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Penile Shaft Hypospadias in Children: Anatomical Classification, Surgical Reconstruction Techniques, Postoperative Complications, and Long-Term Functional Outcomes

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Abstract: Penile shaft hypospadias is a congenital malformation of the male external genitalia characterized by an abnormally positioned urethral meatus on the ventral surface of the penile shaft. It is commonly associated with ventral curvature of the penis, incomplete foreskin development, and abnormal distribution of penile skin. The severity of the condition depends on the anatomical location of the meatus, the degree of chordee, penile curvature, glans configuration, and the quality of available urethral plate tissue. Hypospadias management requires detailed anatomical assessment and individualized surgical planning. Modern reconstructive techniques include tubularized incised plate urethroplasty, onlay island flap repair, staged urethroplasty, and other tissue-based reconstruction methods. The choice of procedure depends on the severity of the deformity, urethral plate characteristics, curvature, previous operations, and surgeon experience. Postoperative complications may include urethrocutaneous fistula, meatal stenosis, glans dehiscence, urethral stricture, diverticulum, recurrent curvature, and cosmetic dissatisfaction. Long-term follow-up is essential to evaluate urinary function, penile appearance, sexual health, psychological well-being, and patient satisfaction. This article reviews the anatomical classification, diagnostic assessment, surgical reconstruction techniques, postoperative complications, and long-term functional outcomes of penile shaft hypospadias in children.

Keywords: hypospadias, penile shaft hypospadias, pediatric urology, urethroplasty, tubularized incised plate, chordee, surgical complications, long-term outcomes.

Introduction

Hypospadias is one of the most common congenital anomalies of the male genital system. It develops when the urethral opening fails to reach the normal position at the tip of the glans during embryological development. Instead, the meatus is located on the ventral surface of the glans, coronal

region, penile shaft, or, in more severe cases, near the penoscrotal junction or perineum. Penile shaft hypospadias represents an intermediate anatomical form and may be associated with different degrees of ventral curvature, abnormal foreskin development, and inadequate ventral penile skin.

The clinical importance of penile shaft hypospadias extends beyond the abnormal position of the urethral opening. Significant curvature may affect urinary direction, penile development, future sexual function, and psychological well-being. Surgical treatment therefore aims not only to place the meatus in an anatomically appropriate position but also to achieve a straight penis, create a functional urethra, provide adequate glans coverage, and obtain an acceptable cosmetic result. Treatment is usually performed during infancy or early childhood by an experienced pediatric urology team.

Anatomical Classification and Clinical Assessment

Hypospadias is generally classified according to the location of the urethral meatus after correction of penile curvature. Distal hypospadias includes glanular and coronal forms, while proximal forms include penoscrotal, scrotal, and perineal variants. Penile shaft hypospadias may be described as distal shaft, midshaft, or proximal shaft depending on the position of the meatus. However, meatal location alone does not always reflect the true severity of the condition because the degree of curvature, urethral plate quality, glans size, and tissue deficiency may significantly influence surgical complexity.

Clinical evaluation should include inspection of the meatus, glans, preputial development, penile skin, scrotum, and testicular position. The degree of curvature should be assessed, particularly during surgery after degloving the penis. Associated abnormalities such as cryptorchidism, bifid scrotum, micropenis, or disorders of sex development may require additional evaluation in selected patients with severe or atypical genital development. In most isolated distal and midshaft cases, extensive endocrine or genetic investigation is not routinely required, but severe proximal hypospadias with bilateral undescended testes requires specialist assessment.

Surgical Reconstruction Techniques

The main objectives of hypospadias surgery are correction of penile curvature, reconstruction of a sufficiently wide and functional urethra, positioning of the meatus near the glans tip, restoration of glans anatomy, and achievement of an acceptable cosmetic appearance. The operative technique is selected according to the anatomical characteristics identified during examination and surgery.

Tubularized incised plate urethroplasty, commonly known as the TIP or Snodgrass technique, is widely used for selected distal and some midshaft cases. The procedure involves tubularization of the urethral plate, often after a controlled midline incision to increase the width and flexibility of the reconstructed urethra. The urethra is then covered with vascularized tissue, frequently using a dartos or other local tissue layer, to reduce the risk of fistula formation. The technique can provide satisfactory functional and cosmetic outcomes when the urethral plate and glans anatomy are suitable.

Onlay island flap urethroplasty may be considered when the urethral plate is inadequate for tubularization or when additional tissue is required. A vascularized preputial or penile skin flap is used to reconstruct or augment the urethra without completely tubularizing the native urethral plate in the same manner as the TIP procedure. This technique requires careful preservation of tissue vascularity and precise reconstruction to reduce postoperative complications.

Staged urethroplasty is frequently used in complex or proximal hypospadias, severe curvature, inadequate urethral plate, or cases requiring extensive tissue reconstruction. In the first stage, curvature

is corrected and a suitable tissue graft or local tissue bed is prepared. In the second stage, the graft or reconstructed tissue is tubularized to create the neourethra. Staged procedures may provide greater flexibility in complex anatomy but require multiple operations and prolonged follow-up.

Correction of chordee is a fundamental part of surgery. Mild curvature may improve after penile degloving and release of abnormal fibrous tissues. More severe curvature may require additional procedures, including dorsal plication, ventral lengthening, or other reconstructive techniques. The chosen method must balance penile straightness with preservation of penile length and vascular integrity.

Postoperative Complications

Despite advances in surgical techniques, complications remain possible, particularly in proximal hypospadias and cases with severe curvature or inadequate tissue. Urethrocutaneous fistula is one of the most common complications and occurs when an abnormal connection develops between the reconstructed urethra and the penile skin. The risk may be influenced by tissue quality, infection, tension, inadequate vascular coverage, and the complexity of the reconstruction.

Other complications include meatal stenosis, urethral stricture, glans dehiscence, urethral diverticulum, wound infection, skin necrosis, and recurrent penile curvature. Meatal stenosis may cause a narrow urinary stream, prolonged urination, spraying, or straining. Urethral stricture and diverticulum can lead to obstructive symptoms and may require additional diagnostic evaluation and reconstructive surgery.

Cosmetic complications may include an abnormally positioned meatus, irregular glans appearance, residual skin asymmetry, scarring, and dissatisfaction with penile appearance. The assessment of cosmetic outcomes should be performed carefully and, when the child is older, should include age-appropriate communication and consideration of psychological well-being.

Long-Term Functional Outcomes

Long-term follow-up is important because some complications may become evident months or years after surgery. Clinical assessment should evaluate urinary flow, stream direction, recurrent curvature, meatal position, urethral obstruction, penile growth, and cosmetic appearance. Uroflowmetry may be useful in older children who are able to cooperate with the examination, particularly when obstructive symptoms or abnormal urinary flow are suspected.

Sexual and reproductive outcomes are also important in long-term care. Severe residual curvature, urethral obstruction, penile deformity, and psychological distress may affect future sexual function. Although many children achieve satisfactory functional outcomes after reconstruction, patients with proximal hypospadias and multiple procedures may have a higher risk of persistent complications and dissatisfaction.

Psychological outcomes should not be overlooked. Penile appearance, repeated operations, urinary difficulties, and concerns about future sexual function may influence self-esteem and social well-being. Long-term follow-up should therefore be individualized and may extend into adolescence when clinically indicated. Patients and families should receive realistic information regarding possible late complications and the potential need for revision surgery

Conclusion

Penile shaft hypospadias is a heterogeneous congenital condition that requires detailed anatomical evaluation and individualized reconstructive planning. The location of the meatus, degree of chordee,

quality of the urethral plate, glans anatomy, and available skin tissue are important factors in selecting the surgical technique. Tubularized incised plate urethroplasty, onlay flap reconstruction, and staged urethroplasty are among the principal approaches used in contemporary pediatric urology.

Successful treatment requires more than repositioning the urethral opening. The principal objectives are a straight penis, a functional urethra, an appropriate meatal position, adequate glans reconstruction, and a satisfactory cosmetic result. Postoperative complications such as fistula, stenosis, stricture, recurrent curvature, and glans dehiscence require early recognition and appropriate management. Long-term follow-up is essential for evaluating urinary function, penile development, psychological well-being, and patient satisfaction. Continued improvements in surgical planning, tissue reconstruction, minimally invasive assessment, and patient-centered follow-up may further improve outcomes in children with penile shaft hypospadias.

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