Original Research

EVALUATION OF DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN CASES OF UNDESCENDED TESTIS IN PAEDIATRIC POPULATION

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ABSTRACT

Introduction: Undescended testis (cryptorchidism) is a common congenital anomaly in the male paediatric population, affecting 3-4% of full-term and up to 45% of preterm neonates. Early diagnosis and management are crucial to prevent complications such as infertility and testicular malignancy. Ultrasonography (US) is frequently used to assess undescended testis due to its non-invasive nature and availability, but its diagnostic accuracy needs comprehensive evaluation.

Aims: This study evaluates the diagnostic accuracy of ultrasonography in detecting and localizing undescended testes in the paediatric population by comparing its findings with magnetic resonance imaging (MRI) and intraoperative observations**.**

Materials and Methods: A hospital-based cross-sectional study was conducted over 18 months at Nil RatanSircar Medical College and Hospital, Kolkata, involving 150 male paediatric patients (aged 6 months–12 years) diagnosed with undescended testis. Each patient underwent ultrasonography, and the results were compared with MRI and intraoperative findings.Statistical analysis included sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy**.**

Results: Among the 150 patients included in the study, ultrasound examination showed that the most common finding was intracanalicular location in 60 patients (40.0%), followed by superficial ring in 42 patients (28.0%), deep ring in 18 patients (12.0%), not found in 18 patients (12.0%), and intra-abdominal location in 12 patients (8.0%).MRI evaluation was performed in 40 patients, among which deep ring location was identified in 24 patients (16.0%) and intra-abdominal location in 16 patients (10.7%). MRI was not done in 110 patients (73.3%).On intraoperative findings, the most common location was intracanalicular in 60 patients (40.0%), followed by superficial ring in 42 patients (28.0%), deep ring in 27 patients (18.0%), intra-abdominal location in 16 patients (10.7%), while the structure was not found in 5 patients (3.3%).

Conclusion: Ultrasonography is a valuable first-line imaging modality due to its accessibility, cost-effectiveness, and non-invasiveness. However, its limitations in detecting intra-abdominal testis necessitate supplementary imaging with MRI, particularly for non-palpable cases. A multi-modal imaging approach, integrating clinical assessment, is essential for accurate diagnosis and optimal patient management.

Keywords: Undescended Testis, Ultrasonography, Paediatric Urology, Diagnostic Accuracy, Cryptorchidism**.**

INTRODUCTION

Undescended testis, or cryptorchidism, is a common condition in paediatric populations where one or both testes fail to descend into the scrotum by birth. This condition affects approximately 3-4% of full-term newborns, and the incidence is higher in premature infants. The test is typically descends through the inguinal canal into the scrotum during the latter part of fetal development. If this process is disrupted, the testis remains in the abdomen or

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inguinal canal. Prompt diagnosis and management are crucial because undescended testis can lead to complications such as infertility, testicular cancer, and psychological distress due to cosmetic concerns. Treatment often involves surgical intervention, typically an orchidopexy, which is ideally performed between 6 and 18 months of age to optimize outcomes and minimize long-term risks. Regular follow-up is essential to monitor for any associated issues and ensure proper development and function of the testis.

Evaluating the diagnostic accuracy of ultrasonography in cases of undescended testis in paediatric populations reveals that this imaging modality is a valuable tool but comes with certain limitations. Ultrasonography is non-invasive, radiation-free, and offers real-time imaging, which makes it advantageous for assessing testicular position and differentiating between intra-abdominal and inguinal undescended testes. Studies generally indicate high sensitivity and specificity for ultrasonography in detecting undescended testes, with sensitivity rates often reported between 80% and 90%. However, its accuracy can be influenced by factors such as the operator's experience and the child's anatomical variations. Despite its effectiveness, ultrasonography is often used in conjunction with other diagnostic methods, such as physical examination and, in some cases, magnetic resonance imaging, to improve diagnostic precision. Thus, while ultrasonography is a crucial tool in the diagnostic process for undescended testis, its results should be interpreted within the broader clinical context to ensure comprehensive evaluation and appropriate management.

The testes are particular male organs that are found in pairs and produce androgenic hormones and spermatozoa.[1] By the 35th to 40th week of pregnancy, they descend into the scrotum, which is optimal for their function at 33°C, or roughly 3 to 4 degrees colder than their core body temperature. The condition known as cryptorchidism is characterised by the testicle not being located at the base of the scrotum.[2, 3] A cryptorchid testis may be due to non- descent or due to ectopic location, retractile, or even completely undetectable due to atrophy.[4] Anywhere along the normal line of testicular descent, which extends from the level of the inferior pole of the kidney to the upper scrotum, a testis that is truly undescended can be found.[5]

Cryptorchidism or undescended testis (a testis that is not in the scrotum) is the single most common genitourinary disease in male neonates[6,7]. Normal testicular descent to the scrotum usually occurs between 25 and 35 weeks of gestation[8]. Undescended testis is diagnosed at birth at a rate of 1%–4% in term infants and up to 45% in preterm infants[9]. Many cases of undescended testes will descend spontaneously to the scrotum by 3 months of age. Testicular descent after 3 months of age is also possible, especially in preterm infants. However, in some preterm infants, the testes do not descend until term age. In some cases, a testis that was present at birth in the scrotum may reascendspostnatally. The mechanisms of normal testicular descent, testicular reascend, and testicular regression have not been fully established yet. About 1%– 2% of boys older than 6 months develop undescended testis after its early postnatal descent. Undescended testis is known to be associated with infertility and increased malignancy rates [10]. Timely surgical correction improves fertility rates and decreases malignancy rates. Controversy persists about the effectiveness of hormonal therapy, timing of surgical therapy, and testicular outcomes of undescended testis.

Undescended testis or cryptorchidism is one of the most common congenital genitourinary anomalies affecting newborn males, occurring in about 5% at birth and 1.6% at 3 months of age.[11] It is defined as the absence of one or both testes in the normal scrotal position. The most useful classification is determining palpable versus non-palpable undescended testis, as management is determined by location and actual presence of the testis. The current diagnostic standard is careful clinical examination of a boy in several positions by an experienced examiner. To best assess for testicular position, boys should be examined in the supine and if possible, the upright cross-legged, squatting and standing position. To minimize the effects of the cremasteric reflex, patient distraction, a warm room and hands, use of liquid soap and repeat examination may assist in localization of the testes.

The initial diagnoses of undescended testis are usually made by primary care providers, who refer to paediatric urologists or surgeons for subsequent management.Primary care providers mostly evaluate the patient by getting an ultrasound done, prior to referring to surgeon for undescended testis. Up to 96.4% of surveyed pediatricians reported using ultrasound to evaluate undescended testis.

The present study aims to evaluate the diagnostic accuracy of ultrasonography in cases of undescended testis in the paediatric population. It intends to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ultrasonography in diagnosing undescended testis by comparing its findings with MRI and intra-operative findings. The study also aims to compare the accuracy of preoperative localization of the undescended testis using ultrasonography with MRI findings and intra-operative findings among paediatric patients.

MATERIALS AND METHODS

Study Design: Hospital based cross-sectional evaluation study

Place of Study: Department of Radiodiagnosis , Nil ratanSircar Medical College & Hospital , Kolkata.

Period of Study: 18 months from July 2023 to December 2024

1. Preparatory work-2 months
2. Period of data collection-11 months
3. Data entry into Microsoft excel-2 months
4. Data compilation analysis and report writing-3 months

Total Study Period: 18 months with mutual overlapping**.**

Study Population: Patients of age 6 months-12 years who referred to the department of radiodiagnosis with history of small scrotal size as compared to normal sac size in normal kids of particular age group or having empty scrotal sac on clinical examination, during the study period.

Sample Size: 150 patients

Study Variables:

- Frequency of Palpable/Non-palpable Physical examination
- Comparison of Ultrasound, MRI and Intraoperative Findings
- Comparison of Palpable/Nonpalpable Physical Examination , Ultrasound, MRI with Intraoperative Findings
- Comparison of Palpable/Nonpalpable Physical Examination , Ultrasound, with MRI Findings
- Association between Ultrasound findings: Intraoperative findings

Inclusion Criteria

1) Children with clinically diagnosed undescended testes aged 6 months to 12 years who presented at the Pediatric Surgery department at Nilratansircar medical college& Hospital, Kolkata.
2) Children whose parents/guardians have given consent to participate in the study after appropriate counselling.

Exclusion Criteria

1. Children who have had previous inguinal surgery.
2. Children with retractile testes.
3. Children with anterior abdominal wall defects or other congenital defects which may preclude abdominal ultrasound.
4. Children whose parents/guardians do not give consent to participate in the study.

Statistical Analysis

Data were compiled in Microsoft (MS) excel sheet and then analyzed by appropriate statistical methods. Mean, median and standard deviation were used to describe and summarize continuous variables. Proportions and percentages were used for categorical variables. Data display was done by the help of tables and various charts. The formulae for deriving accuracy, sensitivity, specificity, positive predictive value and negative predictive value are as follows: Accuracy (True positives + True negatives) / (True positives +False positives +False negatives + True negatives) Sensitivity = (True positives) / (True positives + False negative) Specificity = (True negatives) / (False positives + True negatives) Positive Predictive Value (PPV) = (True positives) / (True positives + False positives) Negative Predictive Value (NPV) = (True negatives) / (True negatives +False negatives.

RESULT

Table 1: Frequency of Palpable/Non-Palpable Physical Examination

Palpable/Non-Palpable Physical Examination	Frequency (n)	Percent (%)
Deep Ring	6	4.00%
Intracanalicular	21	14.00%
Non-palpable	87	58.00%
Superficial Ring	36	24.00%
Total	150	100.00%

Table 2: Comparison of Ultrasound, MRI and Intraoperative Findings

Findings	Ultrasound	MRI	IntraoperativeFrequency (%)
Deep Ring	18 (12.0%)	24 (16.0%)	27 (18.0%)
Intra canalicular	60 (40.0%)	—	60 (40.0%)
Intra-abdominal	12 (8.0%)	16 (10.7%)	16 (10.7%)
Not Found	18 (12.0%)	—	5 (3.3%)
Superficial Ring	42 (28.0%)	—	42 (28.0%)
Not Done	—	110 (73.3%)	—

Table 3: Comparison of Palpable/Nonpalpable Physical Examination, Ultrasound, MRI with Intraoperative Findings

	Deep Ring	Intracanalicular	Intraabdominal	Not Found	Superficial Ring	Total	P value

Palpable/Nonpalpable Physical Examination	Deep Ring (6)	6	0	0	0	0	6	<0.0001
	Intracanalicular (21)	0	21	0	0	0	21	
	Non-palpable (87)	21	39	16	5	6	87	
	Superficial Ring (36)	0	0	0	0	36	36	
	Total (150)	**27**	**60**	**16**	**5**	**42**	**150**	
Ultrasound Findings	Deep Ring (18)	18	0	0	0	0	18	<0.0001
	Intra-canalicular (60)	0	60	0	0	0	60	
	Intra-abdominal (12)	0	0	10	2	0	12	
	Not Found (18)	9	0	6	3	0	18	
	Superficial Ring (42)	0	0	0	0	42	42	
	Total (150)	**27**	**60**	**16**	**5**	**42**	**150**	
MRI Findings	Deep Ring (24)	24	0	0	0	0	24	<0.0001
	Intraabdominal (16)	0	0	13	3	0	16	
	Not Done (110)	3	60	3	2	42	110	
	Total (150)	**27**	**60**	**16**	**5**	**42**	**150**	

Table 4: Comparison of Palpable/Nonpalpable Physical Examination, Ultrasound, with MRI Findings

		MRI FINDINGS				
		Deep Ring	**Intraabdominal**	**Not Done**	**Total**	**P value**
Palpable/Non-palpable Physical Examination	Deep Ring (6)	6	0	0	6	<0.0001
	Intracanalicular (21)	0	0	21	21	
	Non-palpable (87)	18	16	53	87	
	Superficial Ring (36)	0	0	36	36	
	Total (150)	**24**	**16**	**110**	**150**	
Ultrasound Findings	Deep Ring (18)	15	0	3	18	<0.0001
	Intra-canalicular (60)	0	0	60	60	
	Intra-abdominal (12)	0	10	2	12	
	Not Found (18)	9	6	3	18	
	Superficial Ring (42)	0	0	42	42	
	Total (150)	**24**	**16**	**110**	**150**	

Table 5: Association between Ultrasound findings: Intraoperative findings

Ultrasound Findings	**Yes**	**No**	**Total**
Yes	130	2	132
No	15	3	18
Total	145	5	150

Chi-square value: 11.2853**; p-value:** 0.0007**;**
Statistically Significant
Sensitivity: 89.7
Specificity: 60.0
Positive Predictive Value: 98.5
Negative Predictive Value: 16.7

Accuracy: 88.7%

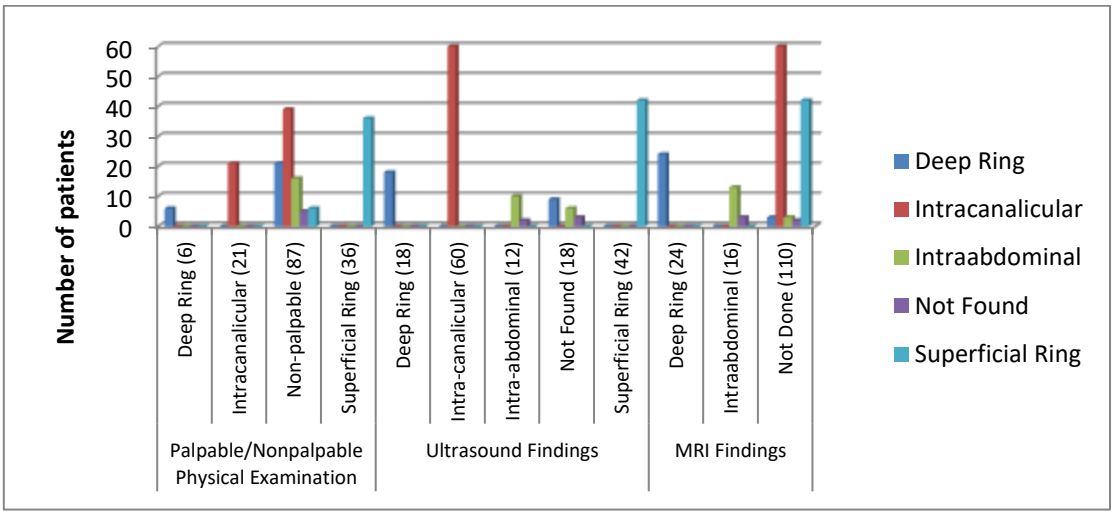

Figure 1: Comparison of Palpable/Nonpalpable Physical Examination, Ultrasound, MRI with Intraoperative Findings

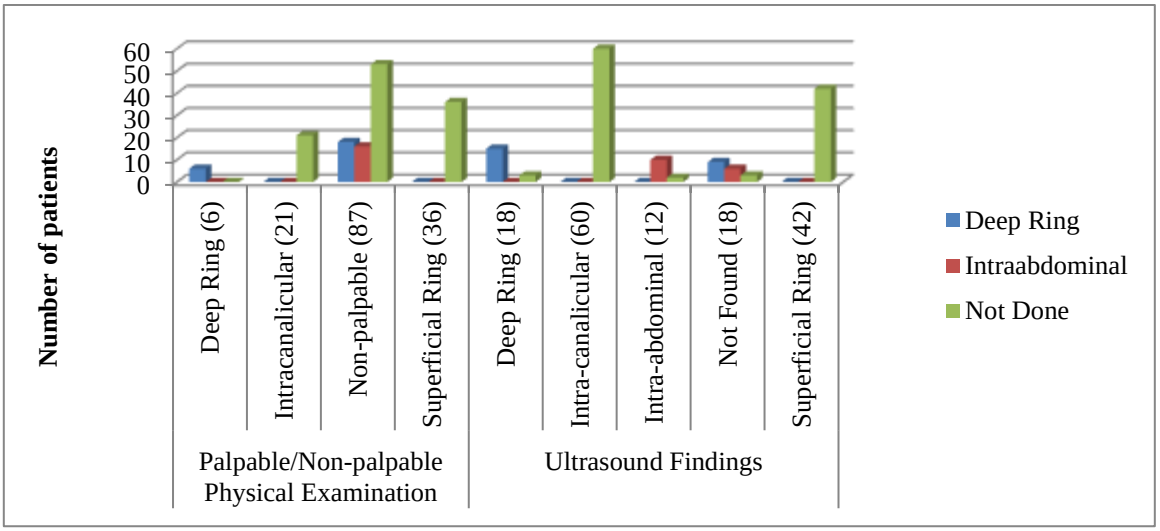

Figure 2: Comparison of Palpable/Nonpalpable Physical Examination, Ultrasound, with MRI Findings

In our study, 6 (4.0%) patients had relative findings at Deep Ring, 21 (14.0%) patients had Intracanalicular findings and 87 (58.0%) patients had Non-palpable and 36 (24.0%) patients had findings of superficial ring. Among the 150 patients included in the study, ultrasound examination showed that the most common finding was intracanalicular location in 60 patients (40.0%), followed by superficial ring in 42 patients (28.0%), deep ring in 18 patients (12.0%), not found in 18 patients (12.0%), and intra-abdominal location in 12 patients (8.0%).MRI evaluation was performed in 40 patients, among which deep ring location was identified in 24 patients (16.0%) and intra-abdominal location in 16 patients (10.7%). MRI was not done in 110 patients (73.3%).On intraoperative findings, the most common location was intracanalicular in 60 patients (40.0%), followed by superficial ring in 42 patients (28.0%), deep ring in 27 patients (18.0%), intra-abdominal location in 16 patients (10.7%), while the structure was not found in 5 patients (3.3%).

Among the 150 patients, comparison of palpable/non-palpable physical examination, ultrasound findings, and MRI findings showed a statistically significant association with the final anatomical location ($p < 0.0001$). On physical examination, the deep ring was identified in 6 patients, intracanalicular location in 21 patients, non-palpable cases showed deep ring in 21 patients, intracanalicular in 39 patients, intra-abdominal in 16 patients, not found in 5 patients, and superficial ring in 6 patients, while 36 patients had superficial ring findings.Onultrasound examination, the deep ring was identified in 18 patients, intracanalicular location in 60 patients, intra-abdominal location in 12 patients, and superficial ring in 42 patients. Among ultrasound findings, deep ring cases corresponded to 18 patients, intracanalicular cases to 60 patients, intra-abdominal cases to 10 patients,

while 2 patients were not found.OnMRI evaluation, deep ring location was detected in 24 patients, and intra-abdominal location in 16 patients. Among these, 13 patients showed intra-abdominal findings, while 3 patients were not found. MRI was not performed in 110 patients, among whom the final findings included 3 deep ring, 60 intracanalicular, 3 intra-abdominal, 2 not found, and 42 superficial ring cases.

Among the 150 patients, comparison of MRI findings with palpable/non-palpable physical examination findings showed a statistically significant association ($p < 0.0001$). On physical examination, deep ring was identified in 6 patients, and all 6 patients (100%) were confirmed as deep ring cases on MRI. Among 21 intracanalicular cases, MRI was not done in all 21 patients. In the non-palpable group (87 patients), MRI identified deep ring in 18 patients, intra-abdominal location in 16 patients, while MRI was not done in 53 patients. Among 36 superficial ring cases, MRI was not performed.Comparison of MRI findings with ultrasound findings also showed a statistically significant association ($p < 0.0001$). Ultrasound detected deep ring findings in 18 patients, among which MRI confirmed 15 patients as deep ring, while MRI was not done in 3 patients. Ultrasound identified intracanalicular location in 60 patients, and MRI was not done in all 60 patients. Among 12 patients with intra-abdominal findings on ultrasound, MRI confirmed 10 patients as intra-abdominal, while MRI was not done in 2 patients. Of the 18 patients with ultrasound findings as not found, MRI showed 9 patients with deep ring, 6 patients with intra-abdominal location, and MRI was not done in 3 patients.

According to, Ultrasound findings vs Intraoperative findings Sensitivity: 89.7, Specificity: 60.0, Positive Predictive Value: 98.5, Negative Predictive Value: 16.7 and Accuracy: 88.7.

DISCUSSION

Similar findings were reported by **Elder JS et al. [12]** who evaluated the role of ultrasonography in detecting non-palpable undescended testes and found that ultrasound was useful in identifying the location of testes, particularly intracanalicular and inguinal positions, with good correlation with operative findings. In the present study, ultrasound demonstrated a high diagnostic performance with sensitivity of 89.7%, positive predictive value of 98.5%, and accuracy of 88.7%, supporting the usefulness of ultrasound as an initial imaging modality. **Al Darrab R t al. [13].** studied the accuracy of ultrasonography in localization of undescended testes and reported that ultrasound had high sensitivity for inguinal and superficial locations but limited ability in intra-abdominal cases Similar to their findings, the current study showed that ultrasound accurately detected superficial ring and intracanalicular locations, whereas some intra-abdominal cases required MRI confirmation.The present study showed MRI confirmation in selected cases, with deep ring and intra-abdominal locations being better demonstrated. This is comparable with the findings of **Parenti GC et al., [14]** who reported that MRI can provide additional anatomical information in non-palpable testes and may help in surgical planning when ultrasound findings are inconclusive. **Fusco R et al. [15]** reported that physical examination remains an important initial assessment tool but has limitations in non-palpable cases. They observed that imaging modalities improve preoperative localization and reduce unnecessary exploration. In the current study, non-palpable cases constituted the majority (58.0%), and imaging modalities were particularly helpful in identifying deep ring and intra-abdominal locations.The significant association between ultrasound and MRI findings in the present study ($p<0.0001$) is supported by Papparella et al., who found that combined clinical and radiological evaluation improved localization accuracy in cryptorchidism and assisted in selecting appropriate surgical approaches .The intraoperative findings in our study showed maximum cases at intracanalicular location (40.0%), which is consistent with the observations of **Alnoaiji MS et al. [16]** who reported that inguinal/intracanalicular testes represent the most frequent location among undescended testes .The ultrasound diagnostic accuracy of 88.7% in the present study was comparable with the results reported by **Shreyas K et al., [17]**who described ultrasonography as a valuable tool for detecting palpable and inguinal undescended testes, although its reliability decreases in deep intra-abdominal positions].**Cisek LJ et al. [18]** emphasized that laparoscopic evaluation remains the gold standard for non-palpable testes because it allows direct visualization of intra-abdominal structures [8]. In our study, intraoperative assessment confirmed the final anatomical location and demonstrated good agreement with preoperative ultrasound and MRI findings.

CONCLUSION

The present study demonstrates that clinical examination, ultrasonography, and MRI play an important role in the preoperative localization of undescended testes and show significant correlation with intraoperative findings. Intracanalicular location was the most commonly identified anatomical position on ultrasound and operative assessment, followed by superficial ring and deep ring locations.Ultrasonography was found to be a reliable and useful initial imaging modality for localization of undescended testes, providing good diagnostic accuracy and assisting in preoperative decision-making. MRI provided additional anatomical information in selected non-palpable

cases, especially for identifying deep ring and intra-abdominal locations.The significant association between physical examination, ultrasound, MRI, and intraoperative findings indicates good agreement between preoperative assessment and surgical findings. A combined approach using physical examination with ultrasonography, with MRI reserved for uncertain cases, can improve diagnostic evaluation, guide surgical planning, and minimize unnecessary exploration in patients with undescended testes.

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