



Ten years of experience in hypospadias management at a tertiary pediatric center in North Macedonia

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ABSTRACT

Aims: Hypospadias is one of the most common congenital anomalies of the male urogenital tract, yet regional outcome data from Southeastern Europe remain limited. This study aimed to evaluate epidemiological patterns, surgical management strategies, and postoperative outcomes over 10 years in North Macedonia.

Methods: A retrospective cohort study was conducted in North Macedonia including patients managed for hypospadias and related postoperative sequelae between January 2011 and December 2020. Demographic, clinical, operative, and outcome data were extracted from institutional records. Primary hypospadias cases were analyzed by anatomical subtype, while surgically treated patients were evaluated for surgical techniques and postoperative complications.

Results: A total of 647 patient records were identified, including 507 patients with primary hypospadias, of whom 469 were surgically treated. Mean age at treatment was 4.9 ± 3.6 years, and mean hospitalization duration was 7.1 ± 3.4 days. Anterior hypospadias was the most common subtype (78.5%), followed by glandular hypospadias (10.3%). Tubularized incised plate (TIP) urethroplasty was the predominant reconstructive technique (73.6%). Proximal variants were associated with longer hospitalization. Urethrocutaneous fistula (7.9%) and urethral stenosis (2.6%) were the most frequent postoperative complications. Most patients were from major urban municipalities.

Conclusions: In this 10-year cohort, hypospadias management included the predominant use of TIP urethroplasty, a substantial proportion of cases requiring reoperation, and longer hospitalization for proximal defects. Most patients originated from major urban municipalities.

Introduction

Hypospadias is among the most common congenital anomalies of the male urogenital tract and is characterized by ectopic ventral placement of the urethral meatus, frequently accompanied by ventral curvature and preputial malformation (1-3). Reported incidence varies across geographic regions, likely reflecting differences in genetic background, environmental exposures, endocrine influences, and case ascertainment practices (2-4). Embryologically, the condition results from

incomplete fusion of the urethral folds during fetal development, mediated in part by androgen-dependent signaling pathways (3).

Clinical severity is primarily determined by meatal location, with distal forms generally more common and proximal variants associated with greater reconstructive complexity, higher complication risk, and increased likelihood of staged repair (1,4,5). Over recent decades, multiple operative strategies have been developed, including tubularized incised plate (TIP/ Snodgrass) urethroplasty, Mathieu repair, meatal advancement

and glanuloplasty incorporated (MAGPI), flap-based procedures, and staged reconstructions for severe cases (5-8). Among these, TIP urethroplasty has become the dominant approach for distal and selected midshaft defects because of its reproducibility and favorable functional outcomes (2,7-10).

Despite technical advances, postoperative morbidity remains clinically relevant. Urethrocutaneous fistula, meatal or urethral stenosis, cosmetic dissatisfaction, and need for reoperation continue to be reported, particularly in proximal and reoperative cases (9-16). In addition, disparities in referral pathways, access to subspecialized care, and heterogeneity in outcome reporting may substantially influence treatment timing and measured results (11,14,17-20).

Although the global literature on hypospadias repair is extensive, contemporary data from Southeastern Europe remain limited. Regional institutional analyses may clarify referral patterns, operative practices, complication burden, and health-system factors influencing care delivery. This study presents a 10-year experience at a tertiary pediatric surgical center, focusing on epidemiology, surgical management, and postoperative outcomes (19,21-24).

Methods

Study Design and Setting

This retrospective cohort study was conducted in North Macedonia at a tertiary referral center for congenital urogenital anomalies. The study evaluated pediatric and adolescent male patients who were managed for hypospadias and related urogenital conditions between January 2011 and December 2020.

Study Population

Eligible patients were identified through institutional electronic medical records and operative databases. The study population comprised patients aged 0-23 years who underwent evaluation and received surgical or conservative management for primary hypospadias, postoperative complications after prior repair, or associated urogenital anomalies requiring institutional care. Older adolescents and young adults represented delayed referrals or secondary or reoperative presentations of congenital hypospadias that were initially diagnosed in childhood.

Patients with incomplete medical documentation precluding extraction of essential study variables, with uncertain diagnoses, or who received treatment performed exclusively outside the study center without adequate follow-up records were excluded. The final analytic cohort consisted of 647 eligible records.

Data Collection

Clinical and operative data were extracted using a standardized data collection framework. Variables included: age at admission, geographic origin, anatomical subtype, number

and type of procedures, length of hospital stay, associated comorbidities, and documented postoperative complications or reinterventions.

Classification of Hypospadias

Hypospadias was classified by urethral meatal location as anterior (distal), middle (penile shaft) or proximal. Classification was based on available diagnostic and operative records.

Surgical Management

Operative procedures were categorized according to the documented reconstructive techniques, including TIP (Snodgrass) urethroplasty, Modified Byars flap reconstruction, Mathieu urethroplasty, Perović repair, MAGPI, Hodgson repair, and other reconstructive approaches. Surgical complexity was defined as the requirement for two or more procedures, including staged repairs or secondary interventions. Correction of chordee, when present, was performed intraoperatively according to standard surgical principles and the surgeon's preference.

Outcomes and Definitions

Patients were stratified into predefined age categories (0-2, 3-5, 6-10, and ≥ 11 years), representing early referral, the recommended age window for primary repair, later childhood, and delayed presentation. Primary outcomes were the distribution of anatomical subtypes, the utilization of operative techniques, hospitalization burden, and postoperative complications and reinterventions. Postoperative complications and reinterventions were defined as documented urethrocutaneous fistula; urethral stenosis; urinary retention; wound-related complications (e.g., hematoma); cosmetic abnormalities (e.g., buried penis); or any postoperative presentation requiring further evaluation, follow-up, or secondary surgical intervention. Secondary outcomes included the municipality of origin and associated anomalies.

Follow-up information was obtained from the institutional archive's available inpatient records, outpatient documentation, and reintervention records. Because follow-up was retrospective and non-standardized, both the duration and the completeness varied among patients. Therefore, the reported complication rates reflect documented institutional outcomes rather than standardized long-term follow-up data. Given the retrospective design, long-term standardized functional, cosmetic, urinary, and psychosocial outcomes were not uniformly available. Outcome assessment was therefore limited to postoperative complications and reinterventions recorded in institutional documentation.

Ethical Considerations

Ethical approval for this retrospective review of archived medical records from the 2011-2020 study period was

obtained from the local Human Research Ethics Committee of the “St. Cyril and Methodius” University in Skopje Faculty of Medicine (approval no: 03-5522/1, date: 23.09.2025) before data extraction and formal statistical analysis. Because of the retrospective design, the use of previously recorded data, and the anonymization of all patient information, the ethics committee waived the requirement for individual informed consent. No patient contact or intervention occurred. The study was conducted in accordance with the Declaration of Helsinki and applicable Good Clinical Practice principles.

Statistical Analysis

Continuous variables are presented as mean $\pm$ standard deviation, whereas categorical variables are expressed as frequencies and percentages. Group comparisons for continuous variables were performed using one-way analysis of variance, while categorical associations were assessed using the chi-square test or Fisher's exact test, as appropriate. Additionally, multivariable logistic regression analysis was performed to explore independent predictors of postoperative complications and reinterventions in the cohort. Variables included in the multivariable model were selected based on clinical relevance and were supported by preliminary univariate analyses. One patient was excluded from multivariable regression analysis due to missing covariate data. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A two-sided p-value <0.05 was considered statistically significant.

Statistical analyses were performed using RStudio (RStudio Team, Boston, MA, USA), running R version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Cohort Characteristics

A total of 647 patient records related to hypospadias and its postoperative sequelae were identified during the 2011-2020 study period (Figure 1). Of these, 507 patients with primary hypospadias were eligible for anatomical subtype analysis, whereas 469 surgically managed patients were included in analyses of operative technique and postoperative outcomes. The mean age at treatment in the overall cohort was 4.9 ± 3.6 years, and the mean hospitalization duration was 7.1 ± 3.4 days. Most corrective procedures were performed during early childhood, with progressively fewer interventions observed in adolescence and young adulthood. Patients were more frequently referred to by major urban municipalities, particularly Skopje and other larger regional centers.

Anatomical Subtype Distribution

Among patients with primary hypospadias, anterior hypospadias was the predominant anatomical subtype, accounting for nearly four-fifths of classified presentations. Glandular hypospadias was the second most frequent subtype, whereas proximal variants such as penoscrotal and scrotal hypospadias were comparatively uncommon. The length of

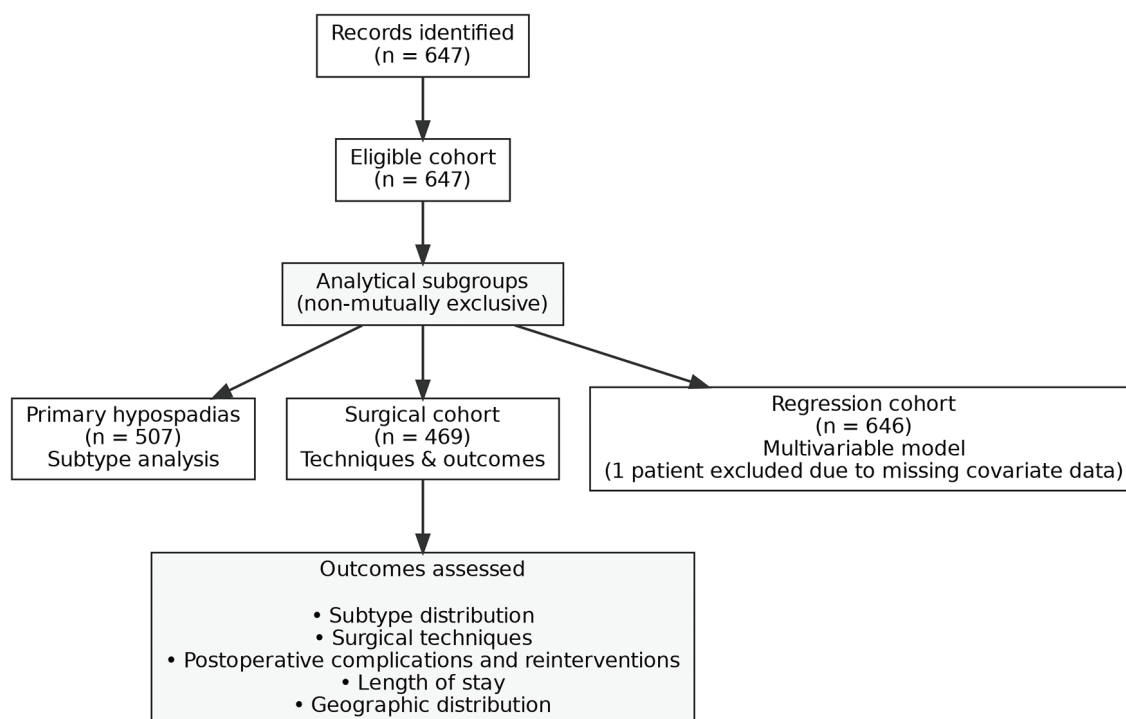


Figure 1. STROBE flow diagram illustrating patient selection, cohort stratification, and analytical subgroups included in the study
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

hospitalization differed significantly by anatomical subtype: more proximal and surgically complex forms were associated with longer inpatient stays, whereas age at treatment did not differ significantly between groups (Table 1).

Surgical Burden and Operative Techniques

Most patients (83.9%) underwent a single operative intervention; 15.0% required two procedures, and only a small minority underwent three or more procedures. Neither patient age nor hospitalization duration differed significantly according to procedural burden (Table 2).

TIP urethroplasty was the predominant reconstructive method and accounted for nearly three-quarters of definitive repairs. Modified Byars-flap reconstruction was the second most frequently used technique, whereas the Mathieu, Perović, MAGPI, and Hodgson procedures were applied selectively based on anatomical complexity and surgeon preference (Table 3).

Postoperative Outcomes

Reoperative presentation following repair was documented in 29.9% of surgically managed patients. Among specific postoperative complications, urethrocuteaneous fistula was the most frequent (7.9%), followed by urethral stenosis (2.6%). Less common complications included urinary retention, hematoma, and cosmetic abnormalities such as buried penis. A substantial proportion of patients (59.3%) had no documented postoperative complications (Table 4).

Table 1. Anatomical subtype distribution and patient characteristics among primary hypospadias cases (n=507)

Anatomical subtype	n	%	Age (years)	LOS (days)
Anterior hypospadias	398	78.5	4.6±3.4	7.4±3.1
Glandular hypospadias	52	10.3	4.9±3.3	6.7±2.9
Penoscrotal hypospadias	24	4.7	5.0±3.6	8.5±4.4
Midshaft (corporalis/penile) hypospadias	20	3.9	4.5±3.2	9.0±3.9
Scrotal hypospadias	13	2.6	4.4±3.0	8.3±3.2
Total	507	100	4.7±3.4	7.5±3.2
Overall comparison (ANOVA): Age p=0.842; LOS: p=0.031 LOS: Length of hospital stay				

Table 2. Surgical burden and hospitalization according to number of procedures in the total cohort (n=647)

Number of procedures	n	%	Age (years)	LOS (days)
1 procedure	543	83.9	5.0±3.8	7.1±3.3
2 procedures	97	15.0	4.6±3.0	7.1±4.0
≥3 procedures	7	1.1	7.1±3.4	7.7±5.7
Total	647	100	4.9±3.6	7.1±3.4
Overall comparison (ANOVA): Age p=0.181; LOS: p=0.900 LOS: Length of hospital stay				

Predictors of Postoperative Complications and Reinterventions

Multivariable logistic regression analysis demonstrated that increasing age was independently associated with higher odds of postoperative complications and reinterventions (adjusted OR: 1.10, 95% CI: 1.04-1.15; p<0.001). In contrast, the use of TIP urethroplasty was independently associated with lower odds of adverse outcomes (adjusted OR: 0.22, 95% CI: 0.13-0.38; p<0.001). Proximal hypospadias showed borderline statistical significance as a predictor of adverse presentations, whereas multiple procedures were not independently associated with adverse presentations (Table 5).

Discussion

This 10-year institutional cohort provides a contemporary overview of hypospadias management at a tertiary referral center and yields four principal observations: interventions occurred later than internationally recommended age windows; TIP urethroplasty was the dominant reconstructive strategy; proximal and reoperative cases were associated with greater treatment burden; and urban clustering most likely reflected referral centralization and proximity to tertiary care services.

The mean age at treatment in our cohort was approximately 5 years, substantially exceeding the commonly recommended repair window of 6 to 18 months (2,3). Early correction is generally

Table 3. Reconstructive techniques used for hypospadias repair among surgically managed patients (n=469)

Surgical technique	n	%
Tubularized incised plate (TIP/Snodgrass) urethroplasty	345	73.6
Modified Byars flap	80	17.1
Mathieu urethroplasty	18	3.8
Perović technique	18	3.8
MAGPI	6	1.3
Hodgson urethroplasty	2	0.4
Total	469	100
TIP: Tubularized incised plate, MAGPI: Mathieu repair, meatal advancement and glanuloplasty incorporated		

Table 4. Detailed postoperative complications and reinterventions among surgically managed patients (n=469)

Variable	n	%
Reoperative/follow-up after prior repair	140	29.9
Urethrocuteaneous fistula	37	7.9
Urethral stenosis	12	2.6
Urinary retention	1	0.2
Hematoma/wound-related complication	1	0.2
Buried penis/cosmetic complication	1	0.2
No documented complication	278	59.3

Table 5. Multivariable logistic regression analysis for predictors of postoperative adverse presentations in the cohort (n=646)

Variable	Adjusted OR	95% CI	p-value
Age (per 1-year increase)	1.10	1.04-1.15	<0.001
Proximal hypospadias	0.24	0.06-1.07	0.061
TIP urethroplasty	0.22	0.13-0.38	<0.001
Multiple procedures	1.04	0.63-1.72	0.887
Model likelihood ratio p<0.001			
TIP: Tubularized incised plate, CI: Confidence interval, OR: Odds ratio			

avored because it may reduce treatment-related psychological stress, facilitate perioperative care, and allow reconstruction before increasing genital awareness in later childhood (2,3). The delayed timing observed in our series likely reflects broader health-system factors rather than isolated surgical preference. Possible contributors include delayed recognition in primary care, late referral pathways, waiting-list constraints, socioeconomic barriers, and unequal availability of pediatric urologic expertise outside metropolitan centers (11,17,19,24). Similar delays have been reported in lower-resource settings where centralized expertise influences access and timing of intervention (11,17). Delayed presentation may also increase reconstructive complexity and intensify psychosocial stress for patients and families.

TIP urethroplasty was the most frequently utilized reconstructive technique, accounting for nearly three-quarters of definitive repairs. This pattern is consistent with contemporary international practice, where TIP remains a preferred technique for distal and selected midshaft hypospadias because of its technical reproducibility, broad applicability, and favorable cosmetic and functional outcomes (5,7-10). Meta-analytic evidence has shown acceptable complication rates in non-proximal repairs, although outcomes remain influenced by tissue quality, surgeon experience, case selection, and duration of follow-up (9,20). More recent series continue to support the central role of TIP while confirming that fistula formation and urethral stenosis remain clinically relevant postoperative concerns (12,15,22). The operative distribution observed in our cohort reflects the predominant use of TIP urethroplasty, with selective use of flap-based and alternative techniques according to anatomical severity and reconstructive requirements.

Anterior hypospadias was the predominant anatomical subtype, whereas proximal variants were less frequent. This distribution is consistent with established epidemiologic data demonstrating predominance of distal forms worldwide (1-4). The high frequency of anterior lesions has practical implications, as distal defects are generally amenable to single-stage reconstruction with favorable outcomes, whereas proximal forms more often require individualized or staged strategies.

Hospitalization duration was significantly longer for proximal forms; this clinically coherent finding likely reflects greater operative complexity, increased use of flaps or staged

reconstruction, and more intensive postoperative monitoring. Previous multicenter studies similarly identify proximal meatal location as a major determinant of complication risk and need for secondary intervention (15,16). Penoscrotal and scrotal defects are frequently associated with marked chordee, deficient ventral tissues, or hypoplastic urethral plates, each of which may complicate one-stage repair and prolong recovery (4,15). In addition, the relatively prolonged hospital stay in our cohort may reflect institutional postoperative protocols (including catheter management strategies and inpatient monitoring practices) and potential socioeconomic factors influencing discharge timing. These findings reinforce the importance of early referral of complex cases to experienced reconstructive centers.

The postoperative burden in our study was substantial. Nearly one-third of surgically managed patients were reoperative or follow-up cases, while urethrocuteaneous fistula and urethral stenosis were the leading complications. The broader categorization of postoperative complications in our study highlights the spectrum of major and minor adverse events and reinforces the importance of comprehensive reporting beyond fistula and stenosis. These remain the most consistently reported adverse outcomes after hypospadias repair across contemporary literature (9,13,16,22). Although such complications may not always prolong the index hospitalization, they frequently necessitate repeated monitoring, secondary surgery, re-exposure to anesthesia, and additional burden on families. Their clinical significance, therefore, extends beyond immediate inpatient metrics.

Multivariable analysis demonstrated that increasing age was independently associated with adverse postoperative outcomes, whereas TIP urethroplasty was associated with lower odds of such outcomes. Although these findings should be interpreted cautiously given the retrospective observational nature of the data, they support the potential importance of timely referral and standardized selection of techniques for appropriately selected patients.

A higher proportion of cases originated in Skopje and other larger municipalities, which may reflect the centralization of referrals. Similar patterns are observed in healthcare systems where specialized pediatric reconstructive services are concentrated within tertiary institutions (19,24). Although centralization may improve technical expertise and outcomes,

it may also create travel burdens, delayed presentations, and unequal access for families from remote areas. Structured referral pathways and broader regional access to specialist assessment may help reduce these disparities.

Recent advances may further improve outcomes in pediatric hypospadias surgery. Enhanced perioperative pathways, including ultrasound-guided penile or caudal regional anesthesia, have demonstrated benefits in postoperative analgesia and recovery quality (21). Technical refinements in tissue handling, multilayer coverage, and suture selection may also influence fistula prevention (20). In parallel, emerging artificial intelligence-based tools may eventually assist with preoperative assessment, risk prediction, and standardized outcome evaluation, although these applications remain investigational at present (23).

Study Limitations

Several limitations should be acknowledged. The retrospective single-center design limits causal inference and generalizability. Standardized long-term follow-up data regarding urinary function, cosmetic appearance, sexual development, patient satisfaction, and psychosocial outcomes were not consistently available across the full cohort, precluding comprehensive assessment using validated instruments such as Hypospadias Objective Scoring Evaluation and Hypospadias Objective Penile Evaluation. The lack of a standardized follow-up duration may have contributed to underestimating late postoperative complications. Consequently, the present findings primarily reflect documented surgical and early clinical outcomes rather than long-term patient-centered results. Inclusion of a broad age range reflects the real-world referral pattern of delayed primary presentations and reoperative cases in adolescents or young adults encountered at a tertiary center. In addition, minor complications managed in outpatient settings, delayed presentations treated elsewhere, or events incompletely documented in historical records may have underestimated the true postoperative complication burden. The broader categorization of postoperative complications in our study highlights the spectrum of both major and minor adverse events, reinforcing the importance of comprehensive reporting beyond fistula and stenosis alone. Evolving surgical preferences over the 10-year study period may also have influenced technique selection and outcomes.

Despite these limitations, this study represents one of the larger contemporary regional series from Southeastern Europe and, to the best of our knowledge, the first dedicated cohort analysis of hypospadias management from North Macedonia. It provides clinically relevant insight into treatment timing, operative practice, and postoperative burden. From a clinical perspective, these findings highlight the need for earlier diagnosis, timely referral to specialized centers, and structured postoperative surveillance to minimize complications and improve long-term

outcomes. These findings underscore the importance of early referrals, centralized surgical expertise, structured long-term follow-up, and standardized reporting to optimize outcomes in hypospadias management.

Conclusion

In this 10-year cohort study, hypospadias management in North Macedonia was characterized by delayed interventions, predominant use of TIP urethroplasty, and a substantial reoperative burden. Proximal defects were associated with longer hospitalizations and greater treatment complexity, while most patients originated from major urban municipalities.

Ethics

Ethics Committee Approval: Ethical approval for this retrospective review of Human Research Ethics Committee of the “St. Cyril and Methodius” University in Skopje Faculty of Medicine (approval no: 03-5522/1, date: 23.09.2025) prior to data extraction and formal statistical analysis.

Informed Consent: Because the study was designed retrospectively no written informed consent form was obtained from the patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: S.M., H.S., M.K., Concept: S.M., H.S., Design: S.M., H.S., Data Collection or Processing: S.M., H.S., M.K., Analysis or Interpretation: S.M., H.S., M.K., Literature Search: S.M., H.S., M.K., Writing: S.M., H.S., M.K.

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