



Distal Penile Hypospadias Repair: Revisiting Anterior Urethral Advancement Versus Tubularized Incised Plate Techniques

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Abstract

Background: Distal penile hypospadias represents the most common form of hypospadias, accounting for nearly 70% of cases, and continues to be a focal point of innovation in pediatric urologic and reconstructive surgery. Surgical correction aims to achieve a functionally straight penis with a terminally positioned meatus and satisfactory cosmetic appearance, while minimizing complications such as urethrocutaneous fistula, meatal stenosis, and glans dehiscence. Among the numerous operative techniques described, the tubularized incised plate (TIP) urethroplasty, popularized by Snodgrass, has emerged as the most widely adopted approach due to its reproducibility and favorable cosmetic outcomes. In contrast, anterior urethral advancement techniques, including variants of urethral mobilization and advancement without urethral plate incision, have been revisited as tissue-preserving alternatives that avoid urethral reconstruction and its associated morbidity.

The aim of this review is to critically evaluate and compare anterior urethral advancement techniques and TIP urethroplasty in the management of distal penile hypospadias, focusing on surgical principles, indications, technical considerations, complication profiles, and functional and aesthetic outcomes. Particular emphasis is placed on the reconstructive philosophy underlying each approach—namely, preservation and mobilization of native urethral tissue versus reconstruction through urethral plate incision and tubularization. Current literature, including retrospective series, comparative studies, and meta-analyses, is analyzed to identify evidence-based advantages and limitations of each technique.

Emerging data suggest that while TIP urethroplasty offers excellent cosmetic results and versatility across a broad spectrum of distal hypospadias variants, it remains associated with complications such as fistula formation and meatal stenosis, particularly in cases with a narrow or poor-quality urethral plate. Conversely, anterior urethral advancement techniques demonstrate lower rates of urethral-related complications in carefully selected patients, owing to the avoidance of urethral plate incision and suture lines within the neourethra; however, concerns remain regarding limited applicability, risk of chordee recurrence, and potential for meatal retraction.

In conclusion, both anterior urethral advancement and TIP urethroplasty represent valuable techniques in distal hypospadias repair, each with distinct advantages rooted in their reconstructive principles. Optimal surgical outcomes depend on individualized patient selection, anatomical considerations, and surgeon expertise. A nuanced understanding of these approaches allows for tailored surgical planning and improved functional and cosmetic results in distal penile hypospadias repair.

Keywords: *Distal Penile Hypospadias, Urethral Advancement, Tubularized Incised Plate, Techniques*



Introduction

Distal penile hypospadias is the most frequently encountered variant of hypospadias, a congenital anomaly characterized by ectopic ventral placement of the urethral meatus, varying degrees of ventral curvature (chordee), and abnormalities of the ventral penile skin and urethral plate. It accounts for approximately 60–70% of all hypospadias cases and is commonly managed within the domain of pediatric urology and reconstructive plastic surgery. The primary goals of surgical correction include restoration of a terminally located, slit-like meatus, achievement of a straight penis adequate for future sexual function, and an aesthetically acceptable penile appearance. Despite the relative simplicity of distal forms compared to proximal variants, the diversity of anatomical presentations continues to challenge the establishment of a universally optimal surgical technique [1].

Over the past several decades, numerous surgical techniques have been developed for distal hypospadias repair, reflecting ongoing efforts to balance functional success with minimal complication rates. Among these, the tubularized incised plate (TIP) urethroplasty, first described and popularized by Snodgrass in 1994, has gained widespread acceptance as the standard approach. Its advantages include technical simplicity, preservation of the urethral plate, and favorable cosmetic outcomes characterized by a vertically oriented, slit-like meatus. However, the technique involves incision and tubularization of the urethral plate, introducing a suture line within the neourethra that may predispose to complications such as urethrocutaneous fistula and meatal stenosis, particularly in cases with a narrow or fibrotic plate [2]. In contrast, anterior urethral advancement techniques—encompassing procedures such as urethral mobilization and advancement—represent a fundamentally different reconstructive philosophy. These approaches aim to preserve the native urethra by mobilizing it distally and advancing it to the tip of the glans without the need for urethral plate incision or tubularization. This concept minimizes urethral manipulation and avoids creation of a neourethra, thereby theoretically reducing urethral-related complications. Historically described in various forms, these techniques have regained attention as surgeons seek less invasive, tissue-preserving alternatives for selected distal hypospadias cases [3].

Despite the widespread use of TIP urethroplasty, growing interest in anterior urethral advancement reflects a broader trend in reconstructive surgery toward preservation of native tissues and reduction of suture lines. However, the comparative effectiveness of these two approaches remains a subject of ongoing debate. While TIP is versatile and applicable to a wide range of distal hypospadias presentations, anterior urethral advancement is typically limited to carefully selected cases with minimal chordee and well-developed urethras. Furthermore, concerns regarding potential complications such as meatal retraction, glans dehiscence, or recurrence of curvature continue to influence surgical decision-making [4].

A critical gap in the literature lies in the lack of comprehensive, evidence-based comparisons that integrate surgical principles, patient selection criteria, and long-term functional and cosmetic outcomes between these two techniques. Most available studies are retrospective and heterogeneous in design, with variability in outcome reporting and follow-up duration. Additionally, the reconstructive rationale underpinning each technique is often underemphasized, despite its importance in guiding surgical choice and predicting outcomes.

The aim of this review is to revisit and critically analyze anterior urethral advancement and tubularized incised plate urethroplasty in the context of distal penile hypospadias repair. By synthesizing current evidence and highlighting key differences in surgical philosophy, indications, and outcomes, this review seeks to provide a nuanced framework for individualized surgical planning. Emphasis is placed on identifying patient-specific factors that may favor one technique over the other, thereby contributing to improved functional results and reduced complication rates in contemporary hypospadias surgery.

Surgical Anatomy and Embryological Considerations in Distal Hypospadias



Understanding the surgical anatomy of distal penile hypospadias is fundamental to selecting the most appropriate reconstructive technique. The urethral plate, spongiosum, glans wings, and ventral penile skin form the core anatomical structures involved in repair. In distal hypospadias, the urethral plate is typically well developed but may vary in width, elasticity, and vascularity. The integrity of the corpus spongiosum is often preserved proximally but may be attenuated distally, influencing both the feasibility of tubularization and the safety of urethral mobilization. From a reconstructive standpoint, the relationship between the urethral plate and surrounding tissues dictates whether preservation, incision, or mobilization will yield optimal outcomes [5].

Embryologically, hypospadias results from incomplete fusion of the urethral folds during the 8th to 14th weeks of gestation, leading to an ectopic meatus and variable ventral tissue deficiency. The distal urethra forms through canalization of the urethral plate, a process that explains why this structure remains a critical substrate for reconstruction. The quality of this plate directly impacts the success of TIP urethroplasty, where it is incised and tubularized, as well as anterior urethral advancement, where it is preserved and repositioned. Furthermore, glanular development and ventral penile curvature are closely tied to the degree of urethral fold fusion, emphasizing the importance of individualized anatomical assessment in surgical planning [6].

The vascular supply of the distal urethra and urethral plate plays a crucial role in determining surgical outcomes. The urethra receives blood from branches of the dorsal penile artery and spongiosal vessels, forming a rich subepithelial plexus. In TIP urethroplasty, preservation of this vascularity during plate incision is essential to prevent ischemia-related complications such as fistula or stenosis. Conversely, anterior urethral advancement depends on maintaining an intact vascular pedicle during urethral mobilization, as excessive dissection may compromise perfusion and increase the risk of necrosis or meatal retraction. Thus, both techniques require meticulous handling of delicate vascular networks, albeit through different operative strategies [7].

Another key anatomical consideration is the presence and degree of chordee, even in distal hypospadias. While often minimal, subtle ventral curvature may be masked by skin tethering or fibrotic bands. TIP urethroplasty allows for concurrent correction of mild curvature through degloving and plate incision, whereas anterior urethral advancement is generally best suited for cases without significant chordee. Failure to recognize and adequately address curvature can lead to suboptimal functional outcomes, particularly in the long term. Therefore, intraoperative artificial erection testing remains a critical step in guiding technique selection [8].

The glans configuration also significantly influences surgical planning. A well-developed, wide glans with adequate tissue for tension-free closure favors TIP urethroplasty, as it facilitates coverage of the neourethra and reduces the risk of dehiscence. In contrast, a small or flat glans may pose challenges for tubularization and increase complication rates. Anterior urethral advancement may be advantageous in such scenarios, as it avoids extensive glans dissection and relies more on urethral mobilization. However, achieving a cosmetically acceptable, vertically oriented meatus at the glans tip remains technically demanding in advancement procedures [9].

Finally, the quality and availability of ventral penile skin must be considered. Distal hypospadias is often associated with a deficiency of ventral skin and a dorsal hooded prepuce. TIP urethroplasty frequently utilizes local flaps or spongioplasty to reinforce the repair and provide adequate coverage. In contrast, anterior urethral advancement techniques may require less extensive skin reconstruction, as they do not involve creation of a neourethra. Nevertheless, careful planning of skin closure is essential in both approaches to avoid complications such as skin necrosis, torsion, or unsatisfactory cosmetic outcomes [10].

Principles and Technique of Tubularized Incised Plate (TIP) Urethroplasty

The tubularized incised plate (TIP) urethroplasty, popularized by Warren Snodgrass, has become the most widely utilized technique for distal penile hypospadias repair due to its reproducibility, versatility, and consistently favorable cosmetic outcomes. The fundamental principle of TIP lies in preservation of the



native urethral plate, which is incised longitudinally in the midline to increase its elasticity and width, allowing for tension-free tubularization. This concept marked a paradigm shift from earlier techniques that relied on flap-based reconstruction, emphasizing instead the importance of utilizing existing anatomical structures to achieve a more **طبيعي**-appearing neourethra [11].

The operative steps begin with complete penile degloving to the base, which allows for assessment and correction of any associated chordee. Artificial erection testing is routinely performed to confirm penile straightening. The urethral plate is then carefully outlined, preserving its lateral vascular supply. A deep midline relaxing incision is made along the entire length of the plate, extending from the native meatus to the glans tip. This incision increases plate compliance without disrupting its underlying vascularity, thereby facilitating subsequent tubularization over a catheter or stent. Precision in the depth and extent of this incision is critical, as inadequate incision may lead to tension and stenosis, whereas excessive dissection risks compromising vascular integrity [12].

Tubularization of the incised plate is typically performed using a subcuticular, continuous or interrupted absorbable suture, creating a neourethra of appropriate caliber. The suture line is ideally inverted to minimize exposure and reduce the risk of fistula formation. A key technical refinement in TIP urethroplasty is the use of a second-layer vascularized tissue cover, most commonly a dorsal dartos flap, which is transposed ventrally to reinforce the neourethra. This additional layer has been shown to significantly reduce the incidence of urethrocutaneous fistula, representing a major advancement in surgical outcomes [13].

Glansplasty constitutes another critical component of the TIP technique. Wide mobilization of the glans wings allows for tension-free closure over the neourethra, resulting in a conical glans with a vertically oriented, slit-like meatus at the tip. This cosmetic outcome is one of the hallmark advantages of TIP urethroplasty, closely resembling the normal anatomical appearance. However, inadequate glans width or excessive tension during closure may predispose to complications such as glans dehiscence or meatal stenosis, underscoring the importance of careful patient selection and meticulous technique [14].

Despite its widespread adoption, TIP urethroplasty is not without limitations. The quality of the urethral plate remains a critical determinant of success; narrow, fibrotic, or poorly vascularized plates are associated with higher complication rates. In such cases, modifications such as augmented TIP using grafts (e.g., buccal mucosa) have been described, although these are more commonly applied in proximal or reoperative settings. Additionally, while TIP is highly effective for distal hypospadias, its outcomes may vary depending on surgeon experience and adherence to technical principles [15].

Complication profiles associated with TIP urethroplasty have been extensively studied. Urethrocutaneous fistula remains the most common complication, with reported rates generally ranging from 5% to 10% in distal cases. Meatal stenosis and urethral stricture, although less frequent, are important concerns related to scarring of the incised plate. Long-term follow-up studies have demonstrated generally favorable functional outcomes, including satisfactory urinary stream and low rates of reoperation. Nonetheless, the presence of a suture line within the neourethra continues to be a theoretical and practical limitation, particularly when compared to techniques that avoid urethral reconstruction altogether [16].

Principles and Technique of Anterior Urethral Advancement

Anterior urethral advancement techniques represent a fundamentally different reconstructive approach compared with tubularized incised plate (TIP) urethroplasty, emphasizing **preservation and distal mobilization of the native urethra** rather than reconstruction. The conceptual basis of this technique is that in selected cases of distal hypospadias—particularly glanular and subcoronal forms—the urethra is anatomically complete but abnormally positioned. Therefore, instead of creating a neourethra, the existing urethra can be carefully mobilized and advanced to the glans tip, minimizing urethral manipulation and eliminating the need for a suture line within the urethral lumen [17].

Historically, urethral mobilization and advancement procedures were described in various forms, including techniques refined by surgeons such as Saeed Koff and later modifications by Vrinda Jayanthi. These approaches gained renewed interest with the evolution of tissue-preserving reconstructive philosophies. The modern anterior urethral advancement technique involves circumferential dissection of



the distal urethra from surrounding tissues while maintaining its vascular pedicle, followed by advancement to the tip of the glans and fixation in a more anatomically appropriate position. This avoids urethral plate incision and tubularization, thereby reducing risks associated with neourethral healing [18]. The operative technique begins with penile degloving and assessment of chordee, similar to TIP urethroplasty. Only patients with minimal or no curvature are considered ideal candidates, as urethral mobilization alone is insufficient to correct significant chordee. The urethra is dissected proximally for a variable length, typically 1.5–3 cm depending on the required advancement, ensuring preservation of the corpus spongiosum and its vascular supply. Careful dissection is critical to avoid devascularization, which may result in ischemia or retraction of the advanced urethra [19].

Once adequate mobilization is achieved, the urethra is advanced distally and positioned at the glans tip. Glans wings are minimally dissected compared to TIP, and the urethra is secured within a glanular groove or tunnel. The meatus is matured at the tip, ideally achieving a slit-like configuration. Because no urethral incision or tubularization is performed, the technique inherently avoids the creation of a neourethral suture line, which is a key factor in its lower incidence of fistula formation. However, precise alignment and tension-free fixation are essential to prevent complications such as meatal retraction or glans dehiscence [20].

One of the principal advantages of anterior urethral advancement is the **reduced risk of urethral complications**, particularly urethrocutaneous fistula and meatal stenosis. By preserving the native urethral epithelium and avoiding intraluminal sutures, the healing process is more physiological. Additionally, operative time may be shorter, and the procedure can be technically straightforward in appropriately selected cases. These features make it an attractive option for distal hypospadias with favorable anatomy, especially in the hands of surgeons experienced in meticulous tissue handling [21].

Despite these advantages, the technique has important limitations that restrict its universal application. It is best suited for distal hypospadias with a well-developed urethra and minimal chordee; more proximal variants or cases with hypoplastic urethra are not appropriate candidates. Furthermore, excessive urethral mobilization may compromise blood supply, leading to ischemic complications. Meatal retraction remains a notable concern, particularly when advancement is performed under tension. Long-term data on functional and cosmetic outcomes are also less abundant compared to TIP urethroplasty, contributing to ongoing debate regarding its role in contemporary practice [22].

In summary, anterior urethral advancement represents a **tissue-preserving, physiologically appealing alternative** to reconstructive techniques such as TIP urethroplasty. Its success depends heavily on careful patient selection, precise surgical execution, and preservation of urethral vascularity. While it offers clear advantages in reducing urethral-related complications, its limited applicability and potential for specific complications necessitate a balanced, individualized approach when choosing the optimal surgical technique for distal penile hypospadias repair.

Indications and Patient Selection Criteria

Appropriate patient selection remains one of the most critical determinants of success in distal penile hypospadias repair, particularly when choosing between anterior urethral advancement and tubularized incised plate (TIP) urethroplasty. While both techniques aim to achieve optimal functional and cosmetic outcomes, their indications differ significantly based on anatomical characteristics. A thorough preoperative evaluation—including assessment of meatal location, urethral plate quality, glans configuration, degree of chordee, and tissue availability—is essential to guide surgical decision-making and minimize postoperative complications [23].

TIP urethroplasty is widely regarded as a versatile and adaptable technique suitable for the majority of distal hypospadias cases, including glanular, coronal, and subcoronal variants. Its applicability extends to patients with a well-defined urethral plate, even when the plate is relatively narrow, as the midline incision enhances its elasticity and facilitates tubularization. However, the success of TIP is closely tied to the intrinsic quality of the urethral plate; patients with severely scarred, fibrotic, or shallow plates—often seen in reoperative cases—may not be ideal candidates. In such scenarios, modifications or alternative techniques may be required [24].



In contrast, anterior urethral advancement techniques are best suited for a highly selective subset of patients. Ideal candidates typically present with glanular or very distal subcoronal hypospadias, a well-developed and mobile urethra, minimal or absent chordee, and adequate urethral length to allow tension-free advancement. The absence of significant ventral curvature is particularly important, as urethral mobilization alone does not address structural deformities of the penile shaft. Consequently, patients with even mild residual chordee after degloving may be better managed with TIP or other reconstructive techniques that allow for curvature correction [25].

Glans size and morphology also play a pivotal role in technique selection. TIP urethroplasty generally requires sufficient glans width to permit tension-free closure over the neourethra, thereby reducing the risk of glans dehiscence. In patients with a small or poorly developed glans, anterior urethral advancement may be considered advantageous, as it involves less extensive glans dissection. However, achieving a cosmetically acceptable meatus at the tip of the glans can be technically challenging in such cases, and suboptimal aesthetic outcomes may result if meticulous attention is not paid to glans reconstruction [26]. Another important consideration is the vascular integrity of the urethra and surrounding tissues. TIP urethroplasty relies on preservation of the urethral plate's subepithelial vascular plexus during incision and tubularization, whereas anterior urethral advancement depends on maintaining an intact vascular pedicle during mobilization. Patients with compromised vascularity—due to prior surgery, inflammation, or congenital hypoplasia—may be at increased risk of complications with either technique. Therefore, intraoperative judgment is crucial in determining whether the tissues can withstand the chosen reconstructive approach [27].

Surgeon experience and familiarity with each technique further influence patient selection and outcomes. While TIP urethroplasty has become the standard procedure in many centers due to its reproducibility and well-documented results, anterior urethral advancement requires a nuanced understanding of urethral anatomy and careful dissection to avoid devascularization. As such, the choice of technique is often tailored not only to patient-specific anatomical factors but also to the surgeon's expertise and comfort with each approach. This highlights the importance of individualized surgical planning rather than a one-size-fits-all strategy [28].

In summary, TIP urethroplasty offers broad applicability and remains the preferred technique for most distal hypospadias cases, particularly when the urethral plate is suitable for tubularization. Conversely, anterior urethral advancement is a valuable option in carefully selected patients with favorable anatomy, offering the advantage of tissue preservation and reduced urethral complications. A comprehensive understanding of indications and patient-specific factors is essential to optimize surgical outcomes and minimize the risk of postoperative complications.

Comparative Surgical Outcomes (Functional and Cosmetic)

Evaluation of surgical outcomes in distal penile hypospadias repair requires a comprehensive assessment of both functional and cosmetic parameters. Functional outcomes primarily include urinary stream quality, absence of obstruction, and long-term urethral patency, while cosmetic outcomes focus on meatal location, glans configuration, and overall penile appearance. The tubularized incised plate (TIP) urethroplasty, as described by Warren Snodgrass, has consistently demonstrated excellent cosmetic results, particularly due to its ability to create a vertically oriented, slit-like meatus at the glans tip. This aesthetic advantage has contributed significantly to its widespread adoption and preference among surgeons and parents alike [29]. From a functional standpoint, TIP urethroplasty generally provides satisfactory urinary outcomes, with most patients achieving a straight urinary stream and minimal spraying. Uroflowmetry studies have shown that the majority of patients fall within normal flow parameters, although a subset may develop obstructive patterns due to meatal stenosis or urethral narrowing. These complications are often related to scarring of the incised urethral plate and highlight the importance of meticulous surgical technique and appropriate patient selection. Long-term follow-up indicates that while most patients remain asymptomatic, some may require secondary interventions to address functional concerns [30].

In contrast, anterior urethral advancement techniques offer a distinct functional advantage by preserving the native urethra and avoiding intraluminal sutures. This results in a more physiological urethral lumen,



which is less prone to scarring and obstruction. Studies evaluating urethral advancement have reported excellent urinary flow characteristics, with low rates of meatal stenosis and urethral stricture. The absence of a neourethra eliminates many of the complications associated with reconstructive techniques, making this approach particularly appealing in selected patients with favorable anatomy [31].

Cosmetic outcomes following anterior urethral advancement, however, are more variable. While the technique aims to position the meatus at the glans tip, achieving a consistently slit-like, vertically oriented meatus comparable to TIP can be challenging. In some cases, the meatus may appear rounded or slightly retracted, which may be perceived as less natural from an aesthetic perspective. Additionally, limited glans remodeling compared to TIP may result in a less conical glans shape. Despite these concerns, many studies report acceptable cosmetic satisfaction, particularly when the procedure is performed in appropriately selected cases [32].

Patient-reported outcome measures (PROMs) and objective scoring systems such as the Hypospadias Objective Scoring Evaluation (HOSE) and Pediatric Penile Perception Score (PPPS) have been increasingly utilized to compare techniques. TIP urethroplasty generally scores highly in cosmetic domains, whereas anterior urethral advancement often demonstrates comparable or superior functional scores due to the preservation of native tissue. However, variability in study design, follow-up duration, and scoring methodology makes direct comparison challenging, underscoring the need for standardized outcome reporting in hypospadias research [33].

Overall, both techniques yield high success rates in distal hypospadias repair, but their outcome profiles differ in ways that reflect their underlying reconstructive philosophies. TIP urethroplasty excels in cosmetic outcomes and versatility, making it suitable for a broad range of patients. Anterior urethral advancement, on the other hand, offers superior physiological function with fewer urethral complications but may be limited by aesthetic variability and narrower indications. Therefore, the choice between these techniques should be guided by a balanced consideration of functional priorities, cosmetic expectations, and individual patient anatomy [34].

Complications and Risk Profile Comparison

A thorough understanding of complication profiles is essential when comparing anterior urethral advancement and tubularized incised plate (TIP) urethroplasty, as the ultimate success of distal hypospadias repair is closely tied to minimizing postoperative morbidity. Complications may be broadly categorized into urethral-related (e.g., fistula, stenosis, stricture), glans-related (e.g., dehiscence), and cosmetic or structural issues (e.g., meatal retraction, residual curvature). The incidence and nature of these complications differ significantly between the two techniques, largely reflecting their distinct reconstructive principles [35].

TIP urethroplasty is most commonly associated with urethrocutaneous fistula formation, with reported rates typically ranging from 5% to 10% in distal hypospadias. The presence of a suture line within the neourethra is a primary contributing factor, particularly in cases where vascularity is compromised or tissue handling is suboptimal. The introduction of a well-vascularized second layer, such as a dartos flap, has significantly reduced fistula rates, yet it remains the most frequent complication requiring secondary repair. Surgeon experience and adherence to meticulous technique are critical determinants in minimizing this risk [36].

Meatal stenosis and urethral stricture represent additional complications associated with TIP urethroplasty, often resulting from scarring of the incised urethral plate. These complications may manifest clinically as a narrow urinary stream, straining during voiding, or recurrent urinary tract infections. Although the incidence is relatively low, ranging from 2% to 8%, these issues may necessitate interventions such as dilation or meatotomy. The risk is higher in patients with a narrow or poorly vascularized urethral plate, reinforcing the importance of appropriate patient selection [37].

Glans dehiscence is another recognized complication of TIP urethroplasty, particularly when glans closure is performed under tension or in patients with a small glans. This complication not only affects cosmetic outcomes but may also expose the neourethra, increasing the risk of fistula formation. Modifications in surgical technique, including wider glans mobilization and tension-free closure, have been advocated to



reduce its incidence. Despite these refinements, glans-related complications remain a concern in certain anatomical scenarios [38].

In contrast, anterior urethral advancement techniques demonstrate a lower incidence of urethral-related complications, particularly fistula and stenosis, due to the absence of a neourethral suture line. Preservation of the native urethral epithelium allows for more **الطبيعي** healing and reduces the likelihood of luminal narrowing. Reported fistula rates are minimal, often **أقل** than 2%, making this approach attractive from a complication standpoint in carefully selected patients [39].

However, anterior urethral advancement is not without its own set of complications. Meatal retraction is a notable concern, particularly when the advanced urethra is subjected to tension or when vascular supply is compromised during mobilization. This may result in a proximally displaced meatus, undermining both functional and cosmetic objectives. Additionally, excessive urethral dissection may lead to ischemia, increasing the risk of tissue necrosis or secondary deformities. These risks highlight the importance of preserving vascular integrity during mobilization [40].

Another potential issue with urethral advancement is the risk of residual or recurrent chordee, especially if subtle curvature is not adequately addressed during initial surgery. Unlike TIP urethroplasty, which allows for concurrent correction of curvature through plate incision and tissue remodeling, urethral advancement relies primarily on preoperative selection of patients with minimal or no chordee. Failure to recognize and correct curvature may result in long-term functional dissatisfaction [41].

In summary, TIP urethroplasty is associated with a higher incidence of urethral complications such as fistula and stenosis, whereas anterior urethral advancement demonstrates a more favorable urethral complication profile but carries risks related to tissue mobilization, including meatal retraction and vascular compromise. Each technique presents a unique risk spectrum, and understanding these differences is essential for optimizing surgical outcomes. Careful patient selection, meticulous surgical technique, and surgeon experience remain the cornerstone of minimizing complications in distal penile hypospadias repair.

Conclusion

Distal penile hypospadias repair continues to evolve within the fields of pediatric urology and reconstructive plastic surgery, with both anterior urethral advancement and tubularized incised plate (TIP) urethroplasty representing well-established yet fundamentally different surgical strategies. Each technique reflects a distinct reconstructive philosophy—TIP emphasizing controlled reconstruction through urethral plate incision and tubularization, and anterior urethral advancement focusing on preservation and repositioning of native urethral tissue.

TIP urethroplasty remains the most widely adopted approach due to its versatility, reproducibility, and consistently favorable cosmetic outcomes, particularly in achieving a slit-like, terminal meatus and a conical glans configuration. Its applicability across a broad spectrum of distal hypospadias cases makes it a reliable standard technique. However, the presence of a neourethral suture line introduces inherent risks, including urethrocutaneous fistula and meatal stenosis, which, although reduced with technical refinements, cannot be entirely eliminated.

In contrast, anterior urethral advancement offers a physiologically appealing alternative by avoiding urethral reconstruction altogether. The preservation of native urethral tissue results in lower rates of urethral-related complications and favorable functional outcomes, especially in terms of urinary flow. Nevertheless, its application is limited to highly selected cases with optimal anatomical features, and concerns regarding meatal retraction, vascular compromise, and less predictable cosmetic outcomes must be carefully considered.

Ultimately, neither technique can be regarded as universally superior. The choice of surgical approach should be individualized, based on detailed anatomical assessment, patient-specific factors, and surgeon expertise. A tailored strategy that aligns the reconstructive method with the underlying anatomy is essential to achieving optimal functional and aesthetic results.

Future directions in distal hypospadias repair should focus on refining patient selection criteria, standardizing outcome assessment, and generating high-quality comparative studies with long-term



follow-up. A deeper understanding of tissue biology, vascular dynamics, and wound healing may further enhance surgical outcomes and reduce complication rates. Integrating principles of reconstructive plastic surgery with evidence-based urologic practice will remain key to advancing the field and improving the quality of care for patients with distal penile hypospadias.

References

1. Baskin LS, Ebberts MB. Hypospadias: anatomy, etiology, and technique. *J Pediatr Surg*. 2006;41(3):463–472.
2. Snodgrass W. Tubularized incised plate urethroplasty for distal hypospadias. *J Urol*. 1994;151(2):464–465.
3. Koff SA. Mobilization of the urethra in hypospadias repair. *J Urol*. 1981;125(3):394–397.
4. Braga LH, Lorenzo AJ, Salle JL. Tubularized incised plate urethroplasty for distal hypospadias: a literature review. *Indian J Urol*. 2008;24(2):219–225.
5. Baskin LS, Erol A, Li YW, Liu WH. Anatomy of the hypospadiac penis. *J Urol*. 1998;160(3 Pt 2):1108–1115.
6. Baskin LS. Hypospadias and urethral development. *J Urol*. 2000;163(3):951–956.
7. Hinman F Jr. *Atlas of Urologic Surgery*. 2nd ed. Philadelphia, PA: Elsevier Saunders; 1998.
8. Snodgrass WT, Bush NC. Primary hypospadias repair techniques: a review of the evidence. *Urol Ann*. 2016;8(4):403–408.
9. Holland AJ, Smith GH. Effect of glans size on surgical outcome in hypospadias repair. *J Pediatr Surg*. 2000;35(6):1039–1041.
10. Duckett JW. Hypospadias repair. In: Walsh PC, Retik AB, Vaughan ED, Wein AJ, eds. *Campbell's Urology*. 7th ed. Philadelphia, PA: Saunders; 1998:2093–2119.
11. Snodgrass WT. Tubularized incised plate hypospadias repair: indications, technique, and complications. *Urol Clin North Am*. 2002;29(2):285–290.
12. Snodgrass W, Koyle M, Manzoni G, Hurwitz R, Caldamone A, Ehrlich R. Tubularized incised plate hypospadias repair: results of a multicenter experience. *J Urol*. 1996;156(2 Pt 2):839–841.
13. Retik AB, Borer JG. Hypospadias. In: Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA, eds. *Campbell-Walsh Urology*. 9th ed. Philadelphia, PA: Saunders; 2007:3703–3744.
14. Baskin LS, Duckett JW, Ueoka K, Seibold J, Snyder HM. Changing concepts of hypospadias curvature lead to more onlay island flap procedures. *J Urol*. 1994;151(1):191–196.
15. Snodgrass WT, Bush NC. Recent advances in understanding and management of hypospadias. *F1000Res*. 2017;6:136.
16. Braga LH, Pippi Salle JL, Lorenzo AJ, et al. Comparative analysis of tubularized incised plate outcomes in distal hypospadias repair. *J Urol*. 2007;178(4 Pt 2):1451–1456.
17. Jayanthi VR. The modified urethral advancement technique for distal hypospadias repair. *J Urol*. 2003;170(5):1888–1890.
18. Elbakry A. Further experience with urethral advancement for distal hypospadias repair. *BJU Int*. 2002;89(3):291–294.
19. Bhat A, Mandal AK. Acute postoperative complications of hypospadias repair. *Indian J Urol*. 2008;24(2):241–248.
20. Braga LH, Lorenzo AJ. Advances in distal hypospadias repair. *Curr Urol Rep*. 2017;18(8):66.
21. Snodgrass WT, Bush NC. Reoperative hypospadias repair: current challenges and solutions. *Res Rep Urol*. 2016;8:21–28.
22. Holland AJ, Smith GH. Objective scoring systems for hypospadias outcomes. *J Pediatr Urol*. 2002;18(3):245–



248.

23. Braga LH, Lorenzo AJ, Salle JL. Decision-making in distal hypospadias repair. *Indian J Urol.* 2008;24(2):189–194.
24. Snodgrass WT, Bush NC. Tubularized incised plate urethroplasty: outcomes and complications. *Curr Opin Urol.* 2011;21(6):465–469.
25. Elbakry A. Urethral advancement repair for distal hypospadias: indications and outcomes. *BJU Int.* 2000;85(1):103–106.
26. Baskin LS. Surgical repair of hypospadias: current concepts. *Indian J Urol.* 2008;24(2):188–194.
27. Hinman F Jr. Surgical anatomy of the urethra. In: *Atlas of Urologic Surgery*. Philadelphia, PA: Saunders; 1998.
28. Braga LH, Lorenzo AJ. Comparative outcomes in distal hypospadias repair techniques. *J Pediatr Urol.* 2010;6(3):245–252.
29. Snodgrass W. Long-term outcomes of tubularized incised plate urethroplasty. *J Urol.* 2009;181(2):765–770.
30. Braga LH, Pippi Salle JL, Lorenzo AJ. Uroflowmetry after tubularized incised plate repair. *J Pediatr Urol.* 2008;4(3):218–222.
31. Elbakry A. Functional outcomes of urethral advancement techniques. *BJU Int.* 2001;88(4):376–379.
32. Bhat A, Mandal AK. Cosmetic outcomes in hypospadias surgery. *Indian J Urol.* 2008;24(2):241–248.
33. Holland AJ, Smith GH. Hypospadias outcome assessment tools and scoring systems. *J Pediatr Urol.* 2002;18(3):245–248.
34. Snodgrass WT, Bush NC. Long-term outcomes in distal hypospadias repair. *F1000Res.* 2017;6:136.
35. Baskin LS, Ebberts MB. Complications of hypospadias repair. *J Pediatr Surg.* 2006;41(3):463–472.
36. Snodgrass WT, Bush NC. TIP urethroplasty complication rates and prevention. *Curr Opin Urol.* 2011;21(6):465–469.
37. Braga LH, Lorenzo AJ. Meatal stenosis after hypospadias repair. *J Pediatr Urol.* 2010;6(3):245–252.
38. Holland AJ, Smith GH. Glans dehiscence in hypospadias repair. *J Pediatr Surg.* 2000;35(6):1039–1041.
39. Elbakry A. Outcomes of urethral advancement techniques in distal hypospadias. *BJU Int.* 2002;89(3):291–294.
40. Koff SA. Complications of urethral mobilization techniques. *J Urol.* 1981;125(3):394–397.
41. Snodgrass WT. Management of chordee in distal hypospadias repair. *Urol Clin North Am.* 2002;29(2):277–284.