

# Diagnostic Accuracy of Conventional MRI with Diffusion Weighted Imaging (DWI) in Detection of Cryptorchidism Taking Diagnostic Laparoscopy as Gold Standard

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## ABSTRACT

**Background:** Use of imaging studies for accurate preoperative localization of the non-palpable testis is a widely prevalent practice. MRI is noninvasive, does not involve ionizing radiation, and yields multiplanar images. The combination of DWI and conventional MRI was the most sensitive and most accurate technique.

**Aim:** To determine diagnostic accuracy of DW-MRI for accurate preoperative localization and planning of the non-palpable testis.

**Methods:** A total of 500 patients of empty scrotum with testis not palpable on physical examination and age  $\leq 10$  years were included in the study. Patients with h/o previous scrotal surgery, anorectal or renal malformation were excluded. All the patients were then underwent DW-MRI. The DW-MRI findings were recorded as presence or absence of the undescended testis. Diffusion weighted magnetic resonance imaging findings were correlated with laparoscopic findings.

**Results:** Mean age was  $7.21 \pm 1.43$  years. DW-MRI detected the cryptorchidism in 378(80.82%) patients, out of which, 360 (True Positive) had cryptorchidism and 18(False Positive) had no cryptorchidism on laparoscopy. Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of DW-MRI in detecting cryptorchidism was 93.51%, 84.35%, 95.24%, 79.51% and 91.40% respectively.

**Conclusion:** This study concluded that diffusion weighted magnetic resonance imaging is a highly sensitive and accurate non-invasive modality for detecting cryptorchidism.

**Keywords:** Undescended testis, non-invasive, imaging modality, sensitivity.

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## INTRODUCTION

Cryptorchidism is a pathological condition which is due to failure of the descent of the testis in the scrotum<sup>1</sup>. The most frequent defect of the male urogenital tract at birth is cryptorchidism. Cryptorchidism causes primitive testicular pathology responsible for infertility<sup>2</sup>. Cryptorchidism is found to be one of the major reasons for infertility and also shows a positive relation with germ cell tumours. The frequency of the problem makes cryptorchidism an area where diagnostic knowledge is particularly important for healthcare professionals. It's ideal management is surgery and the best age for this surgery is  $< 1$  year of age which will reduce its negative impact<sup>3</sup>. There is prevalence of 96.7% of cryptorchidism in boys with empty scrotum<sup>4</sup>.

Ultrasound remains the most widely used imaging modality for detecting cryptorchidism. This imaging modality has shown variable diagnostic accuracy in detecting non-palpable testis i.e.,

sensitivity and specificity of 45% and 78%, respectively. Due to its poor diagnostic accuracy, its use is not common in our routine practice for evaluating cryptorchidism. Diagnostic laparoscopy was found to be a gold standard with 100% sensitivity and specificity for localizing nonpalpable testes and allows for concurrent surgical correction<sup>5,6</sup>.

Currently USG is most used modality, however, its sensitivity and specificity is very limited. The combination of diffusion weighted imaging and conventional magnetic resonance imaging was the most sensitive and most accurate technique. Use of diffusion weighted imaging with a high b value yields information that complements conventional magnetic resonance imaging findings, improving identification and location of cryptorchidism. It is recommended to use conventional MRI in addition to DWI to increase the preoperative sensitivity and accuracy of identifying and locating nonpalpable testes<sup>7</sup>.

The objective of our study is to determine the diagnostic accuracy of conventional MRI with diffusion weighted imaging in detection of cryptorchidism taking laparoscopic findings as gold standard.

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**METHODOLOGY**

This descriptive, cross sectional study was done from January 2015 to December 2015, on 500 patients with empty scrotum with testis not palpable on physical examination and age between ≤10 years, who were referred by clinician to the radiology department of Nishtar Hospital, Multan were selected for the study. Patients with previous scrotal surgery, anorectal malformation and any renal malformation were excluded from the study. After taking informed consent and relevant history from patients' parents/guardians, all the subjects were underwent diffusion-weighted MRI by using 1.5 Tesla MR system. DW-MR images were obtained in all patients using 2D breath-hold T2-weighted half-Fourier acquisition single shot turbo spin-echo (HASTE), breath-hold T2-weighted turbo spin-echo (TSE) and dynamic contrast-enhanced 3D gradient-echo (volumetric interpolated breath-hold examination, VIBE) sequences. All the sequences were done during a single breath-hold, at b value of 800mm<sup>2</sup>/s and scan time of 3-4 minutes. Each DW-MRI report was reviewed by a consultant radiologist (with at least 5 years of experience in abdominal MRI). The reviewer recorded the presence or absence of the undescended testes. DW-MRI findings were correlated with laparoscopic findings (taking as gold standard).

SPSS version 20.0 was used to analyze the data. Quantitative variables were presented as mean and standard deviation. Qualitative variables were presented as frequency and percentage. 2x2 contingency table was used to calculate sensitivity, specificity, PPV, NPV and diagnostic accuracy of conventional magnetic resonance imaging with diffusion weighted imaging in detection of cryptorchidism.

**RESULTS**

Age range in my study was from birth to 10 years with mean age of 7.21±1.43 years. Majority of the patients 37.20% were between 7 to 10 years of age. All the patients were subjected to DW-MRI. DW-MRI detected the cryptorchidism in 378(75.60%) patients. Laparoscopy findings confirmed cryptorchidism in 385(77%) cases where as 115(23%) patients revealed no cryptorchidism. In DW-MRI positive patients, 360 (TP) had cryptorchidism and 18 (FP) had no cryptorchidism on laparoscopy. Among 122, DW-MRI negative patients, 25 (FN) had cryptorchidism on laparoscopy where as 97 (TN) had no cryptorchidism on laparoscopy (p=0.620) as shown in Table I. Overall sensitivity, specificity, PPV, NPV and diagnostic accuracy of DW-MRI in detecting

cryptorchidism was 93.51%, 84.35%, 95.24%, 79.51% and 91.40% respectively (Fig. 1).

Table I: Summary of Results

	Positive result on DW-MRI	Negative result on DW-MRI
Positive on laparoscopic findings	360 (TP)*	25 (FN)**
Negative on laparoscopic findings	18 (FP)**	97 (TN)****

\*-TP=True positive

\*\*-FP=False positive

\*\*\*-FN=False negative \*\*\*\*-TN=True negative

Fig.1: Ultrasound image showing left sided testes in inguinal canal and is associated with mild hydrocele

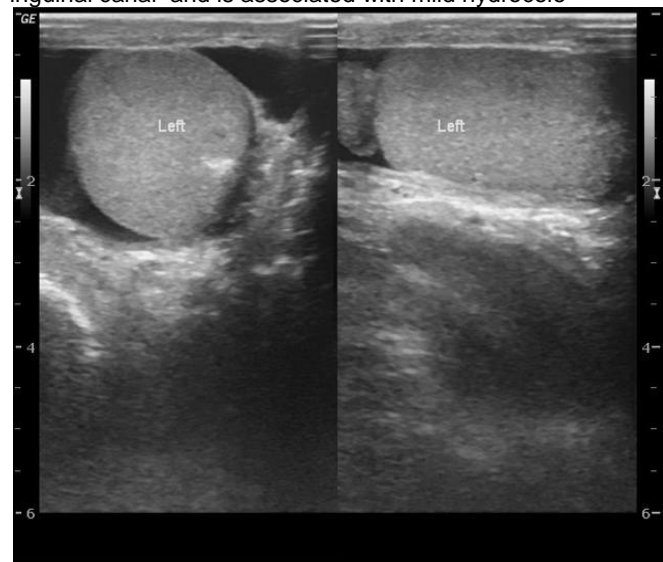


Fig. 2: Diffusion weighted MRI showing right sided testes in inguinal canal giving high intensity signal

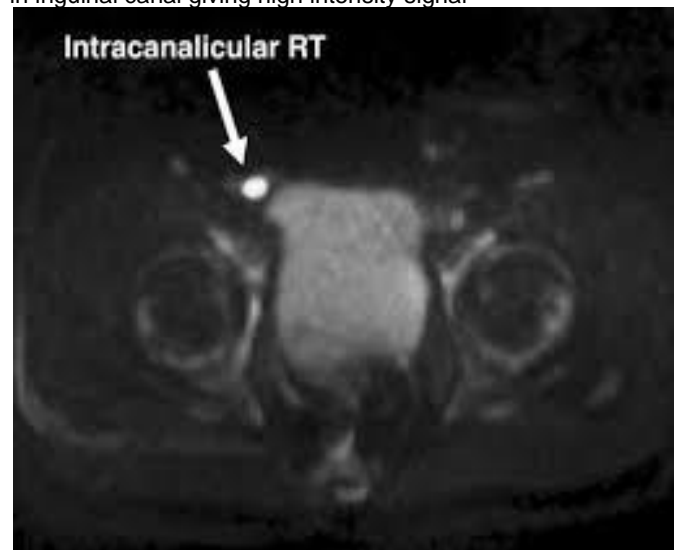
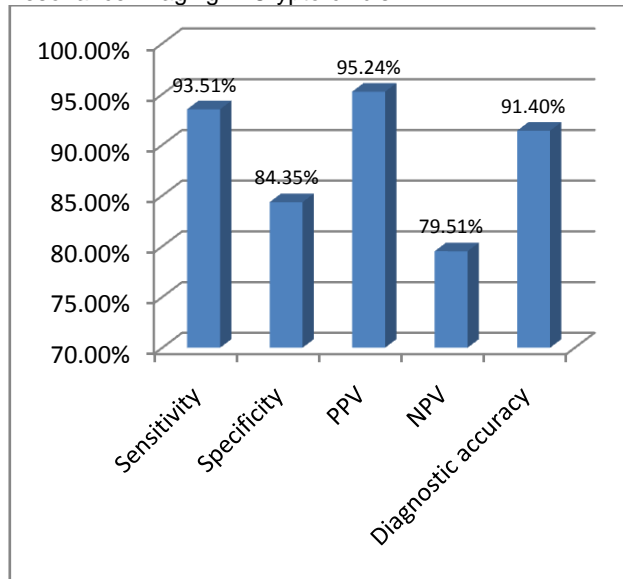


Fig. 3: Diagnostic accuracy of Diffusion Weighted Magnetic Resonance Imaging in Cryptorchidism.



## DISCUSSION

Magnetic resonance imaging is noninvasive, does not involve ionizing radiation, and yields multiplanar images.<sup>8</sup> Studies have shown that adding diffusion weighted imaging to a routine magnetic resonance imaging examination increases diagnostic accuracy.<sup>9,10</sup> On diffusion weighted imaging of the abdomen and pelvis, testes have shown high signal intensity which is due to their high cell density. Thus adding diffusion weighted imaging to routine conventional magnetic resonance imaging would improve the sensitivity and specificity of imaging of non-palpable undescended testes in the abdomen.<sup>7</sup>

In this study, mean age was  $7.21 \pm 1.43$  years which is very much comparable to studies of Kantarci M et al<sup>7</sup> and Pettersson A et al<sup>11</sup> i.e., 7 and 8 years respectively. On the other hand, Musa MT et al<sup>12</sup> in his study has shown a much larger mean age i.e. 26 years, because he included patients with much larger age range in his study as compared to this study. The age at diagnosis is very important for outcome in these particular patients as risk of infertility and testicular carcinoma increases with age. In a study, it was found that age at orchiopexy has an effect on the risk of testicular cancer in patients with an undescended testicle. It was also shown in the same study that the risk of testicular cancer was twice in patients treated at 13 years of age or older compared to those who were treated at younger age.<sup>11</sup> The recommended age for orchiopexy has therefore been successively lowered, and the procedure is now recommended for patients younger than 2 years old and even as young as 6 months old<sup>13</sup>.

In our study, sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of DW-MRI in detecting cryptorchidism was 93.51%, 84.35%, 95.24%, 79.51% and 91.40% respectively. Many previous studies have shown the variable sensitivity and specificity of conventional MRI for detecting cryptorchidism. Kanemoto K et al<sup>14</sup> has found the sensitivity, specificity and accuracy of conventional MRI as 86%, 79% and 85% for the diagnosis of non-palpable testis while Sarihan H et al<sup>15</sup> had found this as 78.6%, 100% and 87% respectively. Shah A et al<sup>16</sup> showed the overall diagnostic agreement of MRI with laparoscopy in 52% of cases. In a meta-analysis done by Krishnaswami S et al<sup>17</sup>, sensitivity of magnetic resonance imaging for identifying the non-palpable cryptorchid intra-abdominal testicles was found to be 62%. However, this sensitivity was found to be high (86%) for inguino-scrotal testis.

However, accuracy of conventional magnetic resonance imaging has been increased if diffusion weighted imaging (DWI) is added to the conventional MRI. Kanemoto K et al<sup>14</sup> had also found that the combination of DWI and conventional MRI was the most sensitive and most accurate technique in the depiction and localization of the nonpalpable undescended testes as compared to DWI or conventional MRI alone. He has found the increase in sensitivity from 86% to 91%, specificity from 79% to 100% and diagnostic accuracy 85% to 92% if diffusion weighted imaging added with conventional MRI for the diagnosis of non-palpable testis. Kato T et al<sup>18</sup> in his study has also concluded that MRI in combination with diffusion-weighted imaging has been shown to improve not only the overall accuracy rate of prediction up to 98.4% but also perform effectively with a high sensitivity rate of 100% for locating intraabdominal testicles. Al-Kayat RHA et al<sup>19</sup> in his study has also shown that the sensitivity of detection of non-palpable testes increase with the use of combined DWI and MRI compared to MRI or DWI alone.

## CONCLUSION

This study concluded that diffusion weighted magnetic resonance imaging is a highly sensitive and accurate non-invasive modality for detecting non-palpable undescended testis and has not only dramatically improved our ability of detecting undescended testis but also improved patient care by timely and proper medical or surgical treatment, which consequently reduces complications. So, we recommend that preop DW-MRI should be done in every patient with non-palpable undescended testis for correct preoperative detection of testis.

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