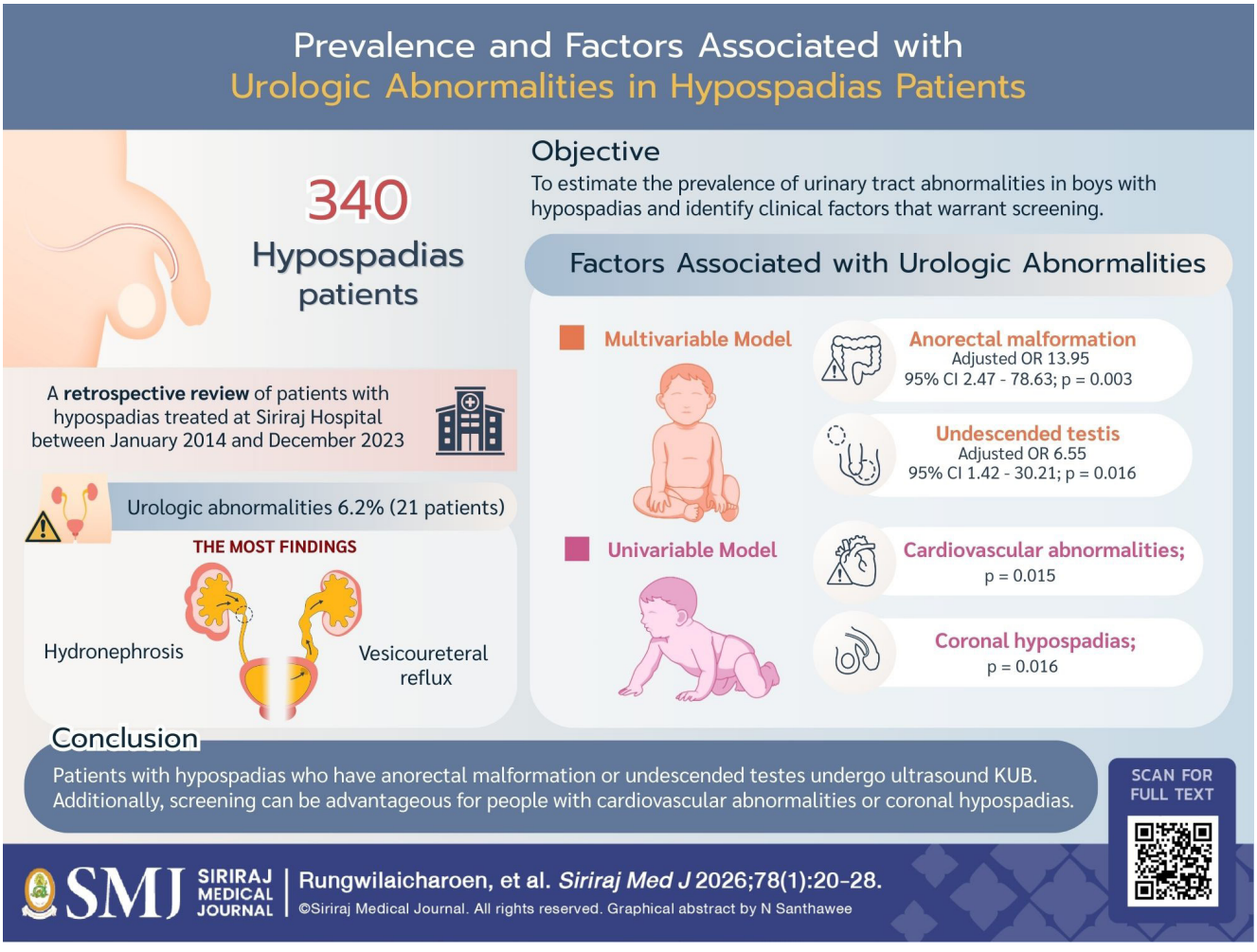
Prevalence and Factors Associated with Urologic Abnormalities in Hypospadias Patients

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ABSTRACT

Objective: To estimate the prevalence of urinary tract abnormalities in boys with hypospadias and identify clinical factors that warrant screening.

Materials and Methods: A retrospective review was conducted of patients with hypospadias treated at Siriraj Hospital between January 2014 and December 2023. No standardized radiographic screening protocol was applied.

Results: Urinary tract abnormalities were identified in 6.2% (21/340) of patients with hypospadias. The most prevalent findings were vesicoureteral reflux (VUR) and hydronephrosis, primarily non-obstructive, non-reflux hydronephrosis. Ultrasound KUB was a valuable screening tool (n = 95), detecting 19 urinary tract abnormalities and 13 additional abnormalities. Analysis of KUB-related anomalies in hypospadias showed no direct relationship between urethral opening and the frequency of urinary tract abnormalities, except in coronal hypospadias, which demonstrated a higher rate of anomalies. On multivariable binary logistic regression, anorectal malformation (adjusted OR 13.95, 95% CI 2.47 - 78.63; p = 0.003) and undescended testis (adjusted OR 6.55, 95% CI 1.42 - 30.21; p = 0.016) predicted KUB abnormalities in patients with hypospadias. In the univariable model, cardiovascular abnormalities and coronal hypospadias were also significantly associated with urinary tract abnormalities (p = 0.015 and p = 0.006, respectively), with medium to high effect sizes.

Conclusion: Of patients with hypospadias, 6.2% had anomalies of the urinary tract. It is advised that patients with hypospadias who additionally have anorectal anomalies or undescended testes undergo ultrasound KUB. Additionally, screening can be advantageous for patients with cardiovascular abnormalities or coronal hypospadias.

Keywords: Hypospadias; kidney-ureter-bladder (KUB); ultrasonography; urogenital anomalies; voiding cystourethrogram.
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INTRODUCTION

Hypospadias is the most prevalent abnormality of the male urogenital tract.[1] The reported incidence of associated urinary tract anomalies in patients with hypospadias varies widely, from 1.7%[2] to 40%.[3] This variation is largely attributed to differences in diagnostic methods used to detect urinary tract abnormalities. Earlier studies, particularly those conducted before 1976, often reported higher prevalence rates, likely because intravenous pyelography (IVP) was the primary diagnostic tool.[4] In contrast, more recent studies using ultrasonography as the main screening method have reported a much lower prevalence of associated abnormalities, approximately 1.7%.[2]

The role of ultrasonography in screening for urological abnormalities in patients with hypospadias remains controversial, with three main viewpoints: 1. All patients with hypospadias should undergo screening for urological abnormalities.[5,6] 2. Screening should be reserved for patients with severe hypospadias or other associated abnormalities.[4], and 3. No screening is necessary for any patient with hypospadias, regardless of its severity.[7,8]

The aim is to estimate the prevalence of urinary tract abnormalities in hypospadias and identify factors that warrant screening, such as the severity of hypospadias or the presence of associated abnormalities.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of Siriraj (COA no. Si 320/2024). We retrospectively reviewed all patients with hypospadias admitted for further evaluation and surgical treatment at the Divisions of Pediatric Surgery and Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, between January 2014 and December 2023. Patients were excluded if they lacked complete follow-up medical records, had bladder exstrophy or cloacal exstrophy, or had disorders of sex development.

In this investigation, the type of hypospadias was classified based on the position of the urethral opening prior to surgical chordee correction in cases where chordee was present. The decision to perform additional urological testing, such as ultrasound kidney-ureter-bladder (KUB), voiding cystourethrogram (VCUG), IVP, or a combination of these, varied by surgeon. This decision was typically guided by the suspected lesion and the results of the initial KUB ultrasonography, in the absence of a clear standardized investigative protocol.

Demographics and clinical data were systematically collected, including type of hypospadias, genital anomalies, KUB anomalies, and other congenital anomalies.

For statistical analysis, qualitative variables were compared between groups using Fisher's exact test or

Pearson's χ^2 test. Associations between exposures (types of hypospadias, kinds of genital malformations, and other anomalies) and outcomes (KUB anomalies) were assessed by calculating odds ratios (OR). Univariable models reported unadjusted ORs with 95% confidence intervals (CI), evaluating each independent variable separately without adjustment for confounders. Variables with $p < 0.10$ entered the multivariable logistic regression alongside clinically relevant covariates. Model fit was assessed with the Hosmer–Lemeshow test and pseudo-R^2. Variables were further analyzed in multivariable logistic regression models to account for the impact of confounding factors, yielding adjusted ORs with 95% CI.

All analyses were performed using the PASW Statistics program (SPSS for Windows, version 26.0, SPSS Inc., Chicago, Illinois, USA). A p-value lower than 0.05 was considered statistically significant.

RESULTS

Among 340 patients with hypospadias enrolled between January 2014 and December 2023, KUB abnormalities were identified in 21 patients (6.2%). The precise location of the urethral opening was not recorded in two patients. Based on the penoscrotal junction as the reference point, 196 patients had hypospadias distal to the junction: 27 glandular hypospadias, 25 coronal, 47 distal penile, 81 midshaft, and 16 proximal penile. A further 142 patients had hypospadias from the penoscrotal junction to the perineum: 133 penoscrotal, 8 scrotal, and 1 perineal. Details of congenital urinary system abnormalities by urethral position are shown in Table 1.

KUB abnormalities occurred in 13/196 patients with urethral openings distal to the penoscrotal junction (6.6%) and in 8/142 patients with openings from the junction onward (5.6%). The most frequent abnormalities were hydronephrosis (usually non-obstructive, non-reflux, though some cases were obstructive) and vesicoureteral reflux. Additional kidney abnormalities included two cases of renal agenesis and one hypoplastic kidney in patients whose urethra opened distal to the penoscrotal junction. The types of hypospadias were categorized based on the urethra's position and the frequency of urinary tract abnormalities, as shown in Table 2.

TABLE 1. Comparison of the prevalence of KUB anomalies in hypospadias with a urethral opening* distal to the penoscrotal junction (n = 196) versus hypospadias with a urethral opening between the penoscrotal junction and the perineum (n = 142).

KUB anomalies** (n = 21); n (%)	Distal to penoscrotal junction (n = 13); n (%)	Penoscrotal junction to perineum (n = 8); n (%)
Hydronephrosis (non-obstructive, non-reflux)	5 (38.5)	4 (50.0)
Hydronephrosis (obstructive hydronephrosis)	1 (7.7)	1 (12.5)
Vesicoureteral reflux	7 (53.8)	2 (25.0)
Renal agenesis	2 (15.4)	0 (0)
Bladder diverticulum	2 (15.4)	0 (0)
Prostatic utricle cyst	1 (7.7)	2 (25.0)
Horseshoe kidney	0 (0)	1 (12.5)
Medullary nephrocalcinosis	1 (7.7)	0 (0)
Hypoplastic kidney	1 (7.7)	0 (0)
Patent urachus	1 (7.7)	0 (0)
Neurogenic bladder	1 (7.7)	0 (0)
Hydroureter	1 (7.7)	0 (0)
Incomplete double collecting system	1 (7.7)	0 (0)

*In two of the 340 hypospadias individuals, the exact position of the urethral opening was not noted.
**Patients may have more than one abnormality.

TABLE 2. Percentage and frequency of KUB abnormalities by the type of hypospadias.

Type of hypospadias	KUB anomalies** (n = 21)	No KUB anomalies** (n = 317)	Total (n = 338)*	p-value
Glandular; n (%)	1 (4.8)	26 (8.2)	27 (8.0)	1.000
Coronal; n (%)	5 (23.8)	20 (6.3)	25 (7.4)	0.013
Shaft of Penis; n (%)	7 (33.3)	137 (43.2)	144 (42.6%)	0.510
Distal penile	3 (14.3)	44 (13.9)	47 (13.9)	1.000
Midshaft	3 (14.3)	78 (24.6)	81 (24.0)	0.419
Proximal penile	1 (4.8)	15 (4.7)	16 (4.7%)	1.000
Penoscrotal Junction to Perineum; n (%)	8 (38.1)	134 (42.2)	142 (42.0)	0.883
Penoscrotal	8 (38.1)	125 (39.4)	133 (39.3)	1.000
Scrotal	0 (0)	8 (2.5)	8 (2.4)	
Perineal	0 (0)	1 (0.3)	1 (0.3)	
Total; n (%)	**21 (6.2)**	**317 (93.8)**	**338 (100.0)**	

*In two of the 340 hypospadias individuals, the exact position of the urethral opening was not noted.
**Patients may have more than one abnormality.

Among 340 patients, urethral position was missing for 2; thus, Table 2 totals 338. As per Table 2, the prevalence of KUB abnormalities was comparable across most hypospadias subtypes, except for coronal hypospadias, where five of 25 patients were affected (20%), a significantly higher rate compared with other groups (p = 0.013).

Ultrasound KUB was the most commonly performed test for urinary tract abnormality screening, either alone (n = 75), in conjunction with VCUG (n = 18), or with IVP (n = 2). VCUG was the second most common, performed either alone (n = 10) or with ultrasound KUB plus VCUG (n = 18). Only one patient underwent IVP as a standalone test. Radiologic modalities identifying urinary and associated anomalies are presented in Table 3.

Hydronephrosis was successfully diagnosed by ultrasound KUB. The most common diagnosis was non-obstructive, non-reflux hydronephrosis (two patients on ultrasound KUB alone, two on ultrasound KUB + VCUG, and two on ultrasound KUB + IVP). Vesicoureteral reflux was diagnosed in five patients with ultrasound KUB + VCUG and in one patient on ultrasound KUB alone. Other related abnormalities included hydroceles (n=8) and undescended testes (n=4), also detectable by ultrasound KUB alone. Among 95 patients who underwent initial ultrasound KUB, 19 urinary tract anomalies and 13 additional anomalies were identified.

Urinary tract abnormalities appear to be more common in patients with hypospadias who also present with related conditions. Urinary tract abnormalities are more common in patients with hypospadias with certain types of related malformations. Table 4 summarizes the association between urinary tract anomalies and related malformations in other organs.

According to Table 4, among patients with hypospadias and undescended testes, three of 16 (18.75%) patients demonstrated KUB abnormalities. This association was nearly statistically significant (p = 0.068).

In the group with extra-urinary malformations, KUB abnormalities were statistically significant in seven of 27 patients with hypospadias and the "Vertebral defects, Anal atresia, Cardiac defects, Tracheo-esophageal fistula, Renal anomalies, and Limb abnormalities" association (VACTERL association) (p < 0.001). Additionally, three out of seven individuals with anorectal malformations and hypospadias (n = 7) had KUB abnormalities, also statistically significant (p = 0.006).

Patients with hypospadias and cardiovascular anomalies showed a higher prevalence of urinary tract abnormalities. Specifically, four of 20 patients demonstrated KUB abnormalities (p = 0.027). These were more common in patients with non-cyanotic heart defects compared with those with cyanotic heart diseases.

TABLE 3. Radiological techniques used to detect all anomalies, including KUB anomalies and other anomalies.

Investigation	Total (n = 340); n (%)	KUB anomalies* (n = 21); n (%)	Other abnormalities* (n = 210); n (%)	No abnormalities (n = 109); n (%)
US KUB; n (%)**	**75 (22.1)**	**7 (33.3)**	**13 (6.2)**	**55 (50.5)**
Hydronephrosis (non-obstructive, non-reflux)		2 (28.6)		
Hydronephrosis (outflow tract obstruction)		1 (14.3)		
Hypoplastic kidney		1 (14.3)		
Medullary nephrocalcinosis		1 (14.3)		
Vesicoureteral reflux		1 (14.3)		
Prostatic utricle cyst		1 (14.3)		
Hydrocele			8 (61.5)	
Undescended testis			4 (30.8)	
Retractile testis			1 (7.7)	
Indirect inguinal hernia			2 (15.4)	
Varicocele			1 (7.7)	
VCUG; n (%)	**10 (2.9)**	**1 (4.8)**	**0 (0)**	**9 (8.3)**
Bladder diverticulum		1 (100.0)		
IVP; n (%)	**1 (0.3)**	**1 (4.8)**	**0 (0)**	**0 (0)**
Hydronephrosis (outflow tract obstruction)		1 (100.0)		
US KUB + VCUG; n (%)**	**18 (5.3)**	**10 (47.6)**	**0 (0)**	**8 (7.3)**
Hydronephrosis (non-obstructive, non-reflux)		2 (20.0)		
Vesicoureteral reflux		5 (50.0)		
Renal agenesis		1 (10.0)		
Prostatic utricle cyst		2 (20.0)		
Patent urachus		1 (10.0)		
US KUB + IVP; n (%)**	**2 (0.6)**	**2 (9.5)**	**0 (0)**	**0 (0)**
Hydronephrosis (non-obstructive, non-reflux)		2 (100.0)		
Horseshoe kidney		1 (50.0)		
Extrarenal pelvis		1 (50.0)		

*The patient may have many deformities, and there may be abnormalities in the urinary system or other systems together.
**US KUB = Ultrasound KUB

TABLE 4. Association between urinary tract malformations and other organ anomalies in patients with hypospadias.

Other anomalies	Total (n = 340); n (%)	KUB anomalies* (n = 21); n (%)	No KUB anomalies* (n = 317); n (%)	p-value
Other genital anomalies; n (%)	**62 (18.2)**	**6 (28.6)**	**56 (17.7)**	**0.240**
Undescended testis	16 (4.7)	3 (14.3)	13 (4.1)	0.068
Bifid scrotum	10 (2.9)	1 (4.8)	9 (2.8)	0.476
Shawl scrotum	6 (1.8)	1 (4.8)	5 (1.6)	0.320
Indirect inguinal hernia	12 (3.5)	1 (4.8)	11 (3.5)	0.541
Hydrocele	21 (6.2)	1 (4.8)	20 (6.3)	1.000
Extra-urinary anomalies; n (%)	**32 (9.4)**	**7 (33.3)**	**25 (7.9)**	**0.002**
• VACTERL association; n (%)	**27 (7.9)**	**7 (33.3)**	**20 (6.3)**	**<0.001**
• Vertebral anomalies; n (%)	**1 (0.3)**	**0 (0)**	**1 (0.3)**	**1.000**
- Spinal lipoma	1	0	1	
• Anorectal malformation; n (%)	**7 (2.1)**	**3 (14.3)**	**4 (1.3)**	**0.006**
• Low type	**1**	**1**		
- ARM with anocutaneous fistula	1	1		
• Non-low type	**6**	**2**	**4**	
- ARM with rectoprostatic urethra fistula	1	1		
- ARM with rectobladder neck fistula	2	1	1	
- ARM with rectobulbar urethra fistula	1		1	
- ARM without Fistula	1		1	
- ARM with non-low type fistula (unknown location)	1		1	
• Cardiovascular anomalies; n (%)	**20 (5.9)**	**4 (19.0)**	**16 (5.0)**	**0.027**
• Non-cyanotic heart disease				
- Atrial Septal Defect (ASD)	5	3	2	
- Patent Ductus Arteriosus (PDA)	6	2	4	
- Ventricular Septal Defect (VSD)	6	1	5	
- Mitral Valve Regurgitation (MR)	2	1	1	
- Aortopulmonary Septal Defect (APSD)	1		1	
• Cyanotic heart disease				
- Severe Pulmonary Valve Stenosis (PS)	1		1	
- Tetralogy of Fallot (TOF)	5	1	4	
- Pulmonary atresia (PA)	1		1	
- Complete Atrioventricular Canal Defect (CAVC)	1		1	
- dextro-Transposition of the Great Arteries (dTGA)	1		1	
• Tracheoesophageal anomalies; n (%)	**2 (0.6)**	**0 (0)**	**2 (0.6)**	**1.000**
- EA type C	2		2	
• Other anomalies; n (%)	**6 (1.8)**	**2 (9.5)**	**4 (1.3)**	**0.047**
• Head & Neck anomalies; n (%)	**4 (1.2)**	**2 (9.5)**	**2 (0.6)**	**0.020**
- Cleft lip & Cleft palate	1	1		
- Bifid uvula	1	1		
- Microcephaly	2	1	1	
- Craniosynostosis	1		1	
• GI tract anomalies; n (%)	**2 (0.6)**	**0 (0)**	**2 (0.6)**	**1.000**
- Hirschsprung's disease	1		1	
- Hypertrophic pyloric stenosis	1		1	

*The patient may have many deformities, and there may be abnormalities in the urinary system or other systems together.

Urinary tract abnormalities were also significantly more frequent in patients with head and neck conditions linked to hypospadias, such as microcephaly, bifid uvula, and cleft lip and cleft palate (p = 0.020).

Taken together, this study suggests that certain significant factors, such as coronal-type hypospadias, undescended testes, anorectal malformations, cardiovascular anomalies, and head and neck abnormalities, are associated with an increased risk of urinary tract abnormalities in patients with hypospadias. As a result, screening for these abnormalities should be considered. Table 5 presents the results of univariate and multivariable binary logistic regression analyses using the aforementioned components.

When assessing the relationship between hypospadias and KUB anomalies, the univariable analysis showed that coronal-type hypospadias, undescended testes, anorectal malformations, cardiovascular anomalies, and head and neck anomalies were all statistically significant predictors. However, only undescended testes and anorectal malformation were statistically significant when correlated with KUB abnormalities in the multivariable model, as shown in Table 5. This may be attributable to the effect sizes of these factors, which ranged from medium to large. With a larger sample of patients presenting with coronal hypospadias or cardiovascular anomalies, these associations might reach statistical significance in multivariable analysis.

DISCUSSION

Even though hypospadias is the most prevalent urogenital tract abnormality in boys[1], there is ongoing discussion on whether all patients should undergo routine screening for related urogenital tract abnormalities. The urinary system can be screened for abnormalities using a variety of techniques. Historically, IVP was the primary screening method,[4] yielding a high reported incidence of anomalies. Reported rates have varied widely, from 1.7%[2] to 56%.[3,7] largely due to differences in diagnostic techniques. More recently, ultrasound KUB has become the preferred initial screening tool. However, identifying a urinary tract anomaly does not always alter clinical management.[8]

Current perspectives on ultrasound screening in hypospadias patients fall into three categories: 1. Screening all patients, as some studies reported urological anomalies[5,6] ranging from 13.26%[5] to 18.46%[6], 2. Selective screening, limited to patients with severe hypospadias or other abnormalities[4], and 3. No routine screening, even in severe hypospadias[2,7,8], given the relatively low prevalence and the predominance of clinically insignificant anomalies.[2,7]

In this study, 6.2% (21/340) of hypospadias patients had urinary tract malformations, most commonly hydronephrosis (mainly non-obstructive and non-reflux) and vesicoureteral reflux. These findings align with previous research that these two disorders are the most prevalent abnormalities of the urinary tract.[7] Although kidney malposition (pelvic kidney and horseshoe kidney) has been frequently described elsewhere[7], it was rare in our series, while sporadic renal agenesis was noted, which was extremely uncommon in earlier studies.[7]

Ultrasound KUB was the primary screening method. Either an ultrasound KUB examination was performed alone (n = 75), followed by either an ultrasound KUB and VCUG combination (n = 18) or an ultrasound KUB and IVP combination (n = 2). If an abnormality was discovered. According to guidelines, 19 urinary tract

TABLE 5. Univariate and multivariable binary logistic regression analyses of variables linked to KUB abnormalities in patients with hypospadias.

Factors	Univariable model		Multivariable model	
	Unadjusted OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Coronal hypospadias	4.641 (1.542, 13.963)	0.006	3.691 (0.990, 13.758)	0.052
Undescended testis	3.923 (1.025, 15.018)	0.046	6.550 (1.420, 30.213)	0.016
Anorectal malformation	13.125 (2.729, 63.119)	0.001	13.945 (2.473, 78.631)	0.003
Cardiovascular anomalies	4.456 (1.343, 14.789)	0.015	3.323 (0.745, 14.825)	0.115
Head & Neck anomalies	16.684 (2.227, 125.005)	0.006	1.456 (0.090, 23.466)	0.791

anomalies were found in hypospadias patients who had their first KUB ultrasonography (n = 95), or 20% of the total. This is comparable to the findings of *Gupta L.*[6], who found that 18.46% of patients had an ultrasound-detected urinary tract abnormality.[6] Ultrasound was also used in this investigation to identify other anomalies in 13 other systems. This suggests that ultrasonography screening is highly beneficial and an effective method for identifying patients who are more likely to have abnormalities of the urinary system.[5]

Researchers also found urinary tract malformations in 6.2% (21/340) of hypospadias patients, consistent with previous studies. Given this low prevalence, additional criteria, such as hypospadias type, associated genital anomalies, or other organ deformities, are needed to better identify patients who require screening for urinary tract malformations.

The type of hypospadias remains a contentious factor when determining the need for KUB anomaly screening. Traditionally, proximal hypospadias, extending from the penoscrotal junction to the scrotum or perineum, was thought to be associated with a higher incidence of urinary tract malformations compared with hypospadias that extend distal to the penoscrotal junction.[4,5] *Davenport*[4] found that severe hypospadias was associated with a higher incidence of urinary tract malformations, with positive ultrasound rates of 5.4% for coronal hypospadias, 11.1% for distal shaft hypospadias, 28.5% for proximal shaft hypospadias, and 20.0% for perineal hypospadias cases. However, the present study found no direct correlation between urethral opening location and urinary tract abnormalities, consistent with earlier reports that showed no association between hypospadias position and overall urinary tract deformities.[7,8,11] Similarly, no correlation was observed between the incidence of vesicoureteral reflux[3,9], hydronephrosis[3,10,11], or kidney malposition[6,11] and hypospadias position as determined by the urethral opening. The researchers were unable to explain why the coronal hypospadias group in this study had a considerably higher incidence of urinary tract deformities than other groups (p = 0.013). In comparison to other research, the degree of hypospadias in this study was typically more severe. The distal part of the penis shaft with combined coronal and glandular hypospadias was only visible in 52 out of 338 patients (15.38%) in this study. In contrast, in studies conducted elsewhere, most hypospadias patients had their urethral opening distal to the mid-shaft of the penis. Therefore, caution is warranted when interpreting the association between coronal hypospadias and urinary tract anomalies, which might only occur in this cohort composition.

Researchers also examined whether hypospadias patients with associated anomalies had a higher incidence of urinary tract malformations, which would justify further KUB radiologic screening.

Although not statistically significant (p = 0.068), patients with hypospadias and contemporaneous undescended testes showed more urinary tract anomalies compared with those without. This study excluded patients with Disorders of Sex Development, preventing direct comparison with prior studies. Disorders of Sex Development is considered a confounding factor, as multiple previous studies from various institutions have shown that hypospadias with undescended testes often represents manifestations of Disorders of Sex Development, warranting automatic ultrasound KUB evaluation.

Urinary tract anomalies were significantly more common in patients with hypospadias and anorectal malformations (p = 0.006). Apart from the author's previous research on genitourinary anomalies in anorectal malformation and urological investigations,[12] no prior studies have addressed this problem, and the proposed pathophysiological explanation remains unclear. Similarly, urinary tract abnormalities were significantly more prevalent in patients with cardiac abnormalities and hypospadias (p = 0.027), particularly in those with hypospadias and non-cyanotic heart disorders, than in those with cyanotic heart diseases.

When the prevalence and contributing factors of urinary tract malformations (KUB anomalies) in hypospadias patients were examined using the univariable model, all factors - including the coronal type of hypospadias, undescended testes, anorectal malformation, cardiovascular anomalies, and head and neck anomalies - were found to be statistically significant.

To account for confounding factors, the researcher entered several variables into a multivariable logistic regression model. Then, the researcher computed the adjusted OR with a 95% CI. Using a multivariable model, it was discovered that only anorectal malformation and undescended testes were statistically significant (p = 0.003 and p = 0.016, respectively). The multivariable model did not exhibit statistical significance, but the univariable model column showed that cardiovascular abnormalities and coronal hypospadias were statistically significant. This condition may be corrected by the medium to large effect sizes of coronal hypospadias and cardiovascular abnormalities. If the study included a large enough sample group, it might be possible to find statistically significant KUB anomalies in hypospadias patients in the coronal hypospadias and cardiovascular abnormalities in a multivariable model.

CONCLUSION

Urinary tract abnormalities were observed in 6.2% of patients with hypospadias. Our data support selective ultrasound KUB in hypospadias with anorectal malformation or undescended testis; screening may also be considered with coronal meatus or cardiovascular anomalies, acknowledging wide CIs and potential selection effects.

Data Availability Statement

The datasets generated and analyzed in this study are not publicly available. However, they can be accessed upon reasonable request made to a corresponding author.

LIMITATIONS

1. The decision to conduct further urological testing is necessary, such as ultrasound KUB, VCUG, IVP, or a combination of these techniques. Every surgeon approaches this in a unique way. In the absence of a standardized protocol, the choice depends largely on the suspected lesion and findings of the initial ultrasound KUB. Developing a universal protocol is difficult, as current textbooks present divergent recommendations.

2. In Thailand, minor or glandular hypospadias cases typically do not undergo distal hypospadias surgery. Therefore, compared with studies conducted internationally, particularly in Western nations, the patients in this study presented with more severe forms of hypospadias.

3. This study reflects the experience of a single institution, which also serves as a referral center for hypospadias. While it represents the largest single-center study of its kind in Thailand, the findings may not be fully generalizable to other contexts.

4. The absence of long-term follow-up data limited the ability to identify urinary tract abnormalities that might present later in adolescence or adulthood.

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DECLARATIONS

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Conflict of Interest

All the authors confirm that they have no personal or professional conflicts of interest to declare relating to any aspect of this research study.

Registration Number of Clinical Trial

Not applicable.

Author Contributions

Conceptualization and methodology, D.R., R.R.; Formal analysis, D.R., R.R.; Visualization and writing – original draft, R.R.; Writing – review and editing, D.R., R.R.; Supervision, R.R.; All authors have read and agreed to the final version of the manuscript.

Use of Artificial Intelligence

Artificial intelligence was not used in the preparation of the manuscript. All study concepts, analysis, interpretation, and writing were carried out by the authors.

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