

RADIOLOGICAL DIAGNOSTIC APPROACHES IN CRYPTORCHIDISM – UTILITY, SENSITIVITY AND EFFECTIVENESS

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Abstract

Objective: This study aims to evaluate the diagnostic accuracy of Diffusion-Weighted Imaging (DWI) in localizing undescended testicles [cryptorchidism] using classic orchidopexy findings as the gold standard in our local population.

Material and Method: Within this study, DW-MRI is employed for localizing undescended testicles, with classic orchidopexy findings serving as the gold standard. Ten patients, six with unilateral undescended testicles and four with bilateral undescended testicles, were included. All patients underwent ultrasound examination, and five were subsequently evaluated with MRI incorporating a diffusion sequence.

Results: DWI using magnetic resonance imaging, particularly when performed with a high b value [≥ 3000 s mm⁻²], enhances the detection of undescended testicles. Diagnostic accuracy consistent with classic orchidopexy findings was achieved in five patients.

Conclusion: DW-MRI improves the detection of undescended testes and may serve as the preferred imaging modality to enhance preoperative diagnostic accuracy in localizing non-palpable undescended testicles.

Keywords: cryptorchidism, diagnostics, accuracy, MRI-DWI, classical orchidopexy, radiology

Introduction

Cryptorchidism, within a medical context, denotes undescended testicles, specifically a pathological condition wherein the testicle fails to descend into the scrotum. It stands as the most prevalent birth defect of the male urogenital tract, contributing to primitive testicular pathology associated with infertility and exhibiting an increased propensity for Germ cell tumors.

Surgery represents the ideal treatment, with recommended intervention typically occurring before the age of 2 [two] [1].

Undescended testicles or cryptorchidism rank as the most common congenital genitourinary anomaly among male newborns, boasting an incidence of 1-3% in term infants and 15-30% in premature male infants. The etiology remains largely unknown, although it's hypothesized to stem from a defect in testicular embryological development.

Notably, undescended testicles may be palpable or non-palpable; approximately 20% of cases are non-palpable and may be located in the abdomen, inguinal canals, or may even be atrophic or entirely absent [2].

Cryptorchidism is linked to impaired fertility, inguinal hernia, and an elevated risk of testicular cancer. The primary motives for treating cryptorchidism encompass the heightened risk of infertility, testicular malignancy, torsion, and/or inguinal hernia. Early detection and localization of the testicles preoperatively can inform the optimal type of procedure and facilitate effective future planning.

Radiological imaging methods, particularly in cases of missing or absent testicles, hold potential to obviate the need for surgical exploration [3].

Ultrasound stands as the predominant imaging modality for cryptorchidism, although its diagnostic accuracy varies in detecting non-palpable testicles. Further evaluation with MRI, particularly employing the DW sequence, is often warranted due to ultrasound's limited accuracy. Classical

orchidopexy emerges as the gold standard, exhibiting 100% sensitivity and specificity for localizing non-palpable testicles, thereby enabling simultaneous surgical correction [4].

High-b diffusion-weighted imaging [DWI] augments conventional MRI findings, enhancing the identification and localization of undescended testicles. Its incorporation into MRI protocols improves preoperative sensitivity and accuracy in localizing non-palpable testicles. DW-MRI proves invaluable in urogenital imaging, facilitating tissue characterization at the microscopic level [5].

The signal intensity of testicles on DWI reflects their high cell density, elucidating tissue characteristics.

Moreover, published reports underscore DWI's diagnostic efficacy in evaluating various scrotal pathologies, including the detection and localization of non-palpable testicles, diagnosis of testicular torsion, and differentiation between benign and malignant conditions [6].

Accurate diagnosis and localization of undescended testicles are imperative for tailored management strategies, which may encompass watchful waiting, hormonal treatment, or surgery.

Precise preoperative diagnosis can avert unnecessary surgery for absent testicles, while accurate localization can streamline surgical procedures, minimizing anesthesia duration [7].

This study aims to ascertain the diagnostic accuracy of radiological imaging methods, including the DWI sequence of magnetic resonance imaging, in localizing undescended testicles [cryptorchidism], employing surgical findings as the gold standard in our local population.

Material and method

In the scope of the empirical research conducted and analyzed in this study, a cohort of five patients with undescended testicles, ranging in age from 0 to 14 years with an average age of 6 years, was enrolled.

The research was conducted over a two-month period [January and February]. Methodologically, the diagnostic procedure employed magnetic resonance imaging [MRI] of the small pelvis with standard pulse sequences and diffusion-weighted imaging [DWI] to evaluate the testicles for localization, size, and signal specificity.

Furthermore, regarding the implemented procedure, MRI imaging was carried out utilizing a 1.5 T unit from Siemens Avanto MAGNETOM, equipped with high-gradient performance and a six-element phased body coil.

Prior to the DWI sequence, the following sequences were executed: a coronary T2 spin-echo sequence [HASTE] with repetition time [TR] = 1200ms, echo time [TE] = 95 ms, flip angle [FA] = 150, matrix 256 X 154, section thickness of 5 mm, with a gap between sections of 30%, field of view [FOW] = 40 cm, and averages = 1. Additionally, an axial 3-D gradient echo T1 sequence [VIBE] with TR = 4.96 ms, TE = 2.38 ms, FA = 10, matrix 256 X 166, section thickness of 3 mm, with a gap between sections of 20%, FOW = 40 cm, and averages = 1 was performed.

Moreover, a 2-D gradient echo T1 in-phase and out-of-phase sequence with TR = 124ms, in-phase TE = 4.77 ms, out-of-phase TE = 2.38 ms, FA = 70, matrix 256 X 168, section thickness of 5 mm, with a gap between sections of 20%, FOW = 40 cm, and averages = 1 was conducted. Finally, axial and coronary respiratory-activated, turbo spin-echo T2 sequences with fat saturation, TR = 3800 ms, TE = 85 ms, FA = 150, matrix 320 X 320, section thickness of 5 mm, with a gap between sections of 30%, FOW = 40 cm, and averages = 1 were executed.

The DWI procedure employed a single-shot spin-echo echo planar imaging [EPI] sequence with a b value of 50, 400, 800 s/mm². To enhance signal-to-noise ratio and facilitate patient cooperation, DWI during free breathing was conducted with the following technical parameters: TR = 6200ms, matrix 125 X 192, section thickness of 5 mm, with a gap between sections of 20%, FOW = 40 cm, and averages = 4.

The acquisition time for the three different b-values was approximately 3 minutes. Parallel imaging algorithms [GRAPPA] with a factor of acceleration of 2 were employed to reduce acquisition time. Additionally, spectral fat saturation was utilized to suppress chemical shift artifacts, **Table 1**.

Table 1. Protocol for MR cryptorchidism evaluation – examinations performed on the Siemens Avanto MAGNETOM 1.5T machine.

MR protocols in the evaluation of testicles	Duration of exam: 15 mins
T1 tse cor	T1 coronal
T2 tse cor	T2 coronal
T1 tse tra	T1 transverse
T2 tse tra	T2 transverse
T2 fat sat	T2 fat suppression
DWI	Diffusion values: 50, 800, 1500

Results

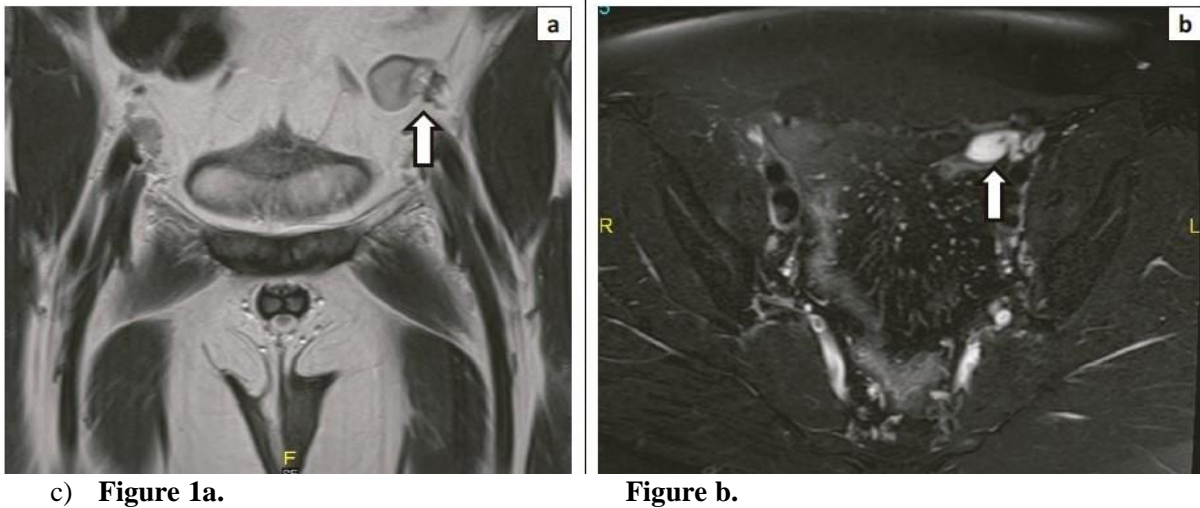
Cryptorchidism, also known as undescended testicles, is a pathological condition characterized by the failure of the testicles to descend into the scrotum. The aim of this study is to assess the diagnostic accuracy of diffusion-weighted magnetic resonance imaging [DW-MRI] in localizing undescended testicles, using surgical findings as the gold standard [8], **Figure 1**.

Regarding the findings of the conducted empirical research, the following key points have been underscored:

- A total of 10 patients, all aged up to 14 years and presenting with cryptorchidism, underwent ultrasound examination. Among them, 5 patients underwent MR examination of the small pelvis with pulse sequences aimed at evaluating the testicles to determine their localization, size, and signal.
- The data obtained from these examinations were analyzed and compared with the findings from surgical exploration, specifically orchidopexy.

Figure 1a and b.

- a) T2 coronal section depicting a case of left-sided cryptorchidism with a high position, revealing the presence of testicular tissue within the abdominal cavity.
- b) T1 FatSat [fat suppression] axial section illustrating an intra-abdominally positioned left testicle, observed in the same patient.



Discussion

Preoperative awareness of testicle position in cases of non-palpable undescended testicles is crucial for surgical planning, facilitating surgical incision placement, and choosing operative techniques, particularly during classic orchidopexy [9].

A hypertrophic contralateral testicle may correlate with an absent or atrophic testicle. However, this does not exclude surgical exploration of the abdomen and/or inguinal canal, as compensatory hypertrophy is not specific enough. When the testicle is non-palpable, ultrasound examination is always warranted. Expertly conducted ultrasound exhibits a high positive predictive value for inguinal area located testicles, approximately 91%, with a sensitivity of 78% [9].

When performed by a pediatric radiologist, ultrasound examination revealing an inguinal testicle may obviate the need for unnecessary diagnostic laparoscopy, with laparoscopy emerging as the new "gold standard" diagnostic method for non-palpable testicles, offering both diagnostic and therapeutic advantages.

Age at diagnosis is a crucial prognostic factor in undescended testicles as the risk of developing testicular cancer and infertility increases with age.

During surgery, thorough clinical examination is vital as it may identify a previously non-palpable testicle, altering the planned laparoscopic surgical approach to a standard inguinal orchidopexy.

However, palpating the testicles in the scrotum, especially in an obese child, can be challenging even under anesthesia. Some studies indicate that despite diagnosis by a pediatric surgeon and urologist, an inguinal testicle has been discovered in 21 - 85% of patients during surgery [10].

Standard management of non-palpable testicles is surgical, which can be challenging and contentious. Orchidopexy is indicated if the testicle remains undescended after 6 months as it improves fertility rates and allows close monitoring for the development of possible testicular masses. Subsequent testicular removal or orchidolysis and orchidopexy can be performed using the same approach to achieve therapeutic goals [11].

Some surgeons may prefer starting with inguinal surgical exploration, with the possibility of laparoscopy during the procedure. After years of practice, an inguinal approach, along with examination under anesthesia, may be advisable as the first line of treatment, thereby potentially rendering laparoscopy unnecessary and reducing procedural time, especially in obese children [12].

During the research, patient registration and information collection, adhered to the Helsinki Declaration. The study included ultrasound examinations of the abdomen-pelvis and scrotum for non-palpable undescended testicles. Preoperative abdominal and pelvic DW-MRI examinations were conducted using a 1.5-T MRI with a body coil.

DW-MRI findings were correlated with orchidopexy findings, considering classic orchidopexy as the gold standard. All data were meticulously recorded by the principal researcher using a pre-designed pro forma. Bias and confounding were minimized by strictly adhering to the inclusion criteria.

Data were analyzed using the Statistical Package for Social Sciences [SPSS] version 20.0. Mean values \pm SD were calculated for quantitative variables, while frequencies and percentages were calculated for qualitative variables. Age and location stratification were employed to control effect modifiers, and post-stratification was utilized to calculate sensitivity, specificity, PPV, NPV, and diagnostic accuracy.

The primary objective of the study was to determine the sensitivity, specificity, and efficiency of radiological methods [ultrasound, MRI] in precisely localizing, sizing, and evaluating the morphological structure of the testicles. It is essential to note that this was a prospective-retrospective study conducted in accordance with ethical rules and codes for empirical research, with all patients [or their parents/legal representatives] providing informed consent.

Final data were obtained through additional processing in the SPSS 20.0 program, entered into the computer database, and further statistically analyzed and interpreted.

DW-MRI findings in this study correlated well with surgical findings, indicating that DW-MRI can enhance the detection of undescended testicles and may be recommended as an imaging tool to improve the preoperative diagnostic accuracy of MRI in localizing non-palpable undescended testicles [9].

Conclusion

The study has computed the sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of DW-MRI for localizing undescended testicles, utilizing orchidopexy as the gold standard.

In summary, DWI-MRI significantly enhances the detection of undescended testicles with a high level of accuracy. The inclusion of diffusion-weighted imaging notably enhances the effectiveness of MRI in pinpointing non-palpable undescended testicles.

Moreover, it is concluded that DWI conducted with a high b value markedly enhances the detection of undescended testicles. Therefore, the combined utilization of conventional MRI and DWI is recommended to enhance the preoperative diagnostic accuracy for identifying and locating non-palpable undescended testicles.

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