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Original Article

Imaging Before Operation for Undescended Testes: Is It Necessary?

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Abstract ***Introduction:*** Cryptorchidism occur in 1% of all males born full term. Existing international guidelines do not recommend routine pre-referral imaging, however, the use of imaging before operative intervention is still prevalent in our locality. ***Aim:*** To assess the use of radiological imaging prior to operative management for children with undescended testis (UDT) and their clinical impact. ***Method:*** Retrospective review of children under 17 years' old who underwent orchidopexy was done from January 2015 to January 2020. Demographics, types of imaging studies, the indications for imaging and its findings were correlated with intra-operative findings. Data analysis were done using Fisher-exact and student t-test. ***Results:*** A total of 286 testes in 254 patients were reviewed. Overall, 36.6% patients (n=93) had imaging before operative intervention. One hundred and four testes had imaging with 89 ultrasound and 4 magnetic resonance imaging before surgery. Imaging was booked by neonatologists (n=55, 52.8%), general paediatricians (n=23, 22.1%), paediatric surgeons (n=19, 18.3%), adult general surgeons (n=5.8%) and endocrinologist (n=1, 1.0%). Indications were to document testicular location (n=88, 84.6%), to detect mullerian structures (n=9, 8.7%), document testicular sizes (n=4, 3.8%) and for other reasons (n=3, 2.9%). Ultrasound only correctly identify testicular position in 26.0% (27/104 studies). Cost impact was HKD$25960 per annum. ***Conclusion:*** Pre-referral imaging is seen in more than one third of all UDT in our locality, of that less than a third correlate with intra-operative position. Therefore, we do not recommend pre-referral imaging for solely to localise the testis, but it might be useful in patient with suspicion of disorder of sexual development to look for Mullerian structures. Timely referral to paediatric surgical centre is crucial for better resource management.

Key words *Magnetic resonance imaging; Orchidopexy; Ultrasound; Undescended testes*

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Introduction

Cryptorchidism (undescended testes, UDT) is one of the most common paediatric urological disorder and occur in 1% of all males born full term and 20-30% of premature infant.[1] Progressive germ and Leydig cell loss is associated with longer length of time a testis remains undescended and cryptorchidism is associated with a 2.7 times increase risk of testicular cancer.[2,3] International guidelines including European Urological Association and American Urological Association recommend operative management for testes that have not descended by 6-12 months of age.[4,5]

The operative approach for cryptorchidism is based upon palpability of the testis at the time of examination under anaesthesia and the above guidelines do not

recommend routine pre-referral imaging as literature has conclusively shown no benefit from radiological investigation and potential delay in management. Our aim is to review the clinical utility of diagnostic imaging in the preoperative evaluation of boys with cryptorchidism, with respect to its benefit, limitations and cost in our locality.

Methods

Medical records of children under 17 years' old who underwent orchidopexies or diagnostic laparoscopy for impalpable testes were retrospectively reviewed from January 2015 to January 2020 in a tertiary paediatric urological referral centre. A comprehensive search on the Clinical Data Analysis and Reporting System using keywords "orchidopexy", "orchidopexies", "undescended testis", "cryptorchidism" and "diagnostic laparoscopy" were carried out.

Demographics such as age and source of referral, age at orchidopexies, laterality (unilateral or bilateral), associated medical conditions were reviewed. Types of imaging studies (ultrasound (USG) or magnetic resonance imaging (MRI)), the indications for imaging and its findings were correlated with intra-operative findings and location of testes on examination under anesthesia or laparoscopy. Records that did not include details of testicular locations were excluded. Data analysis were done using Fisher-exact and student t test.

Results

A total of 286 testes in 254 patients (222 unilateral and 32 bilateral) were reviewed. A total of 104 testes had imaging with 89 ultrasound studies (74 unilateral UDT and 15 bilateral UDT) and 4 MRI studies (3 unilateral, 1 bilateral) were done before operative management.

Source of Referral and Indications for Imaging

Ultrasound scans were booked by neonatologists (n=55, 52.8%), general paediatricians (n=23, 22.1%), paediatric surgeons (n=19, 18.3%), general surgeons (n=5.8%) and endocrinologist (n=1, 1.0%). Three out of 4 MRI scans were ordered by paediatric surgeons (n=3, 75%) (Figure 1). Indications of imaging studies were to

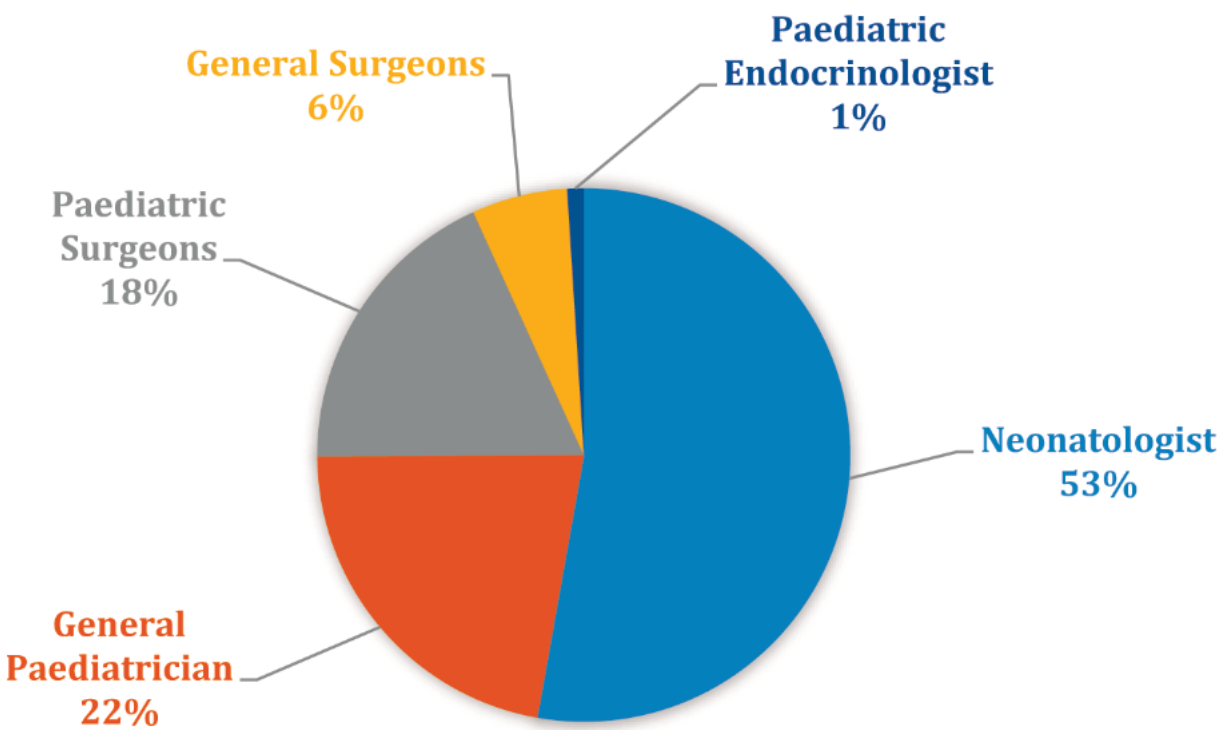

Figure 1 Imaging booked by various specialties.

document testicular location (n=88, 84.6%), to detect mullerian structures (n=9, 8.7%), document testicular sizes (n=4, 3.8%) and for other reasons (n=3, 2.9%) (Figure 2).

Correlation of Imaging with Operative Findings

Ultrasound imaging only correctly identify testicular position in 26.0% (27/104 studies) (Table 1). Ultrasound were reported as absent, intra-abdominal, close to or at deep ring, within inguinal canal, close to or at superficial ring, or in scrotum. According to ultrasound report, 19 testes were more proximal to inguinal canal and considered as impalpable, however only 5 testes ended up being impalpable after examination under anaesthesia and requiring laparoscopy. Therefore, for impalpable testis, ultrasound only correctly identified the location in 26% of the case. For the remaining 80 palpable testes (without asterisk), ultrasound findings correctly identified testicular position in 23 testes (28.8%). Five USG studies and 2 MRI were done for detection of mullerian structures (Tables 2 and 3), all were done in patients with suspected disorder of sexual development. None of the ultrasound identified Mullerian structures, however the two MRI showed abnormalities with Mullerian structures present and splenogonadal fusion.

Timing of Referral and Orchidopexy

Median age at referral for groups with and without imaging was 9 and 11 months, respectively (Table 4). Mean age at referral for the group with imaging and without imaging was 2.1 years and 2.4 years with no statistical difference among the groups (p=0.169). Median age at surgery with and without imaging was 15 and 20 months, respectively. Mean age at surgery for the group with and without imaging was 2.9 years and 3.3 years with no statistical difference among the groups (p=0.158).

Cost Impact

Given the cost of one ultrasound scrotum to be HKD $1000 and MRI pelvis with contrast to be HKD $10200, the total cost during the 5-year study period was calculated to be HKD $129800 and thus approximately HKD $25960 per annum.

Discussion

During the first year of life the human testis undergoes important development with neonatal germ cells (known as gonadocytes) further differentiating to type A

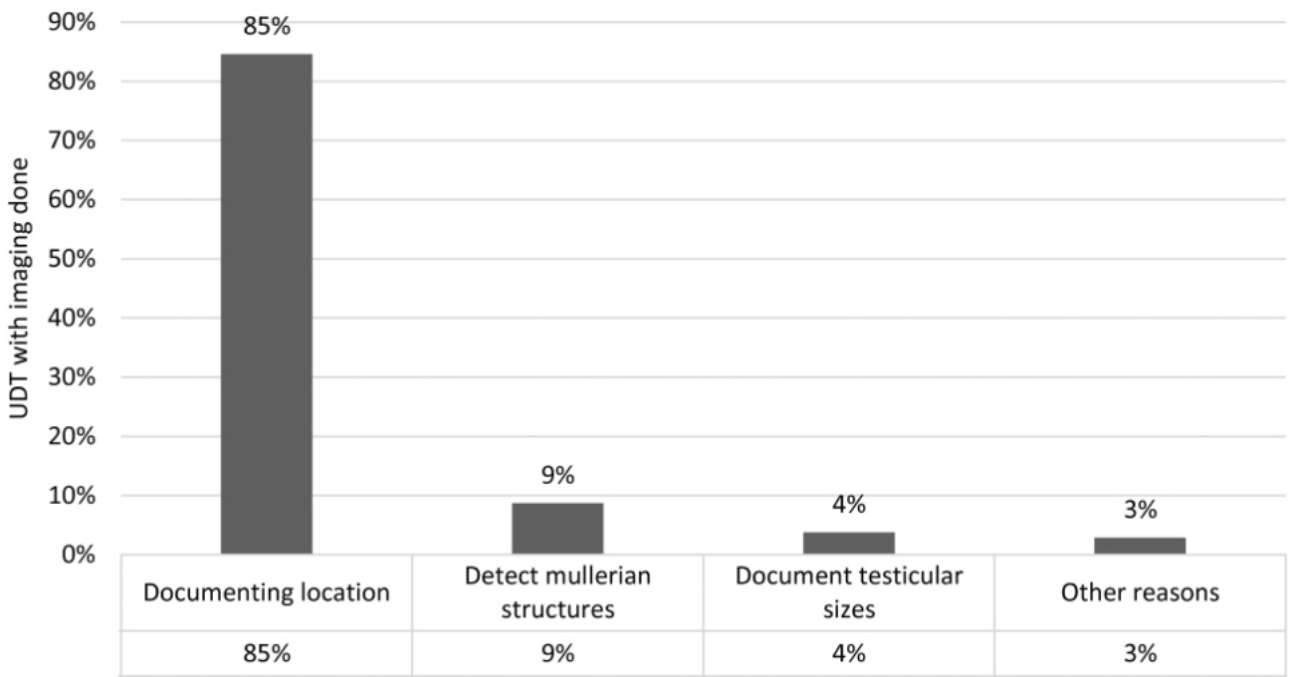

Figure 2 Indications for imaging.

Table 1 USG findings correlation with operative findings

USG findings Reported as	Number of testes Total n= 104	Operative findings		Percentage of USG studies correctly identifying location of testis
		Palpable after EUA 89	Impalpable after EUA 10	
Absent or Not seen	5	4 SIP (n=4)	1 Intra-abdominal (n=1)	0
Intra-abdominal	4	3 Canalicular (n=2) SIP(n=1)	1 Intra-A with FS done (n=1)	1/4 studies = 25%
Close to or at deep ring or peeping	10	7 SIP in 5 Canalicular (n=1) Peeping in 1	3 (Proximal to deep ring in 1 Peeping in 1 Canalicular in 1)	5/10 studies = 50%
Within inguinal canal	65	61 Canalicular in 9 Peeping in 3 SIP in 45 Scrotum in 4	4 Peeping in 3 Intra-abdominal in 1	9/65 studies = 13.8%
Close to or at superficial ring	7	6 SIP in 4 Scrotal neck in 1 Peeping in 1	1 Intra-abdominal in 1	7/10 studies = 70%
Upper scrotum	5	5 Upper scrotum (n=2) SIP(n=3)		5/5 studies = 100%
In scrotum	3	3 Within scrotum (n=2) SIP (n=1)		2/3 studies = 70% **Total 27/104 = 26%**
Other miscellaneous terms found in report	5	Reported as: "in pubic region" in 1 "in groin" in 4		

USG: Ultrasound; EUA: Examination under anaesthesia; SIP: Superificial inguinal pouch; FS: Fowler's Steven procedure

Table 2 Summary of imaging findings with initial indication to look for Mullerian structures

With ultrasound done				
1	Newborn with multiple congenital anomalies and bilateral impalpable testes	Suspected DSD	No Mullerian structures	Laparoscopy and bilateral orchidopexy done
2	Newborn with penoscrotal hypospadias and right inguinal hernia	Suspected DSD	No Mullerian structures	No definite DSD diagnosis
3	Newborn with Prada Willi syndrome, bilateral impalpable testes	Suspected DSD	No Mullerian structures	Laparoscopy and bilateral orchidopexy done
4	Newborn with chromosomal abnormalities and bilateral impalpable testes, proximal penile hypospadias	Suspected DSD	No Mullerian structures	Laparoscopy and bilateral orchidopexy done No definite DSD diagnosis
5	2 years old boy with micropenis and right undescended testis	Suspected DSD	No Mullerian structures	Confirmed Partial Androgen Insensitivity syndrome Foreskin reconstruction and orchidopexy done
With magnetic resonance imaging done				
6	14 months old boy with bilateral undescended testes	Suspected DSD	Mullerian structures present	Later confirmed to have persistent Mullerian Duct syndrome by genetic test (AMH receptor mutation type 2)
7	Newborn with penoscrotal hypospadias and bilateral undescended testes	Suspected DSD	Splenogonadal fusion	Continuous type of splenogonadal fusion

DSD: Disorder of sexual development; AMH: Anti-Mullerian hormone

spermatogonia in the first 3 months postnatally, and subsequently differentiate into type B spermatogonia and then primary spermatocytes by 3-4 years of age. The initial process requires a lower temperature of 33 degree Celsius and failure to achieve this temperature leads to progressive biochemical and physiological abnormalities seen in undescended testes.[1,6,7] As migration through the inguinal canal occurs relatively late in gestational development, cryptorchidism is accordingly higher in premature boys in the first few months of life. Testes may descend after birth, but spontaneous descent is unlikely in boys older than 6 months, corrected for gestational age.[8]

International guidelines including European Urological Association[4] and American Urological Association[5] recommend operative management for testes that have not descended by 6-12 months of age. The operative approach for cryptorchidism is based upon palpability of the testis at the time of examination under anaesthesia. If the testis is palpable, then a conventional inguinal or transcrotal orchidopexy should be performed.[9] If it is not palpable then diagnostic laparoscopy should be carried out.[10] Possible findings include spermatic vessels entering inguinal canal (40%), an intra-abdominal (40%) or peeping (10%) testis, or blind-ending spermatic vessels confirming vanishing testis (10%). Further procedure depends on the exact laparoscopic findings and the above guidelines do not recommend pre-referral imaging including ultrasound, computerised tomography, MRI or angiography as

Table 3 MRI findings and correlation with intra-operative finding

Patient	Clinical history	Indication for imaging	MRI findings	Operative findings
1	8 years old boy referred for impalpable right testis to general surgery	For localisation* of testis	Right testis within inguinal canal	Right testis at SIP
2	14 months old boy with bilateral undescended testes	For detection of Mullerian structures	Mullerian structures present	Later confirmed to have persistent Mullerian Duct syndrome by genetic test (AMH receptor mutation type 2)
3	History of left inguinal herniotomy during at 2 years old referred to us for palpable but smaller left testis	For documentation of testicular sizes	Smaller left testis in subcutaneous fat layer	Left testis adhered to scar tissue at external ring, size ½ of that compare to right side
4	Born with penoscrotal hypospadias and bilateral undescended testes	For detection of Mullerian structures	Splenogonadal fusion	Continuous type of splenogonadal fusion

MRI: Magnetic resonance imaging; SIP: Superificial inguinal pouch; AMH: Anti-Mullerian hormone

*Investigation booked by general surgeon for case 1 and others by paediatric surgeons

Table 4 Comparison of groups with and without imaging done

	Group 1 Imaging done n=93/254	Group 2 No imaging n=161/254	P value
Numbers, n	93 (77 unilateral, 16 bilateral)	161 (145 unilateral, 16 bilateral)	-
Mean age at referral	2.1 years	2.4 years	0.169
Median age at referral	9 months (range 0-13 years)	11 months (range 0-12 years)	-
Mean age at surgery	2.9 years	3.3 years	0.158
Median age at surgery	15 months (range 8.6 months to 14 years)	20 months (8 months to 13 years)	-
Cost (HKD$)	89 USG x HKD $1000 4 MRI contrast x HKD $10200 HKD $129800/study period Approximately HKD $25960 per annum	$0	

USG: Ultrasound; MRI: Magnetic resonance imaging; HKD: Hong Kong dollar

literature has conclusively shown no benefit from radiological investigation and potential delay in management.

In our series we have found that 36% of all patients with UDT had pre-operative imaging, which is similar to published literature. Kanaroglou's series in The Hospital for Sick Children, Toronto in 2019[11] looked at proportion of children who underwent ultrasound before referral for undescended testes, hydroceles and retractile testes. Almost 30% of the infants and children underwent ultrasound prior to referral to paediatric urology centre. They suspected pediatricians were unaware of existing guidelines and believed that ultrasound would be beneficial in decision-making process in the management.

The most common indications for ordering imaging were to document testicular position in our series. However, only 26% of ultrasound findings in our series correlated with operative findings (26% of impalpable testis and 28% of palpable testis). A meta-analysis looking at the diagnostic performance of ultrasound in locating nonpalpable testis by Tasian et al found that ultrasound has a sensitivity of 45% and specificity of 78% and concluded that ultrasound does not reliably localise nonpalpable testes and does not rule out intra-abdominal testis.[12] For palpable testis, regardless of imaging findings, would be a conventional inguinal or transcrotal orchidopexy. Some believed that having imaging findings may help in counseling parents, however reliance of ultrasound may provide misleading information and disastrous if surgical approach is dependent on imaging results. In our series, only 5 out of 19 patients with impalpable testes pre-operatively ended up needing laparoscopy, counseling with their ultrasound results may add to unnecessary stress to the family and additional 14 unnecessary laparoscopy might have been performed if we rely solely on ultrasound findings.

There are several populations which pre-operative imaging might be beneficial including obese patients, patients with suspected Disorder of sexual development and patient undergoing reoperation.[12] None of the ultrasound in this series identified any Mullerian structures. Most MRI in this series were booked by paediatric surgeons after initial consultations to look for presence of Mullerian structures or in patients who had previous groin surgeries. We felt that MRI has a higher sensitivity, and it does not involve ionising radiation and thus makes it an attractive alternative option. However, it is expensive, not readily available and usually requires sedation or even general anaesthesia with the associated risks. A meta-analysis looking at conventional MRI for locating nonpalpable testes concluded that testis not identified on MRI can still be present and thus imaging does not completely exclude its absence.[13] Therefore, we will not recommend routine MRI in all patients but its role in selected patients were well demonstrated in this series.

It has been reported that children who underwent imaging has a three-month delay in surgery.[11] Fortunately, in our cohort the age at referral and surgery was not influenced by whether or not imaging was arranged. We believe that this is due to the fact that imaging was already ordered and done before our first consultation in most cases. Cost impact was approximately HKD $25960 per annum, and we feel that the resources can be reserved for other patients.

There are several limitations in our study. First is the retrospective nature and it is a single centre study with involvement of only three tertiary hospitals in Hong Kong. The reporting of imaging findings was not standardised as they were done in various different radiology department or even in private radiology centres. The protocol for paediatric imaging, sedation requirement and method, the specification of USG and MRI machine and the level of experience of reporting radiographer or radiologist was heterogenous due to the retrospective nature. In addition, most ultrasound was done before referral at around 3 to 6 months and thus it might not be a true reflection of a proper correlation with operative findings as testicular descend after birth is ongoing. The differences in testicular volume between the undescended testis and the contralateral normal side were also not documented in most USG reports. A future prospective study with imaging done just before operation will give better correlation. However, our findings were close to other international literatures in which correlation was seen in one third of the cases. We believe that this study has a good external validity and the results can be applied to our population in other centres with undescended testes. Further studies to address these weaknesses would be valuable.

Conclusion

Pre-referral imaging is seen in more than one third of all UDT in our locality, mainly booked during newborn period for documentation of testicular position. However, only less than a third of all studies correlate with intra-operative position and do not change clinical management. Therefore, we do not recommend pre-referral imaging for solely to localise the testis, but it may be useful in patient

with suspicion of disorder of sexual development. Timely referral to paediatric surgical centre is crucial for better resource management and imaging can be reserved for selected patients.

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Declaration of Interest

The authors declare that they have no conflict of interest.

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