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Original Research Article

Diagnostic Accuracy of Magnetic Resonance Imaging in Cases of Cryptorchidism Keeping Surgical Findings as Gold Standard

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Abstract: *Cryptorchidism is a common congenital urogenital anomaly, and accurate localization of undescended testes is essential for appropriate surgical planning. Magnetic resonance imaging may help identify non-palpable or ectopic testes before surgery.* ***Objective:*** *To determine the diagnostic accuracy of magnetic resonance imaging in cases of cryptorchidism, keeping surgical findings as the gold standard.* ***Methods:*** *This study was carried out on 69 male patients aged 1 to 25 years with suspected cryptorchidism, using non-probability sampling, in the Department of Radiology, Lady Reading Hospital, Peshawar, from 5 July 2024 to 5 January 2025. Patients with ambiguous genitalia or scrotal erythema and swelling were excluded. All patients underwent MRI on a 1.5 Tesla Toshiba Vantage scanner. MRI findings were compared with surgical findings for assessing diagnostic accuracy. Data were analyzed with SPSS 26. Diagnostic accuracy was calculated from a 2×2 contingency table.* ***Results:*** *The mean age of the patients in the present study was 11.55 ± 6.30 years. Surgical findings confirmed cryptorchidism in 29 patients (42.0%), while MRI was positive in 32 patients (46.4%). The sensitivity was 79.31%, the specificity was 77.50%, the positive predictive value was 71.88%, the negative predictive value was 83.78%, and the diagnostic accuracy was 78.26%.* ***Conclusion:*** *The diagnostic accuracy of magnetic resonance imaging in diagnosing cryptorchidism in the present study was 78.26%, with a sensitivity 79.31% and a specificity 77.50%, taking surgical findings as the gold standard.*

Keywords: Cryptorchidism; Magnetic resonance imaging; Diagnostic accuracy; Sensitivity and specificity; Undescended testis; Paediatric radiology

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Introduction

Cryptorchidism is a common condition that affects male infants and adult males rarely. This condition is characterized by the failure of one or both testicles to descend into the scrotum, the external pouch of skin that contains the testes (1). The testes develop within the abdomen during the development of the fetus and slowly descend into the scrotum before birth. In cases of cryptorchidism, such descent does not happen as expected, leaving one or both testicles positioned higher up in the abdomen or within the inguinal canal area (2).

Imaging techniques, including ultrasound and MRI, have become critical tools for the assessment of cryptorchidism. While ultrasound is easily available and cost-effective, it may be less accurate for diagnosing intra-abdominal testes in older children and adults. MRI offers superior soft-tissue contrast and multiplanar imaging capabilities, making it an attractive option for the localization of undescended testes (3). MRI does not expose the patient to ionizing radiation, unlike other imaging options, including computed tomography (4).

MRI provides detailed anatomical information that can aid in the localization and characterization of cryptorchid testes by visualizing the testicles within the abdominal cavity or along the inguinal canal, enabling accurate preoperative planning (4, 5). MRI can also differentiate true undescended testes and retractile testes. The gold standard for diagnosing cryptorchidism is surgical exploration of the inguinal canal and the abdomen to confirm the testicular location (6). Surgical intervention is classically recommended for patients with persistent cryptorchidism beyond the first year of life to alleviate the potential long-term consequences (7). According to a study, the frequency of cryptorchidism was found to be 45.3% (8); however, the sensitivity and specificity of MRI in detecting cryptorchidism were reported as 82.4% and 81.2%, respectively (9).

The goal of this study is to determine the diagnostic accuracy of magnetic resonance imaging in cases of cryptorchidism, using surgical findings as the gold standard. MRI has emerged as a valuable imaging modality for this purpose, thus offering superior soft-tissue visualization without the risks associated with ionizing radiation. This study will critically evaluate MRI's diagnostic accuracy in cases of cryptorchidism and provide insights into its potential benefits and limitations in the management of this condition.

Methodology

The present study was conducted from 05 July 2024 to 05 January 2025 in the department of Radiology, Lady Reading Hospital, Peshawar, as a cross-sectional validation study. The study commenced after taking ethical approval (Ref# 194/LRH/MTI) from the hospital. Sixty-nine patients were selected for this study. The sample size was calculated using the anticipated frequency of cryptorchidism (45.3%; 8), MRI Sensitivity for Cryptorchidism (82.4%; 9), MRI Specificity for Cryptorchidism (81.2%; 9), absolute precision (14%), and a confidence interval of 95%.

All suspected male patients of cryptorchidism (i.e., one or both of the testicles either appear to be missing or cannot be felt in the scrotum) aged 1 to 25 years were enrolled in this study. Patients with ambiguous genitalia and patients with erythema and swelling were excluded.

In this study, cryptorchidism on MRI was labelled as the gubernaculum testes, and the spermatic cord was used to locate the testes, showing an oval mass structure. Cryptorchidism on surgical findings was labelled as by superficial inguinal pouch position, closed or (small) open processus vaginalis, and normal gubernaculum attachment.

An informed written consent form was obtained from each patient or their parents/guardians. Details such as age, gender, and address were noted, medical history was taken, and a physical examination was conducted. MRI was performed on radiologically assessed patients, and the findings were recorded. MRI was performed by using a machine (Toshiba 1.5 Model Vantage), and sequences such as T2 Ax, T2 Cor, Pd Cor, T1 Sag,

T2 Sag, GRE sag, and slice thickness of 4.5 to 5mm were used during the assessment. The patients underwent a surgical procedure, and the surgical findings were recorded. MRI and surgical findings were compared to assess accuracy. This process was supervised by a consultant with 5 years of post-fellowship experience.

For data analysis, SPSS v.26 was used. Frequencies and percentages were presented for categorical data, including MRI findings, surgical findings, Location of undescended testis (Inguinal canal/Pelvis/Pre-scrotal area/Abdomen), residence area, Sensitivity, Specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV). Mean ± SD was calculated for quantitative variables such as age and disease duration. Diagnostic accuracy of MRI, including sensitivity, specificity, positive and negative predictive values, was calculated from a 2x2 table using surgical findings as the gold standard. Diagnostic accuracy was stratified by age, disease duration, and location of undescended testes to observe effect modifiers. Post-stratification Chi-square/Fisher's exact test was conducted at 5% level of significance.

Results

This study included 69 patients. The mean age of the patients was 11.55±6.30 years. The mean duration of disease was 3.71±1.69 months. Regarding residence, 32 (46.4%) patients were from urban areas, while 37 (53.6%) were from rural areas. The suspected location of an undescended testis was most commonly the inguinal canal (34, 49.3%). This was followed by the pre-scrotal area in 15 (21.7%) cases, the pelvis in 12 (17.4%) cases, and the abdomen in 8 (11.6%) cases (Table 1).

On MRI findings, cryptorchidism was positive in 32 (46.4%) cases and negative in 37 (53.6%). At surgery, cryptorchidism was confirmed in 29 (42.0%) cases, while 40 (58.0%) had negative surgical findings (Table 2). Regarding the diagnostic accuracy of MRI, the sensitivity for detecting cryptorchidism was 79.31%, and the specificity was 77.50%. The positive predictive value was 71.88%, and the negative predictive value was 83.78%. The MRI diagnostic accuracy was 78.26% (Table 3). Table 4 presents the stratification of MRI diagnostic accuracy by various parameters.

Table 1: Basic demographic profile

		n	%
Residence	Urban	32	46.4%
	Rural	37	53.6%
Location of suspected undescended testis	Inguinal canal	34	49.3%
	Pelvis	12	17.4%
	Pre-scrotal area	15	21.7%
	Abdomen	8	11.6%

Table 2: Cryptorchidism on MRI and surgical findings

Cryptorchidism on MRI and Surgical Findings		n	%
MRI Findings of Cryptorchidism	Positive	32	46.4%
	Negative	37	53.6%
Surgical Findings of Cryptorchidism	Positive	29	42.0%
	Negative	40	58.0%

Table 3: Diagnostic accuracy of MRI

		Surgical Findings of Cryptorchidism		Total
		Positive	Negative	
MRI Findings of Cryptorchidism	Positive	23	9	32
		79.3%	22.5%	46.4%
	Negative	6	31	37
		20.7%	77.5%	53.6%
Total		29	40	69
		100.0%	100.0%	100.0%
Sensitivity = 79.31%; Specificity = 77.50%; Positive predictive value = 71.88%; Negative predictive value = 83.78%; Diagnostic accuracy = 78.26%				

Table 4: Stratification of diagnostic accuracy of MRI with various parameters

Parameters	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy	P value
Age (Years)						
1 to 7	90.00%	75.00%	75.00%	90.00%	81.82%	0.002
8 to 15	76.92%	73.33%	71.43%	78.57%	75.00%	0.008
> 15	66.67%	84.62%	66.67%	84.62%	78.95%	0.025
Disease duration (Months)						
1 to 3	84.62%	70.00%	64.71%	87.50%	75.76%	0.002
> 3	75.00%	85.00%	80.00%	80.95%	80.56%	< 0.001
Residence						
Urban	78.57%	72.22%	68.75%	81.25%	75.00%	0.004
Rural	80.00%	81.82%	75.00%	85.71%	81.08%	< 0.001
Location of suspected undescended testis						
Inguinal canal	80.00%	68.42%	66.67%	81.25%	73.53%	0.005

Pelvis	85.71%	60.00%	75.00%	75.00%	75.00%	0.098
Pre-scrotal area	80.00%	100.00%	100.00%	90.91%	93.33%	0.004
Abdomen	50.00%	83.33%	50.00%	83.33%	75.00%	0.346

Discussion

The diagnostic performance of magnetic resonance imaging in detecting an undescended testis has been previously reported in the literature. Yadullah et al.'s study included 170 patients with clinically diagnosed undescended testes and reported MRI sensitivities of 82.4% and specificities of 81.2% when correlated with surgical findings. (10) Their study identified the inguinal canal as the predominant location of undescended testes, accounting for 53.9 percent of cases on MRI and 47.4 percent on surgical exploration, followed by the pre-scrotal area at 28.4 percent and 26.6 percent, respectively. (10) The authors highlighted that MRI offers multiplanar capacity and superior resolution without ionizing radiation exposure. (10)

Fazal et al. examined 416 patients with non-palpable undescended testes using DW-MRI with b-values of 50, 400, and 800 sec/mm2 and reported a sensitivity of 65.1%, specificity of 98.0%, and diagnostic accuracy of 81.3% using laparoscopy as the reference. (11) The significantly higher specificity in their study compared to conventional MRI alone suggests that DWI provides superior tissue characterization, enabling radiologists to distinguish testicular tissue from adjacent structures such as inguinal lymph nodes and bowel loops. The authors further observed that combining DWI with conventional sequences improved preoperative diagnostic accuracy for detecting non-palpable testes, especially in cases where ultrasound had failed to identify the gonad. (11) Naz et al. in their study on 175 boys under 16 years of age with DW-MRI achieved a sensitivity of 94.8% specificity of 92.5%, and a diagnostic accuracy of 94.29% when compared with laparoscopic findings. (12) Their work demonstrated that at a b-value of 800 seconds/mm2, testicular tissue exhibited high signal intensity due to its high cellular density, facilitating reliable detection even in high intra-abdominal positions. (12)

Pashoska et al. compared ultrasound and MRI in 41 pediatric patients aged up to 14 years, concluding that MRI significantly improved preoperative diagnostic accuracy, especially for non-palpable undescended testes. (13) Their protocol incorporated T2-weighted fat suppression and DWI sequences, which proved valuable for differentiating testicular tissue from surrounding inflammation or water-containing structures. (13)

The sensitivity of MRI in the present study was 79.31%, with a specificity of 77.50%. These values are comparable to those reported by Yadullah et al., who reported 82.4% sensitivity and 81.2% specificity using MRI. (10) However, the present findings differ from the higher sensitivity of 94.8 % reported by Naz et al., who used dedicated DW-MRI protocols with fat-suppressed T2-weighted sequences. (12) This discrepancy can be attributed to differences in imaging protocols. The specificity of 77.50 % in this study is lower than the 92.5 % reported by Naz et al. (12)

The present study found superior diagnostic value for patients from rural areas; this finding has been reported by Shamim et al. Shamim et al. conducted a study assessing ultrasonography against MRI as the gold standard, while stratifying outcomes by rural-urban residence and income level, showing that rural residents demonstrated 100 % specificity compared to 66.7 % among urban residents. (14)

Conclusion

From the present study, it is concluded that the diagnostic accuracy of magnetic resonance imaging for cryptorchidism was 78.26%, with a sensitivity of 79.31% and a specificity of 77.50% when surgical findings served as the gold standard. Magnetic resonance imaging is recommended as a complementary diagnostic tool rather than a replacement for surgical exploration, especially given its moderate sensitivity and specificity. Preoperative MRI may be most beneficial for ruling out cryptorchidism when clinical suspicion is low, but positive findings should always be confirmed surgically before intervention.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (Ref# 194/LRH/MTI)
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The authors declared the absence of a conflict of interest.

Author Contribution

TF (Postgraduate Resident)
Data collection, analysis, and drafting article
NA (Professor)
Critical input and Conception of Study
AI (Postgraduate Resident)
Assists in methodology designing
SA (Postgraduate Resident)
Literature Review
MN (Postgraduate Resident)
Assists in interpretation of data

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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