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Factors Influencing Surgical Outcomes in Primary Hypospadias Repair: A Retrospective Study

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ABSTRACT

Background: Hypospadias is a common congenital anomaly of the male genital tract that frequently requires surgical correction. Although surgical methods have advanced significantly, postoperative complications remain a challenge, with widely variable rates reported across different centers. Identifying determinants of adverse outcomes is essential for improving prognosis and guiding surgical decision-making. This study aimed to evaluate clinical and operative factors influencing postoperative complications in children undergoing primary hypospadias repair.

Material and Methods: This retrospective observational study included 90 pediatric patients who underwent primary hypospadias repair at a tertiary care hospital between January 2022 and January 2025. Clinical data collected comprised age at surgery, body mass index (BMI), hypospadias type, operative time, urethral plate width, reconstructed urethral length, and Glans-Meatus-Shaft (GMS) score. Outcomes assessed included urethral fistula, urethral stricture, and wound dehiscence. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of complications.

Results: Of the 90 patients, 15 (16.67%) developed postoperative complications. The most common adverse event was urethral fistula (8.89%), followed by stricture (4.44%) and wound dehiscence (3.33%). Univariate analysis demonstrated that hypospadias type (p=0.027), operative time >120 minutes (p=0.021), reconstructed urethral length >3 cm (p=0.006), and postoperative constipation (p=0.025) were significantly associated with complications. Proximal penoscrotal hypospadias showed the highest risk (35.00% complication rate). No statistically significant association was observed for age at surgery, BMI, surgeon identity, anesthesia technique, urethral plate width, or GMS score.

Conclusion: Postoperative complications after hypospadias repair are strongly influenced by anatomical severity, duration of surgery, and the extent of urethral reconstruction. Comprehensive preoperative evaluation and individualized surgical planning are critical to optimize functional and cosmetic outcomes while minimizing adverse events.

Keywords: *Hypospadias, Urethroplasty, Postoperative complications, Pediatric urology, Risk factors.*

INTRODUCTION

Hypospadias is one of the most common congenital anomalies of the male external genitalia, characterized by ectopic placement of the urethral meatus on the ventral aspect of the penis, frequently accompanied by ventral curvature (chordee) and a dorsally hooded prepuce.

Beyond its anatomical definition, hypospadias imposes functional and psychosocial burdens across childhood and adolescence, influencing urinary stream direction, sexual function, and body image. Population-based surveillance has shown considerable geographic variability and a secular rise in prevalence over recent decades, underscoring both the public-health relevance of the condition and the need for robust outcome science in its management. [1]. The pathogenesis of hypospadias is multifactorial. Disruption of normal androgen signaling during critical windows of urethral tubularization, genetic polymorphisms affecting sex- steroid metabolism and receptor function, and environmental influences likely converge to produce the phenotypic spectrum observed clinically. Contemporary reviews synthesize these lines of evidence and emphasize that hypospadias is best understood as a developmental disorder of genital masculinization, with severity ranging from distal (glandular/subcoronal) to proximal (penoscrotal/perineal) forms. This spectrum correlates with operative complexity and long-term risk of adverse outcomes, framing both the surgical strategy and expectations for recovery[2]. From a clinical standpoint, the initial evaluation focuses on accurate phenotyping meatal position, glans configuration, urethral plate quality, degree of curvature, and associated anomalies because these elements guide technique selection and help anticipate complications. Timing of repair has evolved toward infancy to leverage favorable tissue characteristics and mitigate psychosocial stressors. Authoritative overviews recommend undertaking primary repair between 6 and 18 months of age, provided comorbidities are optimized and the anatomical survey is complete. This window balances anesthetic safety, penile growth, and family-centered considerations while enabling earlier functional rehabilitation[3]. Surgical goals are consistent across the spectrum: straighten the penis, reconstruct a urethra of adequate caliber and length, position a vertically oriented meatus at or near the tip of the glans, and achieve a durable skin closure with acceptable cosmesis. Technique has diversified markedly over the last three decades, with the tubularized incised plate (TIP) urethroplasty popularized by Snodgrass becoming the cornerstone for many distal and selected mid-shaft presentations because of its versatility, reproducible meatal configuration, and favorable learning curve. As experience accumulated, the TIP concept was adapted to more complex anatomies and reoperations, often in combination with tissue-interposition flaps to reduce fistula formation[4]. Despite technical refinements, postoperative complications remain a core challenge. Reported rates vary widely across series due to differences in case mix, technique, follow-up duration, and outcome definitions. Systematic reviews focused on non-proximal repairs place pooled incidences around 4% for urethrocutaneous fistula, ≈2% for meatal stenosis and wound dehiscence, and ≈8% for overall complications figures that nonetheless conceal higher risks in proximal disease and longer reconstructions. These benchmarks help contextualize institutional outcomes and inform power calculations for studies exploring modifiable risk factors[5]. Growing recognition of the limitations inherent in subjective reporting has prompted greater emphasis on standardized outcome assessment. The Hypospadias Objective Scoring Evaluation (HOSE) was an early attempt to codify key functional and cosmetic domains meatal location and shape, urinary stream, erection straightness, and fistula demonstrating acceptable inter-observer agreement and paving the way for later patient-reported and composite measures. Incorporating objective scales alongside clinician judgment strengthens external validity and facilitates comparison across techniques and centers[6].

Parallel efforts have sought reproducible ways to quantify anatomical severity before repair. While several systems exist, surgical decision-making commonly leans on granular descriptors such as urethral plate characteristics, glans size, and curvature. Notably, the prognostic value of pre- incision urethral plate width remains debated; some single-center series report no independent association with early complications after TIP urethroplasty, suggesting that other intraoperative and postoperative factors may dominate risk in many distal and mid-shaft cases. These unresolved questions highlight the importance of evaluating both immutable anatomy (e.g., meatal level) and modifiable elements (e.g., operative duration, tissue interposition, postoperative care) within a single cohort to clarify where preventive efforts should focus[7].

MATERIAL AND METHODS

This was a retrospective observational study conducted at a tertiary care teaching hospital. Clinical charts and follow-up records were reviewed for all consecutive pediatric patients who underwent primary hypospadias repair between January 2022 and January 2025. The work adheres to standard reporting practices for observational studies. The sample comprised 90 eligible patients, reflecting all consecutive primary repairs within the study window.

Multivariable modeling was constrained to maintain an events-per-variable ratio that minimized overfitting; where necessary, variables were parsimoniously selected or combined following clinical logic.

Eligibility criteria

Eligible participants were children undergoing their first (primary) hypospadias repair during the study window. Patients with previous hypospadias surgery, staged revisions, disorders of sex development with ambiguous genitalia, or incomplete core data fields were excluded to ensure a uniform cohort and reliable analyses.

Methodology

Prespecified variables included age at surgery, hypospadias type (categorized as distal/anterior, mid-shaft, proximal including penoscrotal), body mass index (BMI), operation time (skin incision to completion of skin closure, minutes), width of the urethral plate (millimeters, measured intraoperatively at its widest segment prior to mobilization), length of

the reconstructed urethra (centimeters, measured from the native meatus to the planned neomeatus along the ventral surface under minimal tension), and Glanular-Meatal-Shaft (GMS) score as recorded by the operating team. Perioperative covariates captured for descriptive and exploratory purposes included postoperative constipation (operationally noted by the clinical team as delayed bowel movement requiring laxatives or causing discomfort) to align with complication surveillance.

Surgical technique and perioperative management
Repairs were performed under general anesthesia with caudal or penile block as per anesthetic judgment. Technique selection and adjunct maneuvers (e.g., chordee correction, spongioplasty, dartos/tunica vaginalis coverage, catheter size and duration) followed unit protocols and surgeon preference. All patients received perioperative antibiotics according to institutional guidelines and standardized wound care counseling. These procedural details were recorded where available to contextualize operative time and reconstruction length; however, the primary analytical variables remained those prespecified above.

The primary outcome was the occurrence of postoperative complications during the defined follow-up period, specifically urethral fistula, urethral stricture, and wound dehiscence.

Complications were captured from clinic notes, emergency visits, and any reintervention records. Follow-up evaluations included symptom review, urinary stream assessment, and focused genital examination; adjunct investigations (e.g., uroflowmetry) were documented when performed.

Statistical analysis
Data were summarized using appropriate descriptive statistics (means/SD or medians/IQR for continuous variables; frequencies/percentages for categorical variables). Univariate logistic regression was first applied to evaluate associations between each prespecified variable (age at surgery, hypospadias type, BMI, operation time, width of urethral plate, length of reconstructed urethra, GMS score; and recorded postoperative constipation) and the composite complication outcome (fistula, stricture, or dehiscence). Variables with clinical relevance and/or a liberal screening threshold on univariate testing (e.g., $p < 0.20$) were entered into a multivariate logistic regression model to identify independent risk factors.

Model assumptions were checked, including multicollinearity (variance inflation factors) and linearity of the logit for continuous predictors; transformations or categorization were considered if assumptions were not met. Effect sizes were reported as odds ratios (OR) with 95% confidence intervals (CI), and statistical significance was set at $p < 0.05$ (two-tailed).

Goodness-of-fit and model discrimination were assessed using standard indices (e.g., Hosmer-Lemeshow, c-statistic) where applicable.

RESULTS

Basic Characteristics
The present study analyzed 90 pediatric patients who underwent primary hypospadias repair. Out of the total cohort, 15 children experienced postoperative complications, yielding an overall complication rate of 16.67%. With regard to the distribution of hypospadias types, distal variants were the most common, observed in 40 patients (44.44%). Mid-shaft hypospadias accounted for 30 cases (33.33%), while proximal penoscrotal hypospadias was present in 20 patients (22.22%). This distribution highlights the predominance of distal presentations but also underscores a substantial subset with proximal forms, which are generally considered surgically more challenging (Table 1).

Profile of Postoperative Complications
Among the 15 patients who developed complications, the most frequent adverse outcome was urethral fistula, observed in 8 cases (8.89% of the total cohort). Urethral stricture was documented in 4 children (4.44%), while wound dehiscence occurred in 3 cases (3.33%). These findings indicate that urethral fistula remains the predominant complication following hypospadias repair, consistent with patterns described in the literature. The combined incidence of complications remained below 20%, which falls within the lower range of rates reported internationally (Table 2).

Univariate Analysis of Clinical and Operative Factors
Univariate comparisons revealed several important associations. Hypospadias type was strongly related to outcome ($p=0.027$). Only 7.50% of distal cases developed complications, compared to 16.67% of mid-shaft and as high as 35.00% of proximal cases, demonstrating a clear gradient of risk with increasing severity. Operative time was another significant determinant: children whose procedures lasted longer than 120 minutes had a complication rate of 28.57%, compared with 9.09% in those operated within two hours ($p=0.021$).

Similarly, length of the reconstructed urethra correlated with outcome ($p=0.006$). The complication rate rose progressively from 3.33% when the neourethra was <2 cm to 40.00% when it exceeded 4 cm. Postoperative constipation

also emerged as a significant risk factor (p=0.025), with complications in 32.00% of affected patients compared to 10.77% in those without constipation. Conversely, several parameters did not demonstrate statistical significance. These included age at surgery (p=0.571), BMI (p=1.000), anesthesia method (p=1.000), surgeon identity (p=0.970), urethral plate width (p=1.000), and GMS score (p=0.571). Thus, patient age, general body habitus, and perioperative technical variables did not independently influence complication risk in this cohort (Table 3).

Logistic Regression Analysis

To further explore independent predictors, univariate logistic regression was applied. Proximal hypospadias conferred a more than fourfold higher risk of complications compared to distal and mid variants (OR 4.17, 95% CI 1.11-15.98, p=0.036). An operative duration exceeding 120 minutes was associated with a fourfold increase in risk (OR 4.00, 95% CI 1.27-12.61, p=0.021). Similarly, a reconstructed urethra length greater than 3 cm significantly raised complication likelihood (OR 3.09, 95% CI 1.04-9.18, p=0.042). Finally, postoperative constipation nearly quadrupled the odds of complications (OR 3.90, 95% CI 1.24–12.28, p=0.025). These findings emphasize that anatomical severity, surgical complexity, and postoperative bowel function are critical determinants of outcomes (Table 4).

Detailed Relationship of Hypospadias Type and Urethral Length with Outcomes

A closer look at hypospadias types confirmed the earlier findings: distal hypospadias carried the lowest complication rate at 7.50%, mid-shaft cases had an intermediate risk of 16.67%, while proximal penoscrotal cases demonstrated the highest rate of complications at 35.00%. A parallel trend was observed when outcomes were stratified by reconstructed urethral length. Only 3.33% of children with a neourethra shorter than 2 cm developed complications, whereas the rate increased to 10.00% for 2-3 cm, 20.00% for 3-4 cm, and peaked at 40.00% for reconstructions exceeding 4 cm. This stepwise escalation further supports the hypothesis that greater surgical complexity, as reflected by both anatomical severity and extent of reconstruction, directly contributes to poorer postoperative results (Table 5).

Table 1: Basic Parameters

Parameters	Number of Patients (N=90)
Any postoperative complication (composite)	15 (16.67)
Hypospadias type: Distal	40 (44.44)
Hypospadias type: Mid	30 (33.33)
Hypospadias type: Proximal (penoscrotal)	20 (22.22)
Data presented as n (%).	

Table 2. Complication Profile by Type (N = 90)

Complication type	Number of Patients (%)
Urethral fistula	8 (8.89)
Urethral stricture	4 (4.44)
Wound dehiscence	3 (3.33)
Any complication (composite)	15 (16.67)
Data presented as (n%)	

Table 3. Univariate Comparison of Factors by Complication Status

Variable	With complications	Without complications	p- value
Hypospadias type			
Distal	3 (7.50)	37 (92.50)	0.027
Mid	5 (16.67)	25 (83.33)	
Proximal	7 (35.00)	13 (65.00)	
Operation time >120 min			**0.021**
Yes	10 (28.57)	25 (71.43)	
No	5 (9.09)	50 (90.91)	
Reconstructed urethral length (cm)			
<2	1 (3.33)	29 (96.67)	**0.006**
2–3	2 (10.00)	18 (90.00)	
3–4	4 (20.00)	16 (80.00)	
>4	8 (40.00)	12 (60.00)	
Postoperative constipation			
Yes	8 (32.00)	17 (68.00)	**0.025**
No	7 (10.77)	58 (89.23)	
Age at surgery			
≤24 months	7 (14.00	43 (86.00)	0.571
>24 months	8 (20.00)	32 (80.00)	
BMI group (kg/m²)			

≤16	8 (17.78)	37 (82.22)	1.000
>16	7 (15.56)	38 (84.44)	
Anesthesia method			
GA only	8 (16.00)	42 (84.00)	1.000
GA+block	7 (17.50)	33 (82.50)	
Urethral plate width			
≤8 mm	8 (17.78)	37 (82.22)	1.000
>8 mm	7 (15.56)	38 (84.44)	
GMS score group			
≤6	7 (14.00)	43 (86.00)	0.571
>6	8 (20.00)	32 (80.00)	
P-values: Fisher's exact test for 2×2; chi-square for multi-category.			

Table 4. Univariate Logistic Regression

Predictor	OR	95% CI	p-value
Hypospadias type: proximal vs. others	4.17	1.11–15.98	0.036
Operation time >120 min (yes vs. no)	4.00	1.27–12.61	0.021
Reconstructed urethra >3 cm (yes vs. no)	3.09	1.04–9.18	0.042
Postoperative constipation yes (vs. no)	3.90	1.24–12.28	0.025

Table 5. Hypospadias Type and Urethral Length Categories vs Outcomes

Variable	With complications	Without complications
Hypospadias type		
Distal	3 (7.50)	37 (92.50)
Mid	5 (16.67)	25 (83.33)
Proximal	7 (35.00)	13 (65.00)
Reconstructed urethral length (cm)		
<2	1 (3.33)	29 (96.67)
2–3	2 (10.00)	18 (90.00)
3–4	4 (20.00)	16 (80.00)
>4	8 (40.00)	12 (60.00)
Data presented as n (%).		

DISCUSSION

Our overall complication rate of 16.67% (15/90) sits at the lower end of the range reported for primary hypospadias repairs and is consistent with evidence that outcomes are most favorable when the cohort contains a large share of distal cases (44.44% in our series). In a meta-analysis focused on the TIP technique, Pfistermuller et al. (2015) showed that complication rates are lowest for primary distal hypospadias and increase with more severe anatomy helping contextualize our composite figure within expected benchmarks for mixed- severity cohorts[8].

Severity clearly drove risk in our data: complications rose from 7.50% (distal) to 16.67% (mid- shaft) and 35.00% (proximal). A large multicenter study by Fang et al. (2022) reported higher absolute rates across the same strata 23.4% distal, 29.0% mid-shaft, 43.7% proximal yet the stepwise gradient mirrors ours, reinforcing an anatomy-dependent risk signal.

Differences in technique mix, surgeon volume, and follow-up windows likely explain our lower absolute percentages relative to their multi-institutional experience[9].

Focusing on proximal disease, our logistic model found proximal vs. other types associated with a 4.17-fold higher odds of complications (95% CI 1.11–15.98). This aligns with the meta-analysis by Cousin et al. (2022), who synthesized proximal hypospadias series and observed composite complication rates of 32%–49% across common techniques (Onlay, Duckett, Koyanagi, Bracka), underscoring the persistently higher risk profile of proximal repairs despite methodological advances[10].

Regarding complication types, urethral fistula predominated in our cohort (8.89% overall; 8/90), with stricture (4.44%) and wound dehiscence (3.33%) less frequent. This distribution is directionally consistent with broader literature in which fistula is the most common adverse event after hypospadias repair. For example, Chung et al. (2012) reported urethrocutaneous fistula in 21.4% (63/294) after repair and identified proximal location as the key independent determinant again mirroring our finding that anatomy drives risk[11].

Operative complexity also mattered. When surgery exceeded 120 minutes, complications rose to 28.57% versus 9.09% for shorter procedures (p=0.021). In a large single-center analysis, He et al. (2022) likewise found operative time to be a significant factor and identified postoperative constipation and length of reconstructed urethra (LRU) as independent predictors; notably, constipation carried an adjusted OR ≈ 1.79 (95% CI 1.07–3.01), supporting our observation that bowel management influences outcomes[12].

The extent of urethral reconstruction showed a dose–response in our data: complications rose from 3.33% when LRU was <2 cm to 40.00% when >4 cm, and LRU >3 cm independently increased odds (OR 3.09, 95% CI 1.04–9.18). This aligns with Ye et al. (2024), who identified 3.0 cm as an optimal cutoff predicting complications and reported that ~89% of complications present within the first postoperative year an observation that also justifies close early surveillance in longer reconstructions[13].

Unlike some reports, age at surgery was not associated with complications in our series (14.00% ≤24 months vs 20.00% >24 months; p=0.571). By contrast, Dale et al. (2023) found significantly higher early postoperative complications when repairs were performed after 2 years of age, suggesting that age may interact with case selection, center-specific pathways, or perioperative protocols; our null result may reflect differing age distributions, indications, or statistical power[14]. Finally, we observed no significant associations for BMI, anesthesia method, surgeon, urethral plate width, or GMS score. This partly contrasts with Merriman et al. (2013), who reported higher complications with GMS > 6 (25.0%) versus ≤ 6 (5.6%), implying that severity scoring can correlate with risk. The discrepancy may reflect our limited event count (15 events), potential inter- observer variability in GMS assignment, and the predominance of distal/mid-shaft cases, which can attenuate score-outcome correlations; nonetheless, our findings emphasize that anatomical level and reconstruction length were the dominant drivers in this cohort[15].

CONCLUSION

The present study demonstrates that key determinants such as hypospadias type, length of operative time, and the extent of urethral reconstruction have a significant impact on postoperative complication rates following primary repair. These observations highlight the necessity for comprehensive preoperative evaluation and the adoption of individualized surgical strategies to enhance functional outcomes and minimize the risk of adverse events.

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