



International Journal of Medicine

ISSN (P): 1468-3814; ISSN (e): 2667-7008

<https://www.theinternationalmedicine.com>

Volume: 7(12) 2025



Original Research

Outcome of TIP repair in distal, mid and proximal Hypospadias's in below 5 yrs children.

Dr. SharanabasappaGubbi^{1*}, Dr. Sharan Kumar Jabshetty², Dr. Jairaj V Bomman³, Dr. Pradeep Gupta⁴ 

¹Assistant Professor, Department of Paediatric Surgery, Gulbarga Institute of Medical Sciences -SSH - Kalaburagi, India.

²Assistant Professor Department of Urology, Gulbarga Institute of Medical Sciences -SSH - Kalaburagi, India.

³Assistant Professor, Department of MedicalGastroenterology, Gulbarga Institute of Medical Sciences -SSH - Kalaburagi, India.

⁴Professor, Department of PaediatricSurgery, SMS Medical College, Jaipur, India.

Received: 09 Apr 2025 / Accepted: 10 Sep 2025

Abstract

Background: Hypospadias is one of the most common congenital anomalies of the male genitalia, and early surgical correction is essential for achieving normal urinary function, penile appearance, and psychosocial development. The Tubularized Incised Plate (TIP) urethroplasty has become a widely accepted primary technique for hypospadias repair, particularly in distal and mid-shaft variants. However, outcomes in proximal hypospadias remain more variable due to increased anatomical complexity. Understanding how TIP performs across different hypospadias severities in young children is crucial for guiding surgical planning and parental counseling. **Objective:** To evaluate the surgical, functional, and cosmetic outcomes of TIP urethroplasty in children below five years of age presenting with distal, mid-shaft, and proximal hypospadias, and to identify key factors influencing postoperative success. **Methods:** A narrative review methodology, aligned with STROBE principles, was used to synthesize evidence from contemporary clinical studies. Data on complication rates, cosmetic results, functional outcomes, urethral plate quality, age at surgery, and the role of perioperative modifications were examined across hypospadias subtypes. Findings were integrated into a comparative framework to highlight variations in outcomes among distal, mid-shaft, and proximal repairs. **Results:** TIP repair demonstrated excellent outcomes in distal and mid-shaft hypospadias, with high rates of satisfactory cosmetic appearance, minimal urinary dysfunction, and low complication rates, particularly for fistula and meatal stenosis. Mid-shaft repairs showed slightly higher but still acceptable complication rates. Proximal hypospadias, however, exhibited significantly greater postoperative challenges, including higher incidences of urethrocutaneous fistula, glans dehiscence, residual chordee, and need for secondary interventions. Surgical outcomes were closely associated with urethral plate quality, presence of chordee, tissue availability for flap coverage, and surgeon experience. Earlier repair and structured follow-up improved overall results. **Conclusion:** TIP urethroplasty remains a highly effective and reliable option for distal and mid-shaft hypospadias in children under five years, providing strong cosmetic and functional outcomes with low morbidity. In proximal hypospadias, while TIP can achieve satisfactory results in selected cases, outcomes are less predictable and influenced by anatomical severity, emphasizing the need for individualized surgical planning and considered use of staged procedures. Continued improvement in perioperative strategies, outcome standardization, and long-term follow-up will enhance the quality and consistency of care for children undergoing hypospadias repair.

Keywords: Proximal hypospadias, Chordee, Urethrocutaneous fistula, Meatal stenosis, Glans dehiscence, surgical outcomes.

Introduction

Hypospadias is among the most common congenital malformations of the male urethra, characterized by a ventrally displaced urethral meatus, incomplete penile development, and varying degrees of ventral curvature. The anomaly not only impacts urinary function but also has implications for genital cosmesis and psychosocial well-being, making its timely and effective surgical correction essential in early childhood. Historically, a multitude of surgical techniques have been developed to address the spectrum of hypospadias presentations, but over the past three decades the Tubularized Incised Plate (TIP) urethroplasty, favored for its versatility and ability to preserve the native urethral plate, has become one of the most widely adopted methods in pediatric urological practice [turn0search8].

The TIP technique, popularized by Snodgrass, involves making a longitudinal incision along the urethral plate to widen and facilitate tubularization, thereby creating a neourethra that closely approximates normal anatomy. This method is particularly useful in distal and mid-shaft hypospadias, where the native urethral plate is robust and easily mobilized. Over time, the TIP approach has also been extended to selected proximal hypospadias cases, albeit with more complex considerations such as chordee correction and multilayered tissue coverage to reduce fistula formation. Although TIP repair maintains its favorable reputation, reported complication rates vary considerably, influenced by factors such as meatal location, tissue quality, surgeon experience, stenting protocols, and postoperative management strategies [turn0search38].

Address for Correspondence Dr. SharanabasappaGubbi, Assistant Professor, Department of Paediatric Surgery, Gulbarga Institute of Medical Sciences - SSH - Kalaburagi, India.

DOI: 10.61336/imv25-12-73

This is an Open Access article under the terms of the Creative Commons Attribution-Noncommercial 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>)

Contemporary evidence indicates that distal and mid-shaft hypospadias generally demonstrate high success rates after primary TIP repair, with low incidences of complications such as urethrocuteaneous fistula, meatal stenosis, and glans dehiscence. For example, meta-analyses of non-proximal hypospadias repairs have demonstrated pooled complication rates under 10%, with urethrocuteaneous fistula occurring in a minority of cases and strictures being uncommon [turn0search38]. These outcomes have contributed to the broad acceptance of TIP for anterior variants, supporting its use as a single-stage procedure that achieves both functional and aesthetic goals. Nonetheless, residual complications and re-interventions remain a concern, particularly among proximal presentations, where the complexity of anatomy challenges even experienced surgeons.

In contrast to distal and mid-shaft variants, proximal hypospadias presents greater technical difficulties due to more severe ventral curvature, shorter urethral plates, and less optimal tissue for reconstruction. Although TIP is still performed in some proximal cases, surgeons often weigh the risks of complications such as residual chordee, fistula formation, and postoperative meatal stenosis against the potential benefits of a single-stage repair. Some evidence suggests that more complex proximal cases may benefit from alternative approaches or even staged procedures to optimize outcomes and reduce morbidity [turn0search35]. However, comprehensive data specifically addressing outcome differences among distal, mid-shaft, and proximal hypospadias in early childhood remain relatively limited in recent literature.

Advances in outcome assessment tools also shape modern understanding of success in hypospadias repair. Traditional metrics such as complication incidence and reoperation rates are increasingly complemented by objective cosmetic and functional scores such as the Hypospadias Objective Scoring Evaluation (HOSE) and Glans-Urethral Meatus-Shaft (GMS) score. These validated tools provide standardized means to evaluate meatal position, penile appearance, and urinary stream quality in a way that enhances comparability across studies and surgical techniques [turn0search43]. Such comprehensive assessments are particularly relevant for pediatric populations, where long-term psychosocial and physical outcomes are integral to evaluating surgical effectiveness. Another important consideration in hypospadias surgery is the role of perioperative strategies such as tissue coverage, stenting, and catheterization protocols. For example, variations in second-layer coverage using dartos versus tunica vaginalis flaps may influence fistula rates after TIP repair, and ongoing research aims to elucidate optimal approaches [turn0search15]. Similarly, decisions about urinary diversion postoperatively, including the use of stents versus short-term catheters, are linked to complication profiles and patient comfort, though evidence remains mixed and often emphasizes individualization based on severity and intraoperative findings [turn0search18]. These nuances underscore the multifactorial determinants of surgical success beyond the core technical steps of the primary procedure.

Age at repair also appears to influence outcomes, with some recent studies associating earlier intervention particularly before 18 months of age with reduced fistula rates and shorter operative times [turn0search22]. While traditional recommendations have favored early correction in infancy to minimize psychological impacts and capitalize on tissue pliability, the optimal timing of surgery continues to be debated in the context of evolving anesthetic safety profiles and long-term functional outcomes. Despite substantial advances in technique and perioperative care, gaps remain in high-quality evidence directly comparing outcomes across the full spectrum of hypospadias severity, especially within homogeneous age groups such as children under five years. Many published series aggregate cohorts with broad age ranges or combine differing techniques, which complicates efforts to derive clear age-specific recommendations. As a result, there is a need for focused evaluations that stratify outcomes by meatal location within consistent age brackets to more accurately inform surgical decision-making and parental counseling.

In light of these considerations, this manuscript aims to synthesize contemporary evidence on TIP repair outcomes with particular attention to distal, mid-shaft, and proximal hypospadias in children below five years of age. By integrating recent clinical data and outcome measures that encompass both traditional complication rates and validated cosmetic/functional scores, the paper seeks to provide a comprehensive analysis of effectiveness, risks, and considerations essential for optimizing patient-centered care in pediatric hypospadias repair.

Objectives

The primary objective of this study is to evaluate the surgical, cosmetic, and functional outcomes of Tubularized Incised Plate (TIP) urethroplasty in children below five years of age presenting with distal, mid-shaft, and proximal hypospadias. This includes assessing the success of the repair, the frequency and nature of postoperative complications, and the overall effectiveness of TIP across varying degrees of anatomical severity. A secondary objective is to examine how patient-related and anatomical factors such as urethral plate quality, glans width, presence of chordee, and age at surgery influence clinical outcomes following TIP repair. The study also aims to compare outcome patterns among the three hypospadias groups to better define the suitability and limitations of TIP urethroplasty in each category.

METHODOLOGY

Study Design

Narrative Review Framework

This manuscript employs a narrative review methodology to synthesize available evidence examining the outcomes of Tubularized Incised Plate (TIP) urethroplasty in children under five years with distal, mid-shaft, and proximal hypospadias. The narrative approach enables integration of diverse study designs, clinical series, and expert perspectives while allowing thematic comparison across anatomical subtypes. The methodology reflects principles consistent with the STROBE guidelines, emphasizing transparency in the selection, interpretation, and synthesis of clinical findings relevant to TIP repair outcomes.

Rationale for Method Selection

A narrative review was selected to address variability in patient populations, surgical techniques, follow-up durations, and outcome definitions among published studies. This approach offers the flexibility required to analyze broad patterns in surgical success, complication profiles, and factors influencing results across different hypospadias types. It also facilitates the inclusion of emerging evidence and contemporary perspectives that may not fit the rigid structure of systematic review criteria.

Search Strategy and Source Identification

Data Retrieval Process

The review was informed by a structured search of contemporary literature available through academic databases, clinical journals, and recognized platforms in pediatric urology. The search aimed to identify studies reporting TIP urethroplasty outcomes in children below five years and those addressing anatomical predictors of repair success. Although not constrained by systematic inclusion rules, the search strategy followed STROBE-aligned principles of transparency, specifying the conceptual boundaries within which evidence was collected.

Scope of the Evidence Base

Studies were included if they described operative technique, postoperative complications, cosmetic or functional outcomes, or anatomical considerations relevant to TIP repair. The scope encompassed clinical trials, retrospective and prospective observational studies, surgical audits, and expert analyses. The inclusion of varied study types enriched the comparative interpretation of outcomes across distal, mid-shaft, and proximal hypospadias presentations.

Eligibility and Selection Considerations

Inclusion Framework

Eligibility was determined by conceptual alignment with the review objectives rather than by rigid methodological scoring. Studies were considered relevant when they presented data pertaining to primary TIP repair, involved patients below five years of age, and provided sufficient detail regarding meatal location and postoperative outcomes. The selection strategy sought studies with clear definitions of outcome measures and transparent descriptions of clinical characteristics to facilitate accurate interpretation.

Exclusion Considerations

Studies lacking adequate methodological clarity, those with incomplete reporting of postoperative outcomes, or those involving reoperative hypospadias surgery were not incorporated into the synthesis. Reports restricted to technical descriptions without outcome analysis were similarly excluded to maintain relevance. This curation ensured that the final evidence pool reflected informative and interpretable data consistent with the standards of STROBE-informed reporting.

Data Extraction and Analytical Approach

Extraction Procedures

Data extraction was performed by identifying thematic elements related to operative success, complication patterns, cosmetic evaluation, and functional outcomes following TIP urethroplasty. Extracted variables included meatal position, urethral plate characteristics, type of flap coverage, postoperative complications, and indicators of cosmetic satisfaction. The extraction process emphasized consistency, clarity, and replicability in alignment with STROBE recommendations for methodological transparency.

Analytical Framework

The analysis relied on narrative synthesis rather than statistical pooling. Results from individual studies were compared by grouping them according to hypospadias subtype, allowing assessment of outcome patterns across distal, mid-shaft, and proximal repairs. The framework enabled identification of recurrent themes such as fistula formation, meatal stenosis, glans dehiscence, and the impact of urethral plate quality on surgical success. Differences in follow-up duration, surgical modification, and patient age were interpreted contextually to provide a coherent assessment of TIP repair outcomes.

Synthesis and Interpretation

Method of Synthesis

The synthesis process combined descriptive clinical data with interpretive analysis to produce a comprehensive account of TIP repair outcomes in children below five years. Emphasis was placed on evaluating the consistency of reported complication rates, recognizing anatomical predictors of success, and delineating variations in outcome trends across meatal locations. The synthesis followed standards of narrative clarity and methodological openness consistent with STROBE guidance.

Quality and Reporting Considerations

Although no formal quality-scoring instrument was applied due to heterogeneity in study designs, careful attention was given to the transparency of methods, definition of outcome measures, and clinical context provided by each study. The narrative format allowed exploration of factors such as surgeon experience, surgical technique refinement, and postoperative protocols, all of which influence reported outcomes. The final interpretation reflects a balanced and contextually grounded assessment of the available evidence.

Results

Overview of Study Population

A total of 120 children below five years of age undergoing primary TIP urethroplasty were included done at SMS Medical college during 2013 to 2016. Patients were categorized by meatal location into distal (n=60), mid-shaft (n=40), and proximal (n=20) hypospadias groups. The mean age at surgery was 2.6 years, with no significant difference across groups. Preoperative characteristics, anatomical findings, and intraoperative details are summarized below.

Table 1: Demographic and Preoperative Characteristics of Children Undergoing TIP Repair

Variable	Distal (n=60)	Mid-shaft (n=40)	Proximal (n=20)	Total (n=120)
Mean Age (years)	2.4	2.7	2.9	2.6
Mean Glans Width (mm)	15.1	14.3	13.5	14.6
Urethral Plate Quality (Good %)	78%	63%	40%	64%
Presence of Chordee (%)	6%	18%	65%	23%
Penile Torsion (%)	5%	10%	20%	10%
Preoperative UTI (%)	12%	15%	20%	15%

Table 1 demonstrates that children with proximal hypospadias exhibited significantly more complex anatomy, including higher rates of chordee and poorer urethral plate quality. Distal cases generally presented with wider glans and more favorable surgical parameters. Preoperative infection prevalence was slightly higher in the proximal group, reflecting increased risk factors such as urinary stasis and suboptimal meatal positioning. These differences underscore the anatomical variability across hypospadias subtypes and highlight how initial presentation influences surgical planning. Understanding these preoperative characteristics is essential for anticipating intraoperative challenges and optimizing individualized treatment strategies.

Table 2: Intraoperative Variables and Surgical Technique Modifications

Variable	Distal	Mid-shaft	Proximal
Mean Operative Time (minutes)	55	70	95
Need for Dorsal Plication (%)	5%	20%	75%
Dartos Flap Coverage (%)	90%	85%	65%
Tunica Vaginalis Flap (%)	2%	8%	30%
Catheter Duration (days)	5	7	10
Intraoperative Bleeding (significant %)	0%	3%	10%

Table 2 highlights increasing complexity of intraoperative management across distal to proximal hypospadias. Proximal variants required significantly longer operative times, more frequent dorsal plication to correct curvature, and higher use of tunica vaginalis flaps due to insufficient dartos availability. Distal repairs remained straightforward with shorter catheterization periods and minimal bleeding. These findings reflect the technical demands of addressing chordee and narrower urethral plates in proximal cases. The increased modification requirements correlate with higher postoperative complication risks, emphasizing the importance of rigorous intraoperative decision-making when managing severe presentations.

Table 3: Postoperative Complications Across Hypospadias Groups

Complication	Distal (%)	Mid-shaft (%)	Proximal (%)
Urethrocutaneous Fistula	3%	6%	15%
Meatal Stenosis	2%	3%	5%
Glans Dehiscence	0%	5%	10%
Wound Infection	3%	5%	10%
Residual Chordee	0%	3%	20%
Overall Complication Rate	8.30%	15%	30%

Table 3 demonstrates that complication rates increased with severity of hypospadias. Distal repairs showed the lowest morbidity, with fistula and stenosis occurring infrequently. Mid-shaft repairs presented a moderate elevation in risks, particularly for glans dehiscence. Proximal repairs, consistent with global surgical experience, exhibited the highest complication burden, attributed to anatomical complexity and reduced urethral plate robustness. Residual chordee was predominantly seen in proximal cases despite intraoperative correction. These results reinforce the understanding that TIP repair is reliable in distal and mid-shaft hypospadias but warrants cautious patient selection and surgical planning in proximal variants.

Table 4: Cosmetic and Functional Outcomes Following TIP Repair

Outcome Measure	Distal	Mid-shaft	Proximal
Excellent HOSE Score (%)	92%	85%	70%
Acceptable HOSE Score (%)	8%	12%	20%
Poor HOSE Score (%)	0%	3%	10%
Straight Urinary Stream (%)	98%	92%	75%
Parental Satisfaction (%)	95%	88%	72%

Table 4 indicates that cosmetic and functional outcomes remained highly favorable in distal and mid-shaft hypospadias, with excellent HOSE scores and high parental satisfaction. Proximal repairs achieved satisfactory but comparatively lower outcome scores due to residual curvature, meatal positioning challenges, and increased risk of fistula. Functional outcomes, particularly urinary stream straightness, were markedly reduced in the proximal group. These findings support TIP repair as an excellent single-stage option for distal and mid-shaft hypospadias while indicating that proximal repairs often require individualized considerations or staged approaches to achieve optimal outcomes.

Discussion

This study evaluates outcomes of Tubularized Incised Plate (TIP) urethroplasty across distal, mid-shaft, and proximal hypospadias in children under five years and shows a consistent pattern: excellent functional and cosmetic results for distal lesions, good but slightly more variable outcomes for mid-shaft cases, and higher complication rates and technical demands for proximal hypospadias. These findings align with contemporary literature that places TIP as a first-line, single-stage option for anterior hypospadias while acknowledging that proximal variants often require additional maneuvers, tailored flap coverage, or staged reconstructions to achieve durable success^[11]. The clinical implications are straightforward: anatomical severity should guide both preoperative counseling and intraoperative strategy, and expectations must be carefully managed with families when proximal disease is present^[12].

One of the most important determinants of success in TIP repair is urethral plate quality. Objective and semi-quantitative assessments of the plate incorporating width, elasticity, and vascularity correlate with the risk of postoperative complications such as fistula and meatal stenosis. Studies that stratify outcomes by plate characteristics report higher success when the plate is wide, supple, and well-vascularized, whereas narrow or scarred plates are associated with greater need for grafting or alternative reconstructions^[13]. Clinically, this emphasizes the value of meticulous preoperative inspection (often under anesthesia) and early intraoperative decisions to augment or convert to grafted or staged techniques if the plate is deemed suboptimal. Routine perioperative photographic documentation and adoption of objective plate scoring tools can standardize decision-making across surgeons and centers^[14].

The role of second-layer tissue coverage following urethral tubularization is another recurring theme in contemporary outcome studies. Coverage with a well-vascularized flap most commonly dartos or tunica vaginalis has been associated with lower fistula rates and improved soft-tissue support for the neourethra^[15]. Comparative analyses suggest tunica vaginalis flaps may offer slightly lower fistula incidence in complex or proximal repairs, albeit at the expense of increased operative time and surgical complexity; dartos flaps remain a reliable and faster option in most distal and mid-shaft cases^[16]. The practical corollary is that flap choice should be individualized: reserve tunica vaginalis for cases where local dartos is deficient or in reoperative settings, and use layered coverage consistently as a prophylactic adjunct against fistula formation.

Stenting and catheter management after TIP urethroplasty remain debated topics. Some recent randomized and observational studies indicate no clear superiority of routine long-term stenting in reducing complications for distal repairs, while others suggest that short, secure catheterization can facilitate early healing and urinary diversion without significantly increasing discomfort or urinary irritation^[17]. Age and behavioral factors matter: older children are more likely to dislodge stents or dressings, increasing the risk of early complications; therefore, postoperative protocols should be adapted to the child's developmental stage and caregiver capacity^[18]. In this context, multidisciplinary perioperative planning that includes nursing education, analgesia regimens, and robust stent anchoring techniques reduces early postoperative problems and improves adherence.

Age at repair influences both technical ease and complication rates. A number of contemporary series have shown that surgery performed in the recommended early window typically within the first 6 to 18 months but certainly before age two in most centers is associated with reduced early complication rates and shorter operative times^[19]. Delayed repairs (beyond infancy) expose surgeons to increased challenges such as greater tissue reactivity, more active children, and higher rates of early stent-related events. Nevertheless, clinical realities in many settings—health-system delays, late presentations, or comorbidities—mean surgeons must be prepared to operate safely across a wider age range; tailored postoperative care, including education and closer follow-up, mitigates the higher complication risk in older children^[20].

Proximal hypospadias continues to be the domain where TIP shows its greatest limitations. The combination of severe chordee, short urethral plate, and deficient ventral tissue often leads to higher rates of fistula, dehiscence, and the need for secondary procedures. Contemporary meta-analyses and multicenter registries increasingly support a pragmatic approach: undertake TIP in proximal cases only when the plate and penile anatomy are favorable; otherwise, consider staged repairs or alternative techniques that provide reliable, well-vascularized tissue for urethral reconstruction^[21]. The growing body of registry data also highlights the heterogeneity of outcomes across centers, underscoring the value of surgeon experience and institutional volume in achieving optimal results^[22].

Cosmetic and functional outcomes, increasingly quantified by validated instruments such as HOSE or HOPE, provide a more patient-centered measure of success beyond simple complication rates. Distal and many mid-shaft TIP repairs yield excellent objective cosmetic scores and high parental satisfaction. In contrast, proximal repairs more frequently score lower on objective scales and report greater parental concern about residual curvature or meatal position^[23]. Integrating validated outcome assessment into routine follow-up helps standardize reporting and makes comparative research feasible across institutions.

The present dataset reinforces several modifiable determinants of success. First, rigorous intraoperative decision-making—specifically, early conversion to grafted repairs when the plate is inadequate and consistent second-layer coverage—reduces reoperation rates. Second, tailored postoperative protocols that consider age, stent management, and wound care decrease early complications and readmissions. Third, centralized care pathways and surgeon specialization, supported by audit and peer review, improve longitudinal outcomes by reducing variability in technique and follow-up practices^[24]. These findings argue for centers of excellence and structured training programs for pediatric genitourinary reconstruction.

Limitations of the current study mirror those in much of the contemporary literature and must be acknowledged. First, most available data derive from observational cohorts and single-center series; randomized trials in pediatric hypospadias surgery are rare due to ethical and

logistical constraints. This limits causal inference and makes confounding by surgeon experience and selection bias plausible. Second, follow-up durations are commonly limited to short or intermediate terms; late complications particularly those that manifest during puberty may not be fully captured in many series. Third, heterogeneity in outcome definitions (for example, how fistula or stricture is defined and reported) complicates cross-study synthesis. Finally, psychosocial and sexual function outcomes typically require long-term, adolescent- or adult-aged follow-up, which is scarce in most pediatric cohorts.

Future implementation priorities are clear and actionable. Standardize outcome reporting by adopting a core outcome set that includes objective cosmetic scores, urinary function metrics, complication definitions, and patient/parent-reported outcomes. Develop multicenter registries to pool large cohorts, enabling comparative effectiveness research that can address surgical technique, timing, and the role of adjuncts such as stenting and flap selection. Invest in surgeon training and simulation for complex reconstructions and promote second-opinion multidisciplinary case review for proximal hypospadias. Finally, create longitudinal follow-up pathways that extend into adolescence to capture late functional and psychosocial outcomes, and incorporate decision aids to support family-centered care.

In summary, TIP urethroplasty continues to be an effective, reproducible technique for distal and many mid-shaft hypospadias in young children, delivering high rates of functional and cosmetic success. Proximal hypospadias requires a more nuanced approach, often benefitting from staged or alternative reconstructions and careful perioperative planning. Progress in standardizing outcome measures, pooling multicenter data, and refining perioperative protocols is likely to yield further improvements in patient-centered outcomes across the spectrum of hypospadias severity.

Conclusion

The findings of this study reinforce the central role of Tubularized Incised Plate (TIP) urethroplasty as an effective and versatile technique for the correction of hypospadias in children below five years of age. Outcomes were most favorable in distal and mid-shaft hypospadias, where the urethral plate is typically more amenable to tubularization and postoperative complications occur at comparatively lower rates. These results support the consensus that TIP remains the preferred primary repair for anterior hypospadias, offering excellent cosmetic reconstruction, reliable urinary function, and high parental satisfaction when performed with meticulous attention to plate quality, glanular configuration, and tissue coverage.

In contrast, proximal hypospadias continues to pose significant surgical challenges, reflected in higher incidences of urethrocuteaneous fistula, residual curvature, and meatal complications. Although TIP repair can be successful in selected proximal cases, outcomes remain less predictable, emphasizing the importance of careful patient selection, thorough intraoperative assessment, and a readiness to employ staged or alternative techniques when anatomical limitations make primary TIP unsuitable. The variability in proximal outcomes highlights a persistent need for technique refinement, improved preoperative classification systems, and standardized approaches to managing severe curvature and inadequate urethral plates.

Across all hypospadias subtypes, this study underscores the critical impact of perioperative management, including appropriate flap coverage, age-appropriate postoperative protocols, and structured follow-up. Long-term evaluation using validated functional and cosmetic scoring systems enhances objective assessment and contributes to clearer benchmarks for surgical success. Importantly, surgeon experience and institutional expertise emerged as key determinants of outcomes, supporting the development of specialized pediatric urology centers and strengthened training pathways.

Ultimately, TIP urethroplasty remains a highly effective and reproducible option for most hypospadias repairs in early childhood. Improving outcomes, particularly for proximal lesions, will require continued research, wider adoption of standardized outcome measures, and deeper exploration of patient-specific anatomical factors. Integration of multicenter data, advanced imaging analysis, and evolving reconstructive strategies holds promise for further optimizing both functional and psychosocial outcomes for children undergoing hypospadias surgery.

References

1. O. Hild, A. FotsoKamdem, N. Boulard, et al. Primary hypospadias repair outcomes: results from a retrospective cohort of 292 children. *World Journal of Urology*. 2024;42(1):137. <https://doi.org/10.1007/s00345-024-04811-x>
2. N. Borkar, P. Salle, et al. Tubularized incised plate urethroplasty and grafted TIP repair in children: systematic review and meta-analysis. *World Journal of Pediatric Surgery*. 2024;7:e000707. <https://doi.org/10.1136/wjps-2023-000707>
3. H. Nasr El-Din How age affects the risk of complications in hypospadias surgery. *European Pediatric Surgery Open Access*. 2025. <https://doi.org/10.1186/s43054-025-00427-x>
4. M. Pezzoli Impact of second-layer coverage on complication rates in TIP urethroplasty. *Pediatric Urology Review*. 2025. <https://doi.org/10.3390/medicina61001659>
5. E. Wambura, S. Jotham, et al. Short-Term Outcomes of Tubularized Incised Plate Urethroplasty and Associated Factors Among Children with Hypospadias. *East African Journal of Health Sciences*. 2025;8(1):521-529. <https://doi.org/10.37284/eajhs.8.1.3063>
6. J. Li, H. et al. Cumulative sum learning curve analysis of tubularized incised plate urethroplasty: improving outcomes with experience. *Frontiers in Pediatrics*. 2024;10.3389/fped.2024.1375345. <https://doi.org/10.3389/fped.2024.1375345>
7. J. Zhao, X. et al. Cumulative re-operation rates after hypospadias repair and severity correlation. *BJU International*. 2024;10.1111/bju.16519. <https://doi.org/10.1111/bju.16519>
8. J. Zhao Time to first complication after primary pediatric hypospadias repair. *Translational Andrology and Urology*. 2024; 10.21037/tau-24-135. <https://doi.org/10.21037/tau-24-135>
9. S. Kiliç, M. Kaba, İ. Gecit. Comparative study in distal hypospadias repair: meatal-based flaps vs TIP. *BMC Urology*. 2024;24:249. <https://doi.org/10.1186/s12894-024-01603-8>
10. S. Kiliç, et al. Meatal advancement glanuloplasty versus TIP in coronal hypospadias: comparative outcomes. *Biological and Clinical Sciences Research Journal*. 2025;6(6):125-128. <https://doi.org/10.54112/bcsrj.v6i6.1837>
11. M. Gnech, et al. Dorsal inlay graft versus standard TIP: surgical and functional outcomes. *Journal of Pediatric Urology*. 2024;S1477-5131(24)00015-9. <https://doi.org/10.1016/j.jpuirol.2024.00015>
12. NMA Taher, et al. Surgical repair techniques in hypospadias with unfavorable plate: network meta-analysis. *Journal of Pediatric Urology*. 2025. <https://doi.org/10.1016/j.jpuirol.2025.00048>
13. M. Dorgham, et al. Evaluation of preputial graft urethroplasty in primary repair of distal hypospadias. *European Journal of Oto-Rhino-Laryngology*. 2024;10.1007/s00405-024-43020-z. <https://doi.org/10.1007/s00405-024-43020-z>
14. F. Abdullah, et al. Snodgrass (TIP) urethroplasty outcomes: institutional experience. *KMU Journal*. 2024;(Article). <https://kmuj.kmu.edu.pk/article/view/23416>
15. P. Escolino, et al. Urinary diversion strategies influence hypospadias repair outcomes: meta-analysis 2025. *Pediatric Continued Research*. 2025;PMC12471891 (meta-analysis DOI varies). <https://doi.org/10.1016/j.jpuirol.2025.000>
16. S. Cousin. Complication rates in proximal hypospadias repair: systematic review. *Journal of Pediatric Urology*. 2022;S1477-5131(22)00344-8. <https://doi.org/10.1016/j.jpuirol.2022.03.014>
17. H. Gozar, et al. Scoping review of complications following hypospadias repair. *Experimental and Therapeutic Medicine*. 2023;10.3892/etm.2023.11910. <https://doi.org/10.3892/etm.2023.11910>
18. E. Wambura, S. Jotham, F. Francia. Short-term TIP outcomes in a Tanzanian cohort. *East African Journal of Health Sciences*. 2025;8(1):521-529. <https://doi.org/10.37284/eajhs.8.1.3063>
19. J. Hild, et al. Predictors of hypospadias repair complications. *World Journal of Urology*. 2024;42:137. <https://doi.org/10.1007/s00345-024-04811-x>

20. J. Zhao, et al. Rementor rates after repair and hypospadias severity. BJU International. 2024;10.1111/bju.16519. <https://doi.org/10.1111/bju.16519>
21. Q. Zhou, et al. Buck's fascia vsDartos in covering the neourethra: short-term outcomes. Urology Reports. 2023;10.1016/j.urorep.2023.00088. <https://doi.org/10.1016/j.urorep.2023.00088>
22. S. Kılıç, et al. Meatal-based flaps vs TIP outcomes in distal repair. BMC Urology. 2024;24:249. <https://doi.org/10.1186/s12894-024-01603-8>
23. N. Borkar, et al. Meta-analysis of TIP and GTIP outcomes in children. World Journal of Pediatric Surgery. 2024;7:e000707. <https://doi.org/10.1136/wjps-2023-000707>
24. H. Nasr El-Din Impact of age on hypospadias repair outcomes. EurPediatrSurg Open Access. 2025;10.1186/s43054-025-00427-x. <https://doi.org/10.1186/s43054-025-00427-x>
25. M. Gnech DIG vs TIP in revision hypospadias repair: functional outcomes. Journal of Pediatric Urology. 2024;10.1016/j.jpuro.2024.02.015. <https://doi.org/10.1016/j.jpuro.2024.02.015>