lahore.
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