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Selection of an Alternative Endoscopic Treatment Method for Primary High-Grade Vesicoureteral Reflux in Children

Raxmatullayev Akmal Abadbekovich, Ergashev Muhammadjon Tursunovich

Department of Pediatric Surgery, Urology, Pediatric Urology, Anesthesiology and Resuscitation, Pediatric Anesthesiology and Resuscitation, Tashkent State Medical University, Uzbekistan

Abstract **Objective.** To improve the effectiveness of endoscopic correction in children with primary high-grade vesicoureteral reflux. **Materials and Methods.** The study included 107 patients diagnosed with primary high-grade vesicoureteral reflux. Based on the criteria identified during diagnostic cystoscopic examination, indications for specific endoscopic injection techniques were selected. **Results.** The STING, HIT-1, and HIT-2 techniques were used for endoscopic correction. In this study, the HIT-1 and HIT-2 techniques demonstrated high efficacy rates of 84.3% and 97.3%, respectively. **Conclusion.** Endoscopic correction methods allow achieving high treatment efficacy in children with primary high-grade vesicoureteral reflux.

Keywords Primary vesicoureteral reflux

1. Introduction

Primary vesicoureteral reflux (VUR) in children accounts for up to 30% of congenital anomalies of the urinary tract. This pathology is characterized by delayed diagnosis, the need for complex treatment approaches, and a relatively high incidence of postoperative complications [1,3,17].

Studies have demonstrated a direct association between VUR in children and recurrent urinary tract infections (UTIs), as well as renal parenchymal scarring. According to research findings, when infection ascends and spreads to the renal pelvicalyceal system, the development of reflux nephropathy is frequently observed. Prolonged or recurrent UTIs lead to inflammatory and fibrotic processes in the renal tissue, ultimately resulting in renal parenchymal scarring and the development of chronic kidney disease [2,4,14].

In recent years, endoscopic correction methods have been increasingly used in the treatment of high-grade VUR. The main advantages of this approach include its minimally invasive nature, short rehabilitation period, and low level of surgical trauma. However, in certain cases, endoscopic treatment does not completely eliminate VUR, and open surgical intervention becomes necessary. Nevertheless, fibrotic changes in the tissues of the urinary system observed after endoscopic correction do not complicate subsequent open surgical procedures and do not increase the risk of postoperative complications such as ureteral stricture or obstruction [5,7,15].

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These factors highlight the importance of early diagnosis, individualized selection of treatment strategies, and improvement of surgical outcomes. Therefore, the development of scientifically grounded approaches for the timely diagnosis and effective management of primary high-grade vesicoureteral reflux in children remains a highly relevant clinical issue [6,8,9].

Despite ongoing scientific debate regarding VUR and its consequences, several important aspects have gained consensus among specialists. In particular, bladder dysfunction has been shown to significantly influence VUR outcomes; in some cases, reflux may resolve spontaneously, and not all children require active surgical or pharmacological treatment [10,11,16].

In recent years, special attention has been given to risk stratification and patient grouping based on factors such as urinary tract infection, patient age, reflux grade, and bladder function [12,13,18].

2. Study Objective

To improve the effectiveness of endoscopic correction methods in children with primary high-grade vesicoureteral reflux (VUR).

3. Materials and Methods

The study included 107 patients treated for high-grade vesicoureteral reflux at the Department of Urology of the

Multidisciplinary Pediatric Clinic of Tashkent State Medical University between 2019 and 2025.

Analysis of the reasons for hospital admission among children with primary high-grade VUR showed that the most common presenting complaints were recurrent urinary tract infections and symptoms of pyelonephritis accompanied by fever. To establish a differential diagnosis of the observed clinical manifestations, a set of laboratory and instrumental diagnostic methods was applied.

The primary objective of the study was to determine the severity and functional changes associated with primary high-grade vesicoureteral reflux in children and to establish comprehensive diagnostic criteria for selecting the optimal surgical treatment strategy.

During cystoscopic examination, the condition of the bladder mucosa (hyperemic, bullous, or trabeculated), the shape of the ureteral orifice (slit-like, oval, or round), and the degree of contraction of the ureteral orifice were evaluated. In cases of high-grade reflux, the ureteral orifice was typically round or funnel-shaped, often accompanied by insufficient contraction and hyperemia of the mucosa.

The appearance of the trigone (Lieutaud's triangle) was also found to be directly related to the severity of reflux. In mild reflux, the trigone was clearly delineated, whereas in moderate and severe reflux its borders appeared indistinct or completely undifferentiated, indicating disruption of the normal anatomical structure of the trigone.

In patients with high-grade VUR who demonstrated relatively preserved cystoscopic findings—intact trigonal structure, minimal mucosal changes, and mild hydrodilatation—endoscopic treatment methods (HIT-1 or HIT-2) were considered effective. However, in patients with deformation of the ureteral orifice, disrupted trigonal boundaries, and pronounced hydrodilatation insufficiency, pneumovesicoscopic or exploratory ureteral reimplantation procedures were selected (Table 1).

In a total of 107 patients included in the study, endoscopic correction was performed using the STING (Subureteric Teflon Injection), HIT-1 (Hydrodistention Implantation Technique — single-stage), and HIT-2 (two-stage) techniques. Polyacrylamide hydrogel (DAM+) was used as the injectable bulking agent for endoscopic correction.

In the STING technique, DAM+ gel was injected into the submucosal layer approximately 2–3 mm below the ureteral orifice at the 6-o'clock position using a cystoscope. As a result of the injection, a mound-like elevation was formed, mechanically preventing the retrograde flow of urine. The main advantages of this technique are its technical simplicity and short procedural time.

In the HIT-1 technique, the injection was performed into the distal part of the intramural segment of the ureter. The gel was delivered into the submucosal layer of the ureteral orifice. As a result, the length of the intramural ureteral segment increased, thereby restoring the physiological antireflux mechanism.

The HIT-2 technique represents a two-stage implantation approach, in which injections were performed into both the distal and proximal portions of the intramural ureteral segment. This combined approach resulted in elevation of the ureteral orifice and restoration of the intramural canal length and closure angle, thereby minimizing the risk of reflux recurrence (Figure 1).

Table 1. Distribution of patients according to sex, vur grade, and cystoscopic factors

Variables	Category	Number (n)	Percentage (%)
Sex	Female	44	41.1%
	Male	63	58.9%
Shape of the ureteral orifice	Slit-like	29	27.1%
	Oval-shaped	36	33.6%
	Round	42	39.3%
Vesicoureteral reflux (VUR) grade	IV	68	63.6%
	V	39	36.4%
Degree of hydrodilatation	H-1	60	56.1%
	H-2	45	42.1%
	H-3	2	1.9%
Differentiation of the trigone	Clearly differentiated	71	66.4%
	Partially differentiated	30	28.0%
	Poorly differentiated	6	5.6%
Surgical method	HIT-1	51	47.7%
	HIT-2	37	34.6%
	STING	19	17.8%

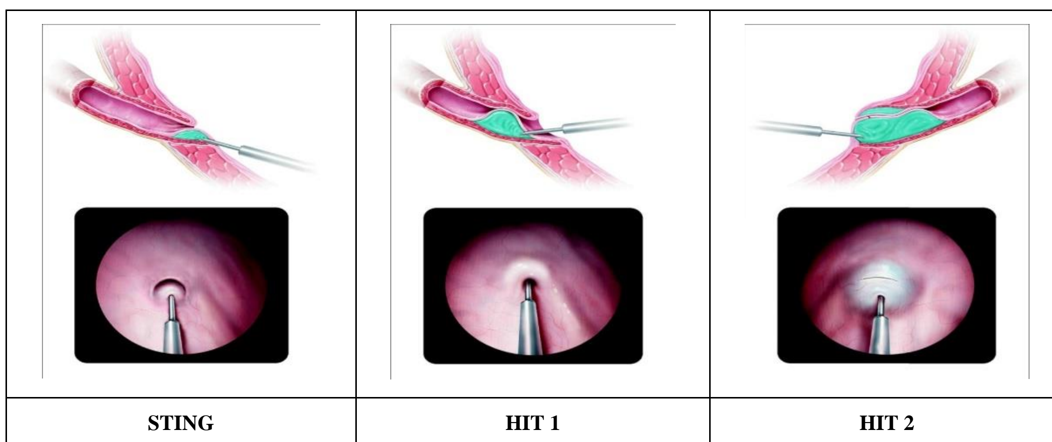

Figure 1

4. Results

The outcomes of endoscopic correction using the STING, HIT-1, and HIT-2 techniques were evaluated in all patients and categorized into three groups: good, satisfactory, and unsatisfactory results (Table 2).

Table 2. Analysis of endoscopic correction outcomes

Surgical method	Results	Number (n)	Percentage (%)
HIT-1 (n=51)	Good	43	84.3%
	Satisfactory	6	11.8%
	Unsatisfactory	2	3.9%
HIT-2 (n=37)	Good	36	97.3%
	Satisfactory	1	2.7%
	Unsatisfactory	0	0%
STING (n=19)	Good	0	0%
	Satisfactory	8	42.1%
	Unsatisfactory	11	57.9%
Overall (n=107)	Good	79	73.8%
	Satisfactory	13	12.1%
	Unsatisfactory	15	14.0%

Patients were analyzed according to VUR grade and the outcomes of endoscopic correction (Table 3).

Table 3. Analysis of VUR Grade and Endoscopic Correction Outcomes

VUR degree	Results	Number (n)	Percentage (%)
IV (n=68)	Good	58	85.3%
	Satisfactory	7	10.3%
	Unsatisfactory	3	4.4%
V (n=39)	Good	21	53.8%
	Satisfactory	6	15.4%
	Unsatisfactory	12	30.8%
Overall (n=107)	Good	79	73.8%
	Satisfactory	13	12.1%
	Unsatisfactory	15	14.0%

Patients were analyzed according to the degree of hydrodilatation (H) and surgical outcomes (Table 4).

Table 4. Analysis of hydrodilatation degree and endoscopic correction outcomes

Degree of Hydrodilatation	Results	Number (n)	Percentage (%)
H-1 (n=60)	Good	52	86.7%
	Satisfactory	4	6.7%
	Unsatisfactory	4	6.7%
H-2 (n=45)	Good	26	57.8%
	Satisfactory	10	22.2%
	Unsatisfactory	9	20.0%
H-3 (n=2)	Good	1	50.0%
	Satisfactory	0	0%
	Unsatisfactory	1	50.0%
Overall (n=107)	Good	79	73.8%
	Satisfactory	13	12.1%
	Unsatisfactory	15	14.0%

Patients were analyzed according to the cystoscopic shape of the ureteral orifice and surgical outcomes (Table 5).

Table 5. Analysis of Ureteral Orifice Shape and Endoscopic Correction Outcomes

Orifice Shape	Results	Number (n)	Percentage (%)
Round (n=42)	Good	29	69.0%
	Satisfactory	2	4.8%
	Unsatisfactory	11	26.2%
Oval-shaped (n=36)	Good	25	69.4%
	Satisfactory	7	19.4%
	Unsatisfactory	4	11.1%
Slit-like (n=29)	Good	25	86.2%
	Satisfactory	4	13.8%
	Unsatisfactory	0	0%
Overall (n=107)	Good	79	73.8%
	Satisfactory	13	12.1%
	Unsatisfactory	15	14.0%

Patients were analyzed according to the cystoscopic differentiation of the trigone (Lieutaud's triangle) and surgical outcomes (Table 6).

Table 6. Analysis of trigone (lieutaud's triangle) differentiation and outcomes

Degree of Differentiation	Results	Number (n)	Percentage (%)
Clearly differentiated (n=71)	Good	65	91.5%
	Satisfactory	6	8.5%
	Unsatisfactory	0	0%
Partially differentiated (n=30)	Good	12	40.0%
	Satisfactory	7	23.3%
	Unsatisfactory	11	36.7%
Poorly differentiated (n=6)	Good	2	33.3%
	Satisfactory	0	0%
	Unsatisfactory	4	66.7%
Overall (n=107)	Good	79	73.8%
	Satisfactory	13	12.1%
	Unsatisfactory	15	14.0%

5. Discussion

The primary aim of this study was to improve the effectiveness of endoscopic correction in children with primary high-grade vesicoureteral reflux (VUR) by using cystoscopic criteria to select the optimal injection technique. The most valuable finding is that the HIT-2 technique achieved a 97.3% success rate, significantly outperforming STING (0% good results) in patients with grade IV–V reflux. Additionally, cystoscopic features such as round ureteral orifices and poorly differentiated trigones were identified as key predictors of treatment failure with less invasive techniques, highlighting the importance of tailoring the surgical approach to individual anatomy.

Our findings align with previous studies reporting limited efficacy of STING in high-grade VUR, while the high success of HIT-2 is consistent with authors such as Yilmaz et al., who demonstrated that two-stage implantation better restores the antireflux mechanism. The main limitations of this study are the modest sample size and lack of long-term follow-up data. Future research should focus on larger, multicenter studies to develop a predictive scoring system that integrates both anatomical and functional factors for personalized treatment selection.

6. Conclusions

In children with high-grade vesicoureteral reflux (VUR), endoscopic correction using polyacrylamide hydrogel (DAM+) was shown to be an effective method for restoring the antireflux mechanism. Accurate assessment of the disrupted antireflux mechanism is of critical importance in managing the disease. Although the STING technique is technically simple and can be performed quickly, the HIT-1 and HIT-2 techniques demonstrated higher efficacy. These methods allowed restoration of the intramural ureteral segment length, physiological reconstruction of the antireflux mechanism, and reduction of the risk of VUR recurrence. Therefore, for cases of high-grade VUR, the HIT-1 and HIT-2 techniques are considered preferable.

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