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Original Research Article

A COMPARATIVE STUDY FOR CLINICAL ASSESSMENT & DIAGNOSTIC ACCURACY OF ULTRASOUND IMAGING IN SCROTAL AND INGUINAL PATHOLOGIES

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Abstract

Background: Accurate diagnosis of scrotal and inguinal pathologies is crucial for effective treatment. This study compares the diagnostic accuracy of clinical examination with ultrasound imaging (USG) in identifying and differentiating scrotal and inguinal pathologies. **Materials and Methods:** This was a single centre, hospital-based, cross-sectional study conducted at our institute by enrolling a total of 120 patients presenting with the complaint of inguinal and inguinoscrotal swelling. Detailed clinical assessment was conducted by surgeons and subsequently, all participants underwent USG. The collected data was analysed to determine the correlation between clinical findings and USG results in identifying the aetiology of the swelling. **Result:** The mean age of the patients were 47.8 years and the most common presenting complain was painless swelling (65.8%) followed by painful swelling (20%). Among 120 patients, clinical examination identified a total of 9 different pathologies with hydrocele 44 (36.7%) being most common followed by inguinal hernias 30 (25%), epididymal cyst 11 (9.2%) and epididymitis 10 (8.3%).In hydrocele cases, clinical examination had an accuracy of 86.4%, whereas USG identified additional pathologies like pyocele and epididymal cyst. For epididymo-orchitis, clinical accuracy was 62.5%, with USG providing more specific diagnoses. In inguinal hernia cases, USG confirmed 90% of clinical diagnoses and identified misdiagnosed epididymal cysts. USG was particularly effective in differentiating conditions with similar clinical presentations, such as enlarged testis and increased vascularity, where it accurately diagnosed underlying conditions like orchitis and seminoma. Notably, the study delineated specific USG characteristics associated with each condition, such as increased testicular size, echogenicity and altered vascularity. **Conclusion:** The study concludes that USG is a superior diagnostic tool compared to clinical examination for scrotal and inguinal pathologies. Its ability to accurately identify and differentiate between various scrotal and inguinal pathologies can enhance the quality of patient care.

INTRODUCTION

Inguinal and inguinoscrotal swellings are common clinical conditions encountered in surgical practice, presenting diagnostic challenges that necessitate accurate and efficient evaluation methods.[1] The differential diagnosis for these swellings is broad, encompassing a range of conditions from benign to life-threatening.[2] Traditional diagnostic approaches have primarily relied on clinical examination, leveraging the clinician's expertise in palpation, inspection, and patient history.[3] However, with the advent of advanced imaging techniques, particularly ultrasonography (USG), there has been a paradigm shift in the diagnostic process.

Ultrasonography, a non-invasive imaging modality, has gained widespread acceptance in the medical field due to its safety profile, absence of ionizing radiation, real-time imaging capabilities, and relative cost-effectiveness.[4] It offers the advantage

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of visualizing the anatomical structures in detail, providing insights that are sometimes elusive in a clinical examination.[5] Particularly in the context of inguinal and inguinoscrotal swellings, USG can differentiate between various pathologies like hernias, hydroceles, varicoceles, and tumors, thus guiding appropriate management strategies.[6] This study aims to evaluate the diagnostic efficacy of ultrasonography compared to traditional clinical examination. The study is conducted in a bid to ascertain whether USG can be considered superior, equivalent, or inferior to clinical examination in diagnosing inguinal and inguinoscrotal swellings. Such a comparison is crucial, as it can potentially influence clinical protocols and guidelines, leading to improved patient outcomes.[7,8] The hypothesis driving this study is that ultrasonography, with its detailed imaging capability, might offer a higher diagnostic accuracy than clinical examination alone. To test this hypothesis, the study involves a detailed comparison of findings obtained through clinical examination and ultrasonography in a group of patients presenting with inguinal and inguinoscrotal swellings. By providing a rigorous comparative analysis, this study aims to contribute valuable insights to the field of surgical diagnostics, potentially influencing the diagnostic approach for inguinal and inguinoscrotal swellings and enhancing patient care.

Objectives

- To Determine the Diagnostic Accuracy of Ultrasonography in identifying the underlying causes of inguinal and inguinoscrotal swellings.
- The study aims to conduct a head-to-head comparison between the two diagnostic modalities, to ascertain if USG provides superior diagnostic accuracy compared to clinical examination.
- The study seeks to identify specific pathologies or clinical scenarios where ultrasonography is particularly advantageous over clinical examination.
- This involves determining whether the addition of USG to the diagnostic process reduces uncertainty and improves confidence in the diagnosis made based on clinical examination alone.

MATERIALS AND METHODS

This was a single, centre, hospital-based, prospective observational study,[9] conducted at Department of Radiology, LN Medical College, Bhopal and associated JK Hospitals over a period of 18 months. The study enrolled a total of 120 patients presenting with inguino-scrotal swelling and fulfilling following criteria-

Inclusion Criteria

- Adults (≥18 years) presenting with an inguinal or inguinoscrotal swelling of at least 4 weeks duration.
- Ability to provide informed consent.

Exclusion Criteria

- Recent history of scrotal trauma.

Participants Recruitment: Participants for this study were recruited through a non-probability, convenience sampling approach.[11] Patients meeting the eligibility criteria during the study period were approached by research team. Informed consent was obtained from all participants after a detailed explanation of the study. Data Collection: Demographic and clinical data was collected using a standardized questionnaire, including age, gender, medical history, presenting symptoms, duration of swelling, any associated pain or discomfort, and relevant physical examination findings. The first phase of data collection involved a comprehensive clinical examination conducted by surgical consultant. This examination included a complete history, inspection, palpation, and other relevant assessments, with findings meticulously documented. Subsequently, patients underwent an ultrasonography examination performed by experienced radiologists who were unaware of the clinical examination outcomes. This step focuses on evaluating the inguinal and inguinoscrotal areas for various pathologies, with all findings and images recorded systematically. Ultrasound examination was performed following a standardized and meticulous protocol to ensure consistency and accuracy across all patient examinations. During the USG procedure, patients were positioned appropriately, usually lying down, and sometimes asked to stand if the condition required it (especially in cases of suspected hernias). A high-resolution ultrasound machine with appropriate frequency transducers was used to optimize the visualization of the inguinal region structures. The sonographer systematically examined the inguinal and inguinoscrotal areas, looking for signs of hernias, hydroceles, varicoceles, tumors, or any other abnormalities. Both static and dynamic imaging techniques were employed. Dynamic imaging, involving actions like coughing or Valsalva maneuver, was particularly important in assessing conditions like hernias. The entire process was carried out with due care to ensure patient comfort and dignity. Both hemiscrotum were examined in transverse, sagittal and oblique planes. All findings, including the size, shape, content, and characteristics of any abnormalities, were meticulously documented. Images were saved and included in the patient's record for future reference. This comprehensive approach of conducting USG ensured that the data collected were of high quality and reliability, contributing significantly to the study's overall findings and conclusions. Data from both the clinical examination and ultrasonography were then entered into a secure electronic database, ensuring accuracy and confidentiality. In cases where further investigations or surgical interventions are necessary, these are conducted,

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and the final diagnosis is established. This diagnosis serves as a reference to assess the accuracy of both the clinical examination and ultrasonography. Data Analysis: Statistical analysis was performed using Stata 17.0 to compare sonographic features with final diagnoses and analyze the impact of ultrasound findings on management decisions and patient outcomes. Frequency tables and measures of central tendency (mean, median) will be used to summarize demographic and clinical characteristics of the participants. Statistical tests like Spearman's rank correlation can be used to explore potential associations between specific ultrasound features and other variables like pain severity or duration of swelling. Finally, a detailed analysis of the data is undertaken, comparing the diagnostic efficacy of clinical examination and ultrasonography.

RESULTS

For the present study, we approached a total of 142 patients presenting with scrotal or inguinal swelling; 14 patients were excluded, 8 patients refused to give consent to participate in the present study, and the remaining 120 patients were enrolled in the present study. The mean age of the patients was 47.8 years (± 11.2), ranging from 7 years to 84 years [Table 1]. Most of the participants were in the age of 41-50 (22.5%) years followed by 51-60 years (16.7%).

The most common clinical complaint was swelling, reported by 79 (65.8% of patients). Pain and swelling were reported by 24 (20.0% of patients), followed by pain, fever, and swelling by 14 (11.7% of patients) [Table 2].

[Table 3] provides compelling data showing how ultrasound imaging (USG) surpasses clinical assessment in accurately diagnosing scrotal pathologies. In almost all categories, USG provided definitive diagnoses while clinical evaluations fell short. A total of 44 patients on clinical examinations were diagnosed as having hydrocele. However, the USG examination of these 44 patients showed that 9.1% of these patients had pyocele and 4.5% of patients had epididymal cyst. Thus, accuracy of clinical examination was only 86.4% to detect hydrocele. While clinical assessment of 8 patients suggested that they have epididymo-orchitis, USG revealed their true nature- 5 of these cases were epididymo-orchitis, 1 was of epididymitis, and 2 patients had inguinal lymphadenopathy. Thus, in cases of Epididymoorchitis, the accuracy of clinical examination was only 62.5%. In the present study, 30 patients were clinically suspected of having inguinal hernia, USG confirmed 90% (27) of these were inguinal hernia and identified 3 patients diagnosed as inguinal hernia actually were epididymal cysts that were missed by clinical examination.

While the clinical examination could only ascertain the change in size and vascularity of the testis, USG was able to accurately diagnose the pathology in these conditions. USG could differentiate between different diagnoses within the same clinical finding, i.e., increased size or change in vascularity. The clinical examination showed that there were 18 patients who had enlarged testis; the exact diagnosis of these patients was only confirmed by USG. Similarly, the clinical examination showed there were 11 patients with increased vascularity; the exact diagnosis in these patients was confirmed by USG examination only as follow-up orchitis (9 patients) and seminoma (2 patients). [Table 4]

[Table 5] elucidates the ultrasonographic characteristics of the epididymis, indicating increased size, hypoechoic echogenicity, and increased vascularity associated with epididymitis. An increased size of the right epididymis was observed in 13 cases (10.83%). All these cases were diagnosed with epididymitis. On the left side, an increased size was noted in 8 cases (6.6%), with 7 of these diagnosed as epididymitis and 1 as seminoma. The right epididymis was hypoechoic in 13 cases (10.83%), all diagnosed with epididymitis. On the left side, hypoechoic echogenicity was found in 7 cases (5.83%), each diagnosed as epididymitis. Only one case (0.83%) showed hyperechoic echogenicity on the left side, which was diagnosed as seminoma. Increased vascularity in the right epididymis was seen in 13 cases (10.83%), all of which were diagnosed with epididymitis. On the left side, increased vascularity was observed in 8 cases (6.66%), with 7 diagnosed as epididymitis and 1 as seminoma.

[Table 6] compares the clinical diagnosis with ultrasonography (USG) findings for inguinal region demonstrating the superior diagnostic accuracy of USG over clinical assessment in identifying the inguinal pathology. There was a total of 20 patients diagnosed as bilateral hydrocele, however, USG refined these findings by accurately diagnosing 18 as B/L Hydrocele and identifying 2 cases as B/L Pyocele, which clinical diagnosis missed. Both clinical diagnosis and USG were in agreement, with each identifying Hydrocele in all 15 cases (12.50%). Out of 17 cases clinically diagnosed as Right Hydrocele, USG confirmed 15 as such but importantly detected 2 cases as Right Pyocele, highlighting its capability to distinguish between similar conditions more effectively than clinical examination alone. These results underscore the value of USG as a diagnostic tool, particularly in its ability to accurately identify and differentiate conditions such as hydrocele and pyocele.

Table 1: Age of participants (n=120)

Age group	Numbers (n)	Percent (%)
1-10	4	3.33
11-20	6	5

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21-30	18	15
31-40	16	13.33
41-50	27	22.5
51-60	20	16.66
61-70	17	14.16
71-80	9	7.5
81-90	3	2.5

Table 2:Clinical Complaints of participants (n=120)

Clinical complaints	Numbers (n)	Percent (%)
Pain, swelling	24	20.00
Pain, Fever swelling	14	11.70
Swelling	79	65.80
Swelling, weight loss, pain	3	2.50

Table 3: Comparison between USG findings and Clinical Findings (n=120)

Clinical Diagnosis	Number(percent)	Ultrasonographic Findings	Number (percent)
Hydrocele	44 (36.67%)	Hydrocele	38 (86.4%)
		Pyocele	4 (9.1%)
		Epididymal cyst	2 (4.5%)
Epididymo-orchitis	8 (6.67%)	Epididymo-orchitis	5 (62.5%)
		Epididymitis	1 (12.5%)
		Inguinal lymphadenopathy	2 (25.0%)
Epididymitis	10 (8.33%)	Epididymitis	10 (100.0%)
Varicocele	9 (7.50%)	Varicocele	9 (100.0%)
Epididymal cyst	11 (9.17%)	Epididymal cyst	11 (100.0%)
Inguinal Hernia	30 (25.0%)	Inguinal Hernia	27 (90%)
		Epididymal cyst	3 (10%)
Neoplastic lesion	2 (1.67%)	Seminoma	2 (100.0%)
Torsion	3 (2.50%)	Torsion	3 (100.0%)
Spermatocele	3 (2.50%)	Spermatocele	(100.0%)

Table 4: Testicular Findings on USG (n=120)

Clinical finding	USG confirmed	Diagnosis	
Increased size of Testis 17(14.2%)	Hypoechoic 15(12.5%)	Orchitis	11
		Torsion	3
		Testicular abscess	1
	Hyperechoic2 (1.7%)	Seminoma2	
Level of Vascularity			
Increase vascularity	11 (9.2%)	Orchitis 9Seminoma 2	
Reduced Vascularity	3 (2.5%)	Torsion 3	

Table 5: Findings of Epididymis on USG (n=21)

	Right epididymis	Diagnosis	Left epididymis	Diagnosis
Size				
Increased	13 (10.83%)	Epididymitis 13 (10.83%)	8 (6.6%)	Epididymitis 7Seminoma 1
Decreased	0	-	0	-
Echogenicity				
Hypoechoic	13 (10.83%)	Epididymitis 13 (10.83%)	7(5.83%)	Epididymitis 7(5.83%)
Hyperechoic	0	-	1 (0.83%)	Seminoma 1 (0.83%)
Vascularity				
Increased	13(10.83%)	Epididymitis 13 (10.83%)	8 (6.66%)	Epididymitis 7Seminoma 1
Decreased	0	-	0	-

Table 6: Inguinal Findings (n=120)

Clinical Diagnosis	Number (%)	USG Diagnosis, Number(%)
B/L Hydrocele	20 (16.60)	B/L Hydrocele- 18 (90%)
		B/L Pyocele-2 (10%)
Left Hydrocele	15 (12.50)	Hydrocele- 15 (100%)
Right Hydrocele	17 (14.20)	Right Hydrocele-15 (88.2%)
		Right Pyocele-2 (11.8%)
Normal	68 (56.7)	No abnormality detected

Findings	Right Inguinal Swelling		Left Inguinal Swelling	
	Number (n)	Percent(%)	Number (n)	Percent (%)
Hernia (Omentum)	12	10.00%	7	5.80%
Hernia (Omentum), LN	3	2.50%	1	0.80%
Hernia (Omentum + Bowel)	22	18.30%	14	11.70%
Hernia (Omentum + Bowel), LN	1	0.80%	0	0
Lymph Node	8	6.70%	8	6.70%

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Metastatic deposits	1	0.80%	0	0
Right Funiculitis	1	0.80%	0	0
Normal	72	60.00%	90	75.00%

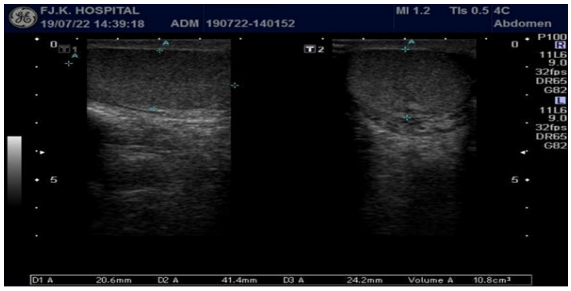

Figure 1: Longitudinal US scan of a normal testis in a 26-year-old man

Figure 2: Ultrasound image showing cyst of epididymis, anechoic cystic lesion in right epididymis

Figure 3: Bilateral Hydrocele in a 28-year-old male with scrotal swelling. Transverse ultra-sonogram of the scrotum shows bilateral anechoic fluid collection

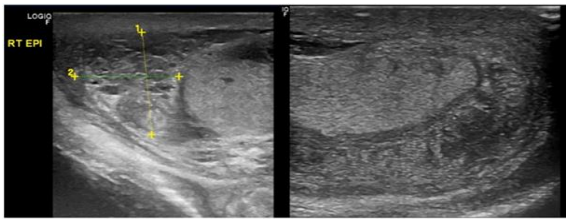

Figure 4: USG image showing Epididymitis, bulky epididymis.

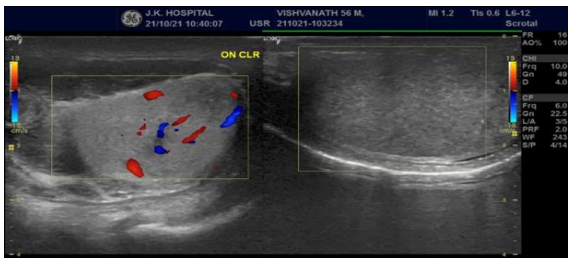

Figure 5: Ultrasound image showing hypo echoic testis with increased Vascularity on color Doppler.

Figure 6: Seminoma in a 30 year old male with a painless, palpable left testicular mass. Grey scale us images of the left testis show a isoechoic mass with marked internal color flow, characteristic of seminoma

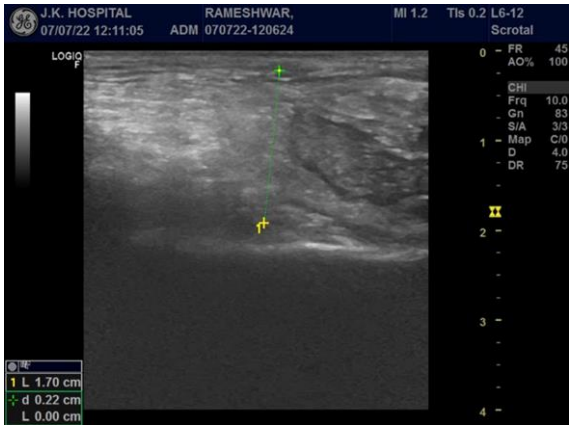

Figure 7: Ultrasound image showing defect seen in anterior abdominal wall of inguinal region

Figure 8: Grey scale USG shows Multiple metastatic deposits noted in left inguinal region and small well defined metastatic deposits in scrotal wall with hydrocele

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DISCUSSION

The findings of this study provide valuable insights into the prevalence and distribution of male genital and inguinal pathologies, as identified through both clinical assessments and ultrasonographic examinations. The study demonstrates the high accuracy of USG in diagnosing inguinal conditions. This suggests that USG is a reliable tool for validating clinical suspicions and can be considered essential for accurate diagnosis in inguinal pathology. In the present study, USG showed superiority in identifying additional pathologies that were not detected through clinical examination alone, such as pyocele. This indicates the importance of USG in providing a more comprehensive evaluation, especially when clinical findings are ambiguous or when more complex pathologies are suspected.

Our cases were predominantly comprised of patients between the ages of 31 and 60, accounting for over 52% of the total. The age group of 81 to 90 years had the lowest number of cases, with only 3 reported. In a study conducted by Thinyu S et al., the age of the patients varied from 13 to 82 years, with a mean age of 38.6 years.[11] The three predominant symptoms reported by patients were edoema, discomfort, and elevated body temperature. In a study conducted by Thinyu S et al, it was observed that among 110 patients, 84 individuals (76.4%) experienced scrotal pain. The researchers concluded that infection was the predominant cause of scrotal pain, accounting for 12 cases. Blaivas M et al. identified 36 patients who reported experiencing acute scrotal pain.[13]

The prevalence of hydrocele in our study was relatively high at 36.67%, which is consistent with its well-established status as one of the most frequently occurring scrotal abnormalities. In a retrospective study conducted by Micallef M et al. on 582 subjects, it was determined that the primary cause of scrotal swelling was extratesticular in nature, accounting for 75% of all cases.[14] Among these cases, hydrocele was found to be the most prevalent, occurring in 13% of the subjects.

Epididymo-orchitis and epididymitis play a significant role in scrotal pathology. The unique ultrasonographic features identified in our study, including enlarged dimensions and reduced echogenicity, emphasise the effectiveness of ultrasonography in distinguishing between these inflammatory conditions. In a retrospective analysis conducted by Arjhansiri K et al., it was found that hydrocele was the most prevalent abnormality, accounting for 29.87% of cases, followed by epididymitis, which accounted for 14.28% of cases.[14] In their study, Sharma M et al. discovered that out of a total of 74 patients exhibiting clinical symptoms associated with scrotal pathology, the most prevalent abnormality identified through sonography was the presence of fluid collection.[15]

In a retrospective analysis of 164 ultrasound examinations, D'Andrea et al. (2010) found that out of the 164 patients, 125 (76%) experienced scrotal pain, 31 (19%) had painless scrotal mass or swelling, and 8 (5%) had trauma(16). In a study conducted by Raj D et al., it was observed that chronic epididymo-orchitis was the most prevalent inflammatory condition identified, found in 18 cases (45%).[16] Acute epididymo-orchitis was the second most common inflammatory condition found, observed in nine cases (22.5%).

Our study revealed that 10.8% of patients exhibited hypoechoic lesions in the right epididymis, and all of these patients were diagnosed with epididymitis based on clinical examination. The left epididymis exhibited hypoechoic lesions in 5.83% of patients, all of which were clinically diagnosed as epididymitis. In their study, Arjhansiri K et al. discovered that the majority of testicular tumours presented as a concentrated mass, whereas testicular infection typically resulted in widespread abnormal echogenicity throughout the testis ($p = 0.008$).[14] The researchers noted that there were no differences in echogenicity, margin of the mass, testicular enlargement, fluid in the scrotal sac, and calcification between testicular infection and tumour. Sharma M et al. noted that the presence of a fluid-filled sac above the testis and epididymis indicated the presence of an encysted hydrocele of the spermatic cord.[15] Neoplastic lesions, torsion, and spermatoceles, although less frequent, require consideration because of their potential effects on fertility and overall scrotal well-being. The relatively low occurrence rates (1.67%, 2.50%, and 2.50%, respectively) emphasise the importance of using a thorough diagnostic method, with ultrasonography playing a crucial role in identifying and describing them.

Our study observed three instances of testicular torsion, where all cases exhibited acute onset of pain and swelling as clinical symptoms. The grayscale image displayed a shift in axis, indicating the presence of edoema. A study conducted by Vijayaraghavan BS et al. involved 221 patients who underwent sonography for acute scrotum. The individual experienced epididymo-orchitis, which involved inflammation of the epididymis and testicles, accompanied by a straight spermatic cord. 61 patients exhibited a total torsion of the testis, as indicated by the presence of the whirlpool sign on grey scale imaging and the absence of blood flow beyond the whirlpool. Four patients exhibited an incomplete torsion, as evidenced by the presence of the whirlpool sign on both grey scale and colour Doppler imaging. The researchers determined that the sonographic real-time whirlpool sign is the most accurate and sensitive indicator of torsion, whether it is complete or incomplete.[16,17]

The high occurrence rate of inguinal hernias (25.0%) highlights the importance of this condition in clinical practice. The varied ultrasonographic diagnoses associated with inguinal swelling, such as

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hernias, lymph nodes, and metastatic deposits, highlight the intricate nature of inguinal pathology. Ultrasonography plays a crucial role in accurately guiding the appropriate surgical treatment.[6,7] Subramanyam et al,[18] conducted research on a group of 65 individuals who had a primary scrotal mass. It was found that sonography is an effective method for identifying and distinguishing between scrotal hernias and other masses in the testicles or surrounding areas. This is achieved by using ultrasound to scan the scrotum and the groin region. Furthermore, it established sonographic criteria that can accurately distinguish between scrotal hernias and primary scrotal pathology. Within this study, we identified three instances of spermatocele, which were observed as cystic structures on a high-frequency ultrasound scan. In their study of 40 subjects, Leung et al. identified 29 instances of epididymal cysts and spermatoceles (19 cases).

To summarise, current study reveals that ultrasonography is highly accurate in diagnosing various male genital and inguinal conditions. This study convincingly demonstrates the superiority of ultrasound imaging (USG) over clinical assessment in accurately diagnosing scrotal pathologies. The findings across various categories paint a clear picture: USG surpasses clinical examination in terms of specificity, sensitivity, and overall diagnostic accuracy.USG identified misdiagnoses made by clinical examinations in several categories, including hydrocele, epididymo-orchitis, inguinal hernia, and enlarged testis. Notably, clinical accuracy dropped as low as 62.5% for epididymo-orchitis. USG excelled at differentiating between conditions presenting with similar clinical features, such as increased size or vascularity. This ability prevented misdiagnoses and ensured appropriate treatment.USG revealed unexpected pathologies undetected by clinical examination, highlighting its ability to rule out false positives. For example, 9.1% of clinically diagnosed hydrocele cases were actually pyocele. USG offered a detailed visualization of the scrotum, allowing for the assessment of internal structures and their characteristics (size, echogenicity, vascularity). This comprehensive view provided crucial information for accurate diagnosis. The findings strongly advocate for incorporating USG as a routine diagnostic tool in scrotal evaluations. Early and accurate diagnosis allows for prompt and appropriate treatment, potentially preventing complications and improving patient outcomes. Accurate characterization of the pathology enables tailored treatment plans, enhancing efficacy and avoiding unnecessary interventions.

While the study highlights the advantages of USG, acknowledging its limitations is crucial. The cost of equipment and operator expertise might pose accessibility challenges. Future research could explore cost-effective solutions and training programs to expand access to USG. Additionally, investigating the utility of USG in conjunction with other diagnostic modalities could further refine diagnostic accuracy and treatment strategies.[19]

CONCLUSION

This study provides compelling evidence for the superiority of USG over clinical assessment in diagnosing both scrotal and inguinal pathologies. Its ability to provide accurate, detailed, and differential diagnoses makes it an invaluable tool for improving patient care and optimizing treatment outcomes. In certain cases, the USG provided definitive diagnosis when the clinical assessment was either inconclusive or was incorrect. Specifically, in certain cases USG was able to provide accurate diagnosis for patients diagnosed to have hydrocele, epididymo-orchitis or inguinal hernia. Ultrasound helped differentiate epididymo-orchitis from isolated epididymitis and inguinal lymphadenopathy, providing more specific diagnoses. Moreover, USG was able to detect additional pathologies which were missed on clinical examination. The findings suggest that USG should be integrated as a standard part of the diagnostic process for scrotal and inguinal pathologies, enhancing the overall quality of patient care.

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