BASIC PRINCIPLES AND NEW METHODS OF SURGICAL TREATMENT OF HYPOSPADIAS IN CHILDREN

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ОСНОВНЫЕ ПРИНЦИПЫ И НОВЫЕ МЕТОДЫ ХИРУРГИЧЕСКОГО ЛЕЧЕНИЯ ГИПОСПАДИИ У ДЕТЕЙ

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Abstract Introduction. Hypospadias is one of the most common congenital anomalies of the male genital system. This study analyzes modern approaches to its surgical treatment, complications, and treatment outcomes.

Methods. A literature review was conducted on different urethroplasty techniques, including one-stage and staged procedures. Epidemiological data and clinical outcomes were analyzed.

Results. The review demonstrated that surgical success rates depend on the severity of hypospadias, penile curvature, and the chosen technique. Two-stage procedures showed lower complication rates in severe cases.

Conclusion. Standardization of surgical techniques and reporting methods will improve hypospadias treatment outcomes. Further research is necessary to refine treatment algorithms.

Введение. Гипоспадия – одна из наиболее распространенных врожденных аномалий мужской половой системы. В данном исследовании рассматриваются современные подходы к хирургическому лечению, осложнениям и результатам лечения.

Методы. Проведен анализ литературы по различным методам уретропластики, включая одноэтапные и двухэтапные процедуры. Проанализированы эпидемиологические данные и клинические результаты.

Результаты. Обзор показал, что успех операции зависит от степени тяжести гипоспадии, кривизны полового члена и выбранного метода. Двухэтапные методы продемонстрировали меньшую частоту осложнений в тяжелых случаях.

Выводы. Стандартизация хирургических методов и методов отчетности позволит улучшить результаты лечения гипоспадии. Необходимы дальнейшие исследования для уточнения алгоритмов лечения.

Hypospadias is a congenital anomaly of the male genitalia, characterized by an abnormal ventral and proximal displacement of the external urethral meatus from the physiological location at the tip of the glans penis. It is one of the most frequently encountered congenital malformations affecting the male urogenital system.

Epidemiological studies estimate the global incidence of hypospadias to be approximately 10 per 3000 live male births (0.33%). However, data from developed Western countries suggest a rising trend in prevalence, with reports indicating an incidence of up to 80 per 1,0000 (0.8%) live male births. The increasing prevalence has been attributed to multifactorial etiological factors, including genetic predisposition, endocrine-disrupting environmental exposures, and improved detection rates due to advances in neonatal screening.

The epidemiology of hypospadias holds significant importance in the field of pediatric urology, as understanding its prevalence and trends is crucial for both clinical management and public health strategies. Over the past five decades, numerous large-scale epidemiological studies have been conducted across various regions worldwide. However, these studies have reported conflicting results, likely due to differences in study methodologies, population characteristics, and diagnostic criteria. [1, 5, 6]

Several factors contribute to the challenges in accurately determining the true prevalence and incidence trends of hypospadias. These include variations in case definitions, differences in healthcare access and reporting systems, as well as environmental and genetic influences. Consequently,

the assessment of global and regional trends remains complex, necessitating standardized epidemiological approaches for more precise and reliable data.

To obtain a precise and comprehensive understanding of the future epidemiological landscape of hypospadias, collaboration between national and international registries is crucial. Establishing unified data collection frameworks and harmonizing case definitions across different regions will enhance the reliability and comparability of reported incidence rates.

Additionally, standardizing methodologies for data calculation, classification, and processing is essential to minimize inconsistencies arising from variations in study design and reporting systems. Such coordinated efforts will not only facilitate a more accurate assessment of prevalence trends but also contribute to identifying potential risk factors and implementing targeted preventive strategies on a global scale. [1, 3]

General Concepts and Terminology

The classification of hypospadias is primarily based on the anatomical position of the ectopic urethral meatus, as outlined in the definition of the anomaly. While various classification systems exist, they generally follow a similar framework without fundamental differences. The condition is categorized into three main forms based on the displacement of the external urethral opening: Anterior (distal) hypospadias – The urethral meatus is located on the glans penis, within the coronal sulcus, or on the distal portion of the penile shaft. This is the most common form of hypospadias. Intermediate (midshaft) hypospadias – The meatus is situated along the midshaft of the penis. Posterior (proximal) hypospadias – The urethral opening is located at the penoscrotal junction, on the scrotum, or in the perineal region. This form is often associated with more severe anatomical abnormalities and may require complex surgical reconstruction.

A precise classification of hypospadias is essential for determining the severity of the anomaly and planning the appropriate surgical approach. [5, 6, 14]

Anatomical abnormalities in hypospadias can involve nearly all penile structures and are frequently associated with cryptorchidism and scrotal anomalies. Hypospadias is associated with various structural abnormalities, including preputial cleft, penile skin deficiency and dysplasia, native urethral dysplasia, penile curvature (chordee), and hypoplasia or dysplasia of the corpora cavernosa and glans, as well as scrotal anomalies such as bifid or transposed scrotum.

These anatomical defects increase the complexity of hypospadias and are critical in determining the surgical strategy and functional outcomes. Due to the extensive anatomical variability of the hypospadiac penis, surgical classifications often include detailed descriptors for individual penile structures. The prepuce may be well-developed, underdeveloped, or absent; the glans may be broad or conical; the navicular fossa may be deep or shallow; and the urethral plate may vary in width. Additionally, penile size differs significantly among children of the same age, highlighting the importance of an individualized assessment in surgical planning. The degree of penile curvature (chordee) must be objectively measured in degrees during artificial erection to ensure accurate evaluation and surgical planning. Cosmetically significant features include scrotal configuration and the prominence of transition zones between anatomical structures, specifically the penopubic and penoscrotal angles, which influence the overall aesthetic and functional outcomes of surgical correction.

The severity of hypospadias often becomes more apparent after the degloving procedure, a surgical step where the penile shaft skin is mobilized from deeper structures and repositioned proximally. This technique allows for a more accurate assessment of underlying anatomical abnormalities, particularly the degree of penile curvature. Studies on post-pubertal penile size in hypospadias patients have shown that individuals with proximal forms tend to have significantly shorter penile length, even in the absence of endocrine disorders. These findings suggest that hypospadias is not merely a urethral malformation but a developmental disorder affecting the entire penis, likely involving abnormalities in tissue growth and differentiation. Due to the complex pathological anatomy of hypospadias, no single classification system fully encapsulates all its morphological variations. However, the most widely accepted approach categorizes hypospadias based on the anatomical location of the ectopic urethral meatus. Some experts propose an additional classification for previously operated hypospadias, recognizing the unique challenges posed by recurrent cases. Accurately assessing the severity and anatomical characteristics of hypospadias in individual patients remains a significant challenge. A study involving 25 experienced surgeons who evaluated the urethral plate in 20 standardized clinical photographs demonstrated a lack of statistical correlation between their assessments. Notably, even among the most experienced participants–comprising 40% of the respondents (treating over 12 hypospadias cases per month)–there was substantial variability in their

descriptions. This inconsistency highlights the inherent subjectivity in anatomical evaluation and underscores the need for standardized assessment tools to enhance diagnostic precision and surgical planning.

Role of Digital Technologies in Hypospadias Assessment and Classification Advancements in digital technologies offer new opportunities for data archiving and anatomical assessment in hypospadias management. One proposed approach involves the routine use of digital photography at all stages of surgical treatment, incorporating standardized measurement references (e.g., a measurement scale) within the frame. This method enables precise numerical documentation of penile anatomical parameters, facilitating objective comparisons over time and helping to identify potential correlations between specific anatomical variations and postoperative complications. Currently, significant efforts are being made to develop scoring systems for the preoperative visual assessment of penile anatomy in hypospadias. One such system is the GMS method (Glans, Urethral Meatus, Shaft), which evaluates the external penile morphology using a four-point scale based on: Glans configuration, Location of the urethral meatus, Degree of penile curvature (chordee).The total GMS score is designed to correlate with the risk of postoperative complications, offering a quantitative and standardized classification of hypospadias. This method not only refines the preoperative assessment but also has practical implications for surgical decision-making and outcome prediction. [1, 5, 8, 14, 15, 16]

Advancements and Implementation of the GMS Method

The developers of the GMS method continue to refine and expand its application. A notable enhancement includes the addition of urethral plate assessment, further improving its accuracy in evaluating hypospadias severity. By providing structured training, the initiative aims to improve interobserver reliability and ensure consistent application of the GMS methodology in clinical practice. While the GMS method shows promise in optimizing surgical decision-making and predicting postoperative complications, further research and validation are necessary to refine its scoring criteria and establish its predictive value across diverse patient populations.

Surgical Correction of Hypospadias: Goals and Challenges

The primary objective of hypospadias surgery is to restore both normal penile function and aesthetics, ensuring a straight erection, a well-positioned urethral meatus, and an acceptable cosmetic outcome. Despite extensive research and advancements in surgical techniques, no single method has been universally recognized as the gold standard for hypospadias repair.

To date, over 300 surgical techniques and their modifications have been described in the literature. The choice of procedure depends on multiple factors, including the severity of hypospadias, penile curvature, urethral plate quality, and surgeon expertise. The lack of consensus on an optimal approach highlights the complexity of the condition and the need for individualized surgical planning to achieve the best functional and cosmetic results. [4, 5, 7, 15]

Advancements in Surgical Approaches for Hypospadias Repair

Modern surgical techniques aim to achieve both functional and cosmetic restoration of the penis. The key objectives include: Correction of ventral curvature (chordee) to ensure a straight erection. Formation of a neourethra reaching the glans tip to ensure normal urination. Penile skin reconstruction with the option of circumcision or preputioplasty. [2, 3]

Historical Development of Hypospadias Surgery

The advancement of hypospadias repair has been closely linked to the improvement of penile curvature correction techniques. Early surgical approaches primarily focused on urethral reconstruction, with less emphasis on straightening the penis. Initially, it was believed that ventral penile tissue in proximal hypospadias was the primary cause of curvature and required complete excision. Consequently, chordee correction was often secondary to urethroplasty.

In the 1970s and 1980s, English-language literature used "curvature" and "chordee" as distinct terms. Over time, they became synonymous, leading to terminological confusion, as all ventral tissue was often referred to as chordee.

From the first radical hypospadias surgeries in the 19th century until the late 1980s, the practice of excising chordee in cases of ventral curvature was rarely questioned. However, concerns regarding functional outcomes, findings from histological studies, and increasing surgical experience in penile curvature correction contributed to a paradigm shift in hypospadias management. [16, 17]

Reevaluation of Penile Curvature and Introduction of the Urethral Plate Concept

A significant turning point came with the work of J. Duckett and colleagues, who challenged the traditional belief that ventral penile tissue was the primary cause of curvature. Their findings suggested that in most cases, penile curvature resolved after degloving and excision of paraurethral tissue.

They also demonstrated that dorsal plication could effectively correct residual curvature.

Duckett and his team introduced the term "urethral plate", replacing the term "chordee" in some cases. This marked the first major reevaluation of penile curvature since S. Duplay's urethroplasty techniques. They concluded that the tissue extending from the meatus to the glans tip did not contribute to curvature and could thus be preserved for urethral reconstruction. [2, 13, 15]

Onlay Techniques and Preservation of the Urethral Plate

The onlay technique, based on the principle of overlay grafting, was designed to maintain the flat (non-tubularized) urethral plate as the posterior wall of the neourethra.

In these techniques: The anterior semicircle of the neourethra is reconstructed using a vascularized skin flap, which serves as an overlay graft. This approach minimizes extensive urethral reconstruction, reducing the risk of complications such as stricture formation and fistula development. These advancements significantly influenced modern hypospadias repair, emphasizing tissue preservation and a more physiological approach to neourethra construction.

Surgical Treatment Methods for Hypospadias

The surgical management of distal hypospadias is primarily considered a cosmetic procedure, with an emphasis on techniques that provide the best aesthetic and functional outcomes. Among the various surgical approaches, urethral plate tubularization has gained widespread acceptance due to its simplicity and effectiveness. [13, 15]

Snodgrass Technique and Its Evolution

A major breakthrough in hypospadias repair was the modification of urethral plate tubularization introduced by W. Snodgrass. Initially, this technique aimed to enhance cosmetic outcomes in mild hypospadias cases, particularly by creating a natural-looking urethral meatus.

Snodgrass later described this method as an unintentional fusion of existing hypospadias repair techniques, which unexpectedly produced excellent results. Its key advantages included: A more anatomically normal meatal appearance. Preservation of the urethral plate, maintaining native tissue for reconstruction. A simpler alternative to the onlay technique, reducing surgical complexity.

Over time, this method was adapted for proximal hypospadias repair, leading to the development of an extended neourethra entirely derived from the urethral plate. This adaptation expanded its applicability, making it one of the most widely used techniques in modern hypospadias surgery. [4, 6, 13]

Advancements in Hypospadias Surgery: The TIP and Two-Stage Techniques

Snodgrass and the Tubularized Incised Plate (TIP) Urethroplasty

The Tubularized Incised Plate (TIP) urethroplasty, introduced by W. Snodgrass, revolutionized hypospadias repair and remains the most widely cited technique in modern pediatric urology. His seminal work, *"Tubularized Incised Plate Urethroplasty for Distal Hypospadias,"* is the most referenced technical publication in urology, and Snodgrass himself is the most cited hypospadiologist in the past 50 years–with 10 of the 150 most-cited articles in this field attributed to him. The TIP technique involves: Dissecting the urethral plate and making a midline incision to release tension. Tubularizing the incised plate over a catheter to create an artificial urethra. Preserving the native urethral plate, which improves functional and aesthetic outcomes.

Initially designed for distal hypospadias, the TIP technique was later adapted for proximal hypospadias repair, making it a versatile and widely utilized approach.

The Two-Stage Approach and Bracka's Contribution While urethral plate-preserving techniques were gaining popularity, alternative approaches emerged, particularly in complex or previously operated cases. One such method was the two-stage repair, which used buccal mucosa or a free graft from the inner preputial layer to reconstruct the urethra.

A. Bracka played a key role in popularizing this two-stage technique, which was initially designed for reoperative hypospadias repair but later became widely adopted for primary proximal hypospadias cases. However, controversy exists regarding the origins of the method: Some surgeons argue that Bracka did not invent the technique but rather refined and promoted it.

There is debate over whether his approach was based on the work of Cloutier or Turner-Warwick, though Bracka himself never explicitly credited either surgeon.

Despite this debate, Bracka's contributions significantly influenced contemporary hypospadias surgery, offering a valuable alternative for complex cases requiring staged reconstruction. [5, 6, 13]

Bracka's Two-Stage Hypospadias Repair: First Stage

The first stage of Bracka's technique focuses on preparing the ventral penile surface for urethral reconstruction by placing a free graft. The key steps include: Excision of abnormal tissue from the hypospadiac meatus to the coronal sulcus to create a uniform graft bed. Midline incision of the glans

and mobilization of its lateral "wings" to facilitate later neourethral formation. Harvesting a free graft from the inner preputial layer (without vascular supply) to serve as the new urethral tissue. Positioning the graft precisely in the future urethral location, ensuring adequate integration. Covering the ventral penile defect with the prepared preputial graft, allowing it to take before the second stage of repair.

This two-stage approach allows optimal graft take and vascularization before proceeding with urethral tubularization in the second stage. It is particularly beneficial for severe proximal hypospadias and cases requiring reoperative repair.

Bracka's Two-Stage Hypospadias Repair: Second Stage of Bracka's technique closely resembles the S. Duplay urethroplasty, where the preputial graft, previously placed on the ventral penile surface, is transformed into a functional neourethra. The main steps include: Dissecting the graft, including the neomeatus, from the underlying tissues. Tubularizing the graft over a catheter to reconstruct the neourethra. Securing the neourethra in place, ensuring adequate healing and minimal tension. [7, 9, 12]

Refinements and Modifications: To improve graft survival and surgical outcomes, modifications to Bracka's technique have been introduced. One key refinement involves perforating the preputial graft multiple times with an 18G needle before fixation, which is believed to: Reduce hematoma formation beneath the graft, preventing complications. Increase the graft's surface area, enhancing its adherence and vascularization. These refinements have contributed to improved functional and cosmetic results, making Bracka's approach a widely used method for complex proximal hypospadias repairs and redo surgeries. [9, 12]

Advanced Modifications in Hypospadias Repair: Combining TIP and Grafting

Techniques: In proximal hypospadias repair, the second stage of Bracka's two-stage technique can integrate elements of TIP urethroplasty, particularly by performing a midline relaxing incision on the preputial graft before tubularization. This modification aims to: Reduce suture line tension, which is essential for proper healing. Prevent complications such as fistulas and urethral stenosis.

Use of Oral Mucosa Grafts Although the inner preputial layer remains the preferred free graft material in Bracka's procedure, oral mucosa continues to be a relevant alternative, particularly in revision surgeries. Oral mucosal grafts are typically harvested from the: Lower lip mucosa (alternative donor site).The technical process for oral mucosa grafting is similar to preputial grafting and is commonly used in patients with complications from previous hypospadias repairs**.**

Role of Hormonal Therapy in Tissue Expansion: In cases where preputial tissue is insufficient (e.g., preputial hypoplasia or small penile size), some surgeons apply testosterone-based ointments preoperatively. This technique has been shown to: Temporarily enlarge the prepuce and increase penile size, facilitating a more successful reconstruction.

GTIP ("Snodgraft") – An Intermediate Approach: An intermediate technique between TIP urethroplasty and Bracka's staged repair involves replacing the defect created by urethral plate incision with a free graft (usually buccal mucosa or the inner preputial layer). This approach is known as GTIP (Grafted TIP) or "Snodgraft", an enhanced modification of TIP urethroplasty.

It is primarily performed in one-stage repairs for patients with a narrow urethral plate but no significant penile curvature. Surgeons prefer this method to minimize the risk of scarring, a common concern following urethral plate incision. [5, 9, 13]

Age-Related Considerations in GTIP Technique

Some experts propose that in older patients undergoing TIP urethroplasty, the need for graft reinforcement with preputial tissue or oral mucosa increases due to a higher risk of stricture formation in a less elastic urethral plate. Improved long-term outcomes when an inlay graft is placed to reinforce the incised urethral plate. The GTIP method is regarded as an effective strategy to minimize stricture formation and improve functional and aesthetic outcomes in select patients undergoing hypospadias repair. [1, 4, 13]

Nesbit's Contribution and Baskin's Modifications

The technique introduced by R. Nesbit in 1965 remains one of the most widely used methods for penile curvature correction. This approach, which involves dorsal plication of the tunica albuginea, has undergone modifications over time. Among these refinements, L. Baskin's adaptation has gained significant popularity, offering improved surgical precision and functional outcomes.

Despite advancements in hypospadias repair techniques, the debate over the role of the urethral plate and the nature of ventral curvature (chordee) continues to shape modern approaches to surgical correction.

Severe hypospadias remains a significant surgical challenge, with one-stage techniques carrying complication rates between 20% and 50%. A key topic of debate in the scientific literature is the

selection of one-stage versus two-stage urethroplasty. [13,15] A 2016 survey of 386 surgeons from 76 countries analyzed surgical preferences, demonstrating a direct correlation between the proximal location of the meatus and the increased likelihood of selecting a two-stage repair.. For distal hypospadias, the TIP (Tubularized Incised Plate) method, which preserves the urethral plate, was the preferred technique in nearly three-quarters (71%) of cases, while only one in every 200 surgeons (0.5%) opted for a two-stage procedure. In contrast, for proximal hypospadias, the preference for two-stage approaches increased to more than three-quarters (76.6%) of cases. [7, 11, 12]

However, the study did not distinguish between specific two-stage techniques, meaning the reported figures encompass both free graft-based methods (which rely on non-vascularized tissue) and procedures utilizing vascularized non-tubularized flaps, typically derived from preputial skin and transferred to the ventral surface. Among these, onlay techniques, such as the approach described by J. Duckett, were used in nearly one-third (29.5%) of penoscrotal hypospadias cases.

Numerous authors conducting comparative analyses of various proximal hypospadias repair techniques have increasingly emphasized the necessity of two-stage correction methods. These approaches are associated with superior functional and aesthetic outcomes, enhanced penile straightening, and lower complication rates.

The selection of a urethroplasty technique is primarily determined at the time of penile curvature correction, and the debate between one-stage and two-stage procedures remains ongoing. A ten-year comparative analysis of publications evaluating different proximal hypospadias repair techniques found that complication rates were comparable between one-stage and two-stage surgeries. Based on this, researchers advocate for refining and integrating multiple surgical techniques to optimize clinical outcomes.

The urethral plate is widely considered the most suitable graft material for urethroplasty, particularly when it is broad, penile curvature is mild, and correction can be achieved through corporal body release or dorsal plication of the tunica albuginea, utilizing techniques by R. Nesbit, L. Baskin, and their modifications.

Several single-stage urethral reconstruction techniques, including N. Hodgson's method (which involves transposition of a tubularized dorsal flap) and TPIF (transverse preputial island flap), have seen a notable decline in usage, with discussions in the scientific literature nearly ceasing over the past decade. However, onlay procedures, such as OIF (onlay island flap), continue to be relevant. [12, 14, 15]

Recently, TIP (Tubularized Incised Plate) and GTIP (Graft-augmented TIP, also known as "Snodgraft") techniques have been increasingly adopted for proximal hypospadias repair, provided that urethral reconstruction can proceed without transecting the urethral plate.

For cases where penile curvature is severe, requiring urethral plate transection, two-stage techniques have gained significant traction. Among these, A. Bracka's technique has become one of the most widely discussed methods in recent years.

One key advantage of Bracka's approach is the creation of an artificial urethra that is anchored to the ventral surface of the corpora cavernosa, closely mimicking normal anatomical structure. This technique helps prevent postoperative displacement of the neourethra beneath the skin. Furthermore, multiple studies have reported that Bracka's technique is associated with lower surgical complication rates compared to single-stage alternatives.

The surgical treatment of proximal hypospadias remains complex due to the high complication rates associated with different techniques. The growing preference for A. Bracka's method among surgeons has prompted multiple studies examining its potential complications. These studies have also emphasized its advantages over single-stage techniques, with complication rates serving as a key indicator of procedural effectiveness. [9, 11, 12]

Modification of Bracka's Technique

An attempt to replace the free graft with a transverse preputial flap on a vascular pedicle for ventral penile surface reconstruction resulted in a marked increase in complications, particularly urethral diverticula.

Due to the high failure rate, this modification was abandoned.

Overall Complication Rates in Proximal Hypospadias Repair

Postoperative complication rates range from 32% to 68%, depending on the severity of hypospadias and the surgical approach used.

Comparative analyses indicate that two-stage techniques generally lead to fewer complications than single-stage procedures. [9, 11]

Outcomes of the Free Graft Technique

When free grafts are used, complication rates are comparable to other techniques.

In primary patients, literature reports suggest a 0% complication rate after the first stage.

After the second stage, the complication rate remains low, at ≤4.5%, demonstrating a significant reduction compared to alternative methods.

The treatment algorithm for hypospadias has evolved, with modern approaches focusing on surgical technique selection based on the severity of penile curvature. Pediatric urologists continue to refine treatment strategies, incorporating preoperative assessments, surgical interventions, and grafting techniques to optimize outcomes.

Initial Surgical Assessment and Curvature Measurement The degloving procedure is the first step, where the penile shaft skin and Dartos fascia are mobilized from Buck's fascia to expose the corpora cavernosa. An artificial erection test is performed using physiological sodium chloride solution injected into one of the corpora cavernosa to evaluate the degree of ventral curvature. [7, 10, 11]

Surgical Approach Based on Curvature Severity Curvature ≤30°: Correction is performed using tunica albuginea plication of the corpora cavernosa. A TIP (Tubularized Incised Plate) procedure is used for urethroplasty. An onlay procedure may be an alternative if the meatus is proximally located, and the surgeon prefers this technique. Single-stage correction is feasible in these cases. Curvature >30°: The urethral plate is transected and excised. Ventral lengthening corporoplasty is performed. The defect on the ventral surface is reconstructed using a free graft from the inner preputial layer, following the first stage of A. Bracka's procedure. Grafting Techniques and Modifications

The risk of complications in hypospadias surgery remains high, prompting ongoing research into new graft materials and modifications of existing techniques. Single-stage correction has been explored using a pre-tubularized buccal mucosal graft, which is anastomosed with the hypospadiac meatus. Buccal mucosa can also serve as an onlay graft on a preserved urethral plate, similar to single-stage urethroplasty. Alternative graft sources include: Ventral tongue mucosa, which represents a variation of the Bracka procedure. Bladder mucosa, used as a tubularized graft. [1, 9, 12]

Advancements in Staged vs. Single-Stage Techniques

Although staged free graft procedures are widely discussed for proximal hypospadias, some authors continue to develop single-stage flap techniques.

Modified single-stage approaches have been reported to reduce complication rates.

Tissue Engineering in Urethral Reconstruction Tissue engineering for urethral reconstruction is an emerging experimental approach, mainly applied to severely affected patients. The technology for preparing and utilizing tissue-engineered grafts is complex and limited to specialized institutions. Reported outcomes show a high success rate of 91% and a minimal complication rate. [2, 3, 11]

Treatment Outcomes in Hypospadias Surgery

The surgeon's expertise and annual surgical volume play a critical role in treatment success. Experts recommend performing 100 to 200 hypospadias surgeries per year to achieve optimal functional and aesthetic outcomes. Complication Rates in High-Volume vs. Low-Volume Centers A study analyzing 17,000+ patients across 75 centers in the UK found that high-volume centers had significantly lower complication rates compared to low-volume centers: High-volume centers: 17,5% complication rate. Low-volume centers: 25% complication rate. Cosmetic Outcome Assessment The HOPE method (Hypospadias Objective Penile Evaluation) provides an objective scoring system to assess postoperative aesthetic results. This method includes a questionnaire and a standardized evaluation of postoperative photographs. HOPE is recommended as a tool for selecting optimal surgical techniques. Standardized Reporting of Treatment Outcomes

A standardized approach to data reporting is essential for comparing outcomes across different clinics. The STROBE method (Strengthening the Reporting of Observational Studies in Epidemiology) was introduced to provide clear guidelines on structuring clinical publications. This reporting system was later adopted and adapted for hypospadias research at an international hypospadias congress. [4, 5, 8]

Conclusion Hypospadias remains a subject of extensive research due to the numerous unresolved challenges in its pathophysiology, surgical correction, and postoperative outcomes. Despite advancements in reconstructive urology, significant variability persists in treatment approaches, highlighting the need for further refinement of surgical techniques and postoperative management strategies.

Current discussions in both international and domestic literature focus on optimizing urethroplasty techniques, minimizing complication rates, and improving functional and aesthetic outcomes. Com-

parative studies continue to assess the efficacy of single-stage versus staged procedures, with increasing emphasis on individualized treatment strategies based on the severity of penile curvature and urethral plate characteristics.

A major area of focus in contemporary research is the standardization of treatment protocols and the development of evidence-based algorithms for surgical correction. Establishing uniform surgical guidelines is expected to enhance treatment predictability, facilitate comparative research across institutions, and contribute to improved patient outcomes. The global scientific community remains committed to refining these protocols, ensuring a higher standard of care for patients with hypospadias.

Литература/References

1. Makhmudovich, Akhmedov Yusuf, et al. "Modern methods in the treatment of hypospadias head type. "American Journal of Biomedical Science & Pharmaceutical Innovation 5.02 (2025): 12-16.
2. Shukhrat, Yusupov Abdurasulovich, et al. "Results of surgical treatment of hypospadia in boys." Academy 5 (56) (2020): 72-75.
3. Pulatov, P. A., and M. A. Baturov. "RESULTS OF SURGICAL TREATMENT OF HYPOSPADIA IN BOYS IN THE COMMUNITY OF INDEPENDENT STATES." MEDITSINSKOE OBRAZOVANIE SEGODNYA: 51.
4. Van der Horst, H. J. R., and L. L. De Wall. "Hypospadias, all there is to know." European Journal of Pediatrics 176 (2017): 435-441.
5. Sparks, Teresa N., and Society for Maternal-Fetal Medicine (SMFM. "Hypospadias." American Journal of Obstetrics and Gynecology 225.5 (2021): B18-B20.
6. Ataullaevich, Akilov Farkhad, et al. "Assessment of the specific characteristics of urethral stricture according to records of Medical Republican Institution of Uzbekistan." European Science Review 9-10-2 (2018): 207-211.
7. Gong, Edward M., and Earl Y. Cheng. "Current challenges with proximal hypospadias: we have a long way to go." Journal of Pediatric Urology 13.5 (2017): 457-467.
8. Takvani, Anil, and Mahakshit Bhat. "Evaluating the Results of Hypospadias Repair: What? Why? When? And How?" Hypospadiology: Current Challenges and Future Perspectives. Singapore: Springer Nature Singapore, 2023. 103-126.
9. Zhang, Youtian, et al. "Grafts vs. flaps: a comparative study of Bracka repair and staged transverse preputial island flap urethroplasty for proximal hypospadias with severe ventral curvature." Frontiers in Pediatrics 11 (2023): 1214464.
10. Lucas, Jacob, et al. "Time to complication detection after primary pediatric hypospadias repair: a large, single center, retrospective cohort analysis." The Journal of Urology 204.2 (2020): 338-344.
11. Cousin, Ianis, et al. "Complication rates of proximal hypospadias: meta-analyses of four surgical repairs." Journal of Pediatric Urology 18.5 (2022): 587-597.
12. Wu, Yong, et al. "Repair of proximal hypospadias with single-stage (Duckett's method) or Bracka two-stage: a retrospective comparative cohort study." Translational Pediatrics 12.3 (2023): 387.
13. Abdullaev, Zafar, et al. "Risk factors for fistula recurrence after urethrocutaneous fistulectomy in children with hypospadias." Turkish Journal of Urology 47.3 (2020): 237.
14. Mole, Rosalind Jane, Stuart Nash, and Duncan Neil MacKenzie. "Hypospadias." BMJ 369 (2020).
15. Kim, Kellie J., et al. "Expert classification of hypospadias: an external validation and evaluation of agreement for Glans–Urethral Meatus–Shaft (GMS) and Hypospadias Objective Penile Evaluation (HOPE) scores." Pediatric Surgery International 40.1 (2024): 233.
16. Hadidi, Ahmed T. "History of Hypospadias." Hypospadias Surgery: An Illustrated Textbook. Cham: Springer International Publishing, 2022. 3-24.
17. Barbagli, Guido, et al. "Natural history of patients with hypospadias who underwent surgical repair: an observational descriptive analysis with a final surprise: MP52-14." Journal of Urology 195.4 (2016): e694.