IJEBM International Journal of Evidence-Based Medicine

International Journal of Evidence-Based Medicine
(eISSN 3083-1776)

Australasia Publishing Group

Original Article

Endoscopic Correction of Vesicoureteral Reflux in Children: A Comparative Analysis of Efficacy and Safety of Minimally Invasive and Open Surgical Methods

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Received: Mar 26, 2026
Accepted: Jun 26, 2026

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Citation: Shamsiev A, Aslam A, Okawada M, Shamsiev J, Soyer T, Ksia A, et al. Endoscopic Correction of Vesicoureteral Reflux in Children: A Comparative Analysis of Efficacy and Safety of Minimally Invasive and Open Surgical Methods. International Journal of Evidence-Based Medicine. 2026;1(2):jebm009.
https://doi.org/10.63946/jebm/18910

ABSTRACT

Introduction: Vesicoureteral reflux (VUR) is one of the most prevalent conditions in pediatric urology, occurring in approximately 1–2% of children; among those presenting with urinary tract infections, VUR is detected in 25–40% of cases. The incidence shows no declining trend and increases annually in line with global population growth.

Methods: This retrospective-prospective, single-center, comparative cohort study enrolled 110 children aged 8 months to 18 years with VUR grades II–IV treated at the Specialized Pediatric Surgical Clinic of Samarkand State Medical University (1989–2022). Patients were allocated to two non-concurrent treatment groups based on the era of admission: the control group (CG, n=32; 1989–2011) underwent open antireflux surgery, and the study group (SG, n=78; 2012–2022) underwent endoscopic correction of VUR (ECVUR). Patients with grades I and V VUR were excluded.

Results: In the SG, the proportion of good outcomes was 78.2%, exceeding that of the CG (65.6%). Unsatisfactory results were 2.9-fold lower (6.4% vs. 18.8%). Hospitalization was significantly reduced from 16.7±3.3 to 5.2±1.2 bed-days ($p<0.001$). The economic efficiency coefficient improved 3.2-fold. Overall ECVUR efficacy was 93.6% versus 81.2% for open surgery.

Conclusion: Minimally invasive endourological methods demonstrate superior efficacy and safety compared with open antireflux surgery for the treatment of VUR in children.

Keywords: Vesicoureteral Reflux; Endoscopic Correction; Children; STING; HIT; Pediatric Urology; Minimally Invasive Surgery; Open Antireflux Surgery

Introduction

Vesicoureteral reflux (VUR) is one of the most prevalent conditions in pediatric urology, occurring in approximately 1–2% of children in the general population; among those presenting with urinary tract infections (UTI), VUR is detected in 25–40% of cases. The incidence shows no declining trend and, given global population growth, the number of affected patients increases annually.

Diagnosis of VUR presents significant challenges owing to the absence of pathognomonic symptoms. Identification of the condition requires comprehensive urological evaluation, feasible only in specialized centres. As a rule, VUR manifests clinically when UTI develops; in advanced cases, renal dysfunction is characteristic. Given the growing number of VUR cases, its distinctive clinical course, the potential for severe complications including impaired renal function, and the risk of reflux nephropathy, the development of optimal diagnostic and minimally invasive surgical treatment methods constitutes an urgent clinical priority.

Leading international organizations — including the International Pediatric Nephrology Association (IPNA), the European Society for Paediatric Urology (ESPU), and the American Academy of Pediatrics (AAP) — are actively researching diagnostic and therapeutic aspects of childhood VUR. The effectiveness of surgery is a key element in management, with reported success rates of endoscopic reflux correction (ERC) ranging from 85 to 90% depending on reflux grade and ureteral anatomy [1, 8].

Connor and Moran [4] emphasize the importance of accurate diagnosis and an individualized therapeutic approach consistent with current ESPU recommendations. Clayton and Gearhart [5] report on the long-term effectiveness of antibiotic prophylaxis. Williams and Diamond [7] explore genetic risk factors, constituting a priority research direction for IPNA. Several studies from Uzbekistan have also addressed various aspects of VUR management [9, 10].

The present study aims to compare the outcomes of minimally invasive endoscopic correction with open antireflux surgery for VUR in children, and to describe the diagnostic-treatment algorithm developed at the Specialized Pediatric Surgical Clinic of Samarkand State Medical University.

Materials and Methods

Study Design and Patient Selection

This was a retrospective-prospective, single-center, comparative cohort study conducted at the Specialized Pediatric Surgical Clinic of Samarkand State Medical University — a 200-bed tertiary referral centre providing round-the-clock (24/7) specialized high-technology care to the pediatric population of Uzbekistan.

Patients aged 8 months to 18 years diagnosed with VUR grades II–IV (classified according to the International Reflux Study Group criteria) and treated between January 1989 and December 2022 were included. Inclusion required complete clinical documentation and parental or guardian consent. Patients with grade I VUR (managed conservatively) or grade V VUR (requiring primary reconstructive surgery) were excluded.

Treatment group allocation was non-randomized and determined by era of presentation rather than clinical selection:

Control group (CG, n=32; 1989–2011): patients who underwent conventional open antireflux surgery prior to the introduction of endoscopic techniques at this institution.

Study group (SG, n=78; 2012–2022): patients who underwent endoscopic correction of VUR (ECVUR) following institutional implementation of endourological technology in 2012.

Acknowledgement of historical bias: The two groups were treated in non-concurrent eras (1989–2011 vs. 2012–2022), introducing potential confounding from secular changes in anaesthetic practice, diagnostic imaging resolution, and postoperative care standards. To minimize this limitation, baseline comparability between groups was formally verified for all key demographic and disease parameters (sex, age, VUR grade, laterality, and disease duration) using appropriate statistical tests; no significant intergroup differences were identified (see Results, Tables 1–3, 7–8). Statistical analysis was performed blinded to treatment outcome. These constraints are acknowledged as limitations.

Ethics Approval and Patient Consent

Ethics approval: The study protocol was reviewed and approved by the Institutional Ethics Committee of Samarkand State Medical University (Protocol No. 12, dated 15 January 2023). All procedures were conducted in accordance with the principles of the Declaration of Helsinki (2013 revision).

Informed consent: Written informed consent was obtained from the parents or legal guardians of all participants prior to inclusion. For the retrospective component (CG), clinical data were de-identified prior to analysis in accordance with institutional data governance policy.

Data availability: The de-identified dataset supporting the conclusions of this article is available from the corresponding author upon reasonable request, subject to applicable institutional data governance regulations.

Diagnostic Protocol

All patients underwent a standardized diagnostic workup including: history and physical examination; complete blood count and urinalysis; serum biochemistry; urine bacteriological culture with antibiotic susceptibility testing; plain abdominal radiography; voiding cystourethrography (VCUG; radiographic units: EDR-750V, CR-30, Flexavision-SF, MINE-2; digital processing: X-Frame CCD); renal ultrasonography (Sono Scape SSI-5000; EDAN 500S; 3.5–7.5 MHz probes); excretory urography; uroflowmetry (FlowSelf portable device); and voiding diary analysis. Dynamic nephroscintigraphy (GE Discovery NM 530c) and MSCT (Siemens Definition AS 128-slice) were performed selectively according to clinical indication. In total, approximately 1,676 investigations were performed across both groups, including radiology, scintigraphy, uroflowmetry, and electrocardiography.

Surgical Techniques

In the CG, open antireflux surgery was performed under general endotracheal anaesthesia. Three techniques were employed: extravesical Lich-Gregoir ureteral reimplantation (n=21; 65.6%), intravesical Politano-Leadbetter technique (n=6; 18.8%), and cross-trigonal Cohen reimplantation (n=5; 15.6%). Post-operatively, ureteral and urethral drainage catheters were maintained for 12–14 days.

In the SG, ECVUR was performed under intravenous general anaesthesia with the patient in the modified lithotomy position. Cystourethroscopy was performed using a Richard Wolf (Germany) 8/9.8 Ch cystoscope (30° optic). For hydrodistension, ozonized (aerated) normal saline (0.5 mg/L) was used at a hydrostatic height of 1 metre above the bladder to achieve optimal intravesical pressure. The bulking agent — collagen (STING technique; n=58 patients, 79 ureters) or DAM+ copolymer (HIT technique; n=20 patients, 25 ureters) — was injected submucosally at the 6 o'clock position, 2–3 mm distal to the ureteric orifice. Volume (0.5–2.0 ml) was titrated according to the quantum satis principle until a 'sickle' or 'volcano'-shaped coaptation was achieved. In boys under 5 years, a urethral catheter was maintained for 24 hours post-procedure. Bilateral VUR was corrected sequentially in the same operative session.

Conservative Therapy

Conservative therapy (applicable to both groups as pre/perioperative management) comprised detoxification, anti-inflammatory treatment, culture-directed antibiotic therapy, uroantiseptics, and immunomodulators.

Statistical Analysis

Data were analysed using Statistica 6.0 (StatSoft Inc., USA) and Microsoft Excel 2020. Continuous data are expressed as mean ± standard error of the mean (SEM). Group comparisons for continuous variables employed Student's t-test or Mann-Whitney U test according to normality. Categorical variables were compared using Pearson's chi-square (χ^2), Yates-corrected χ^2, or Fisher's exact test. For proportions, the z-test was used. Statistical significance was set at $p<0.05$.

Results

Demographic Characteristics

Table 1. Distribution of patients by group and place of residence.

Group	Rural	Urban	Total
Study group (SG, n=78)	66 (84.6%)	12 (15.4%)	78 (70.9%)
Control group (CG, n=32)	23 (71.8%)	9 (28.2%)	32 (29.1%)
Total (n=110)	89 (80.9%)	21 (19.1%)	110 (100%)
χ^2 = 1.631; critical χ^2 (p<0.05) = 3.841; p>0.05; p=0.123 (no statistically significant difference between groups)			

Of 110 patients, 32 (29.1%) formed the CG (treated 1989–2011) and 78 (70.9%) formed the SG (treated 2012–2022). Children from rural areas predominated: 89 (80.9%) versus 21 (19.1%) urban; this distribution was consistent across both groups and did not differ significantly (p=0.123).

Table 2. Distribution of patients by age group and treatment group.

Age group	CG (n=32)	SG (n=78)	Total (n=110)
Up to 4 years	13 (40.6%)	34 (43.6%)	47 (42.7%)
5–9 years	11 (34.4%)	25 (32.1%)	36 (32.7%)
10–14 years	7 (21.9%)	16 (20.5%)	23 (20.9%)
15–18 years	1 (3.1%)	3 (3.8%)	4 (3.7%)
Total	32 (100%)	78 (100%)	110 (100%)
χ^2 = 0.137; critical χ^2 (p<0.05) = 7.815; p>0.05; p=0.988 (groups homogeneous by age)			

The most prevalent age category was children under 4 years (42.7%), consistent with the typical peak incidence of VUR at an age of intensive physical development. The groups were homogeneous with respect to age distribution (p=0.988).

Table 3. Distribution of patients by age group, sex, and treatment group.

Age group	SG Boys	SG Girls	CG Boys	CG Girls	Total Boys	Total Girls
Up to 4 years	15 (19.2%)	19 (24.5%)	5 (15.6%)	8 (25.0%)	20 (18.2%)	27 (24.6%)
5–9 years	10 (12.8%)	15 (19.2%)	4 (12.5%)	7 (21.9%)	14 (12.7%)	22 (20.0%)
10–14 years	3 (3.9%)	13 (16.7%)	5 (15.6%)	2 (6.3%)	8 (7.3%)	15 (13.6%)
15–18 years	2 (2.6%)	1 (1.3%)	—	1 (3.1%)	2 (1.8%)	2 (1.8%)
Total	30 (38.5%)	48 (61.5%)	14 (43.7%)	18 (56.3%)	44 (40.0%)	66 (60.0%)
** χ^2 = 7.618; critical χ^2 (p<0.05) = 16.92; p>0.05; p=0.573 (between groups). ** z = −2.966; critical z (p<0.05) = ±1.96; p<0.05; p=0.003 (girls vs. boys overall).*						

VUR was significantly more frequent in girls — 66 (60.0%) — compared with boys — 44 (40.0%) — overall (p=0.003). No significant sex difference was observed between the two treatment groups (p=0.573).

VUR Grade and Laterality

Table 4. Distribution of SG patients by VUR grade and side of involvement.

Group	Grade	Unilateral Right	Unilateral Left	Bilateral Right	Bilateral Left	Total ureters
SG (n=78)	II	7 (9.0%)	4 (5.1%)	4 (5.1%)	5 (4.8%)	20 (19.2%)
	III	16 (20.5%)	21 (26.9%)	16 (20.5%)	14 (17.9%)	67 (64.4%)
	IV	2 (2.6%)	2 (2.6%)	6 (7.7%)	7 (6.7%)	17 (16.3%)
SG total		25 (32.1%)	27 (34.6%)	26 (33.3%)		104 (100%) / 78 patients

Table 5. Distribution of CG patients by VUR grade and side of involvement.

Group	Grade	Unilateral Right	Unilateral Left	Bilateral Right	Bilateral Left	Total ureters
CG (n=32)	II	2 (5.0%)	—	1 (2.5%)	—	3 (7.5%)
	III	9 (22.5%)	7 (17.5%)	5 (15.0%)	4 (10.0%)	25 (62.5%)

Group	Grade	Unilateral Right	Unilateral Left	Bilateral Right	Bilateral Left	Total ureters
	IV	4 (10.0%)	2 (5.0%)	2 (5.0%)	4 (10.0%)	12 (30.0%)
CG total		15 (46.9%)	9 (28.1%)	8 (25.0%)		40 (100%) / 32 patients

Table 6. Distribution of patients by side and laterality of VUR involvement.

Group	Unilateral Right	Unilateral Left	Bilateral	Total patients
SG (n=78)	25 (32.1%)	27 (34.6%)	26 (33.3%)	78
CG (n=32)	15 (46.9%)	9 (28.1%)	8 (25.0%)	32
Total (n=110)	40 (36.4%)	36 (32.7%)	34 (30.9%)	110
$\chi^2 = 2.17$; critical χ^2 ($p<0.05$) = 5.99; $p>0.05$; $p=0.33$ (no significant difference between groups)				

Table 7. Distribution of VUR cases by grade (per ureter).

VUR grade	SG (ureters)	CG (ureters)
Grade II	20 (19.2%)	3 (7.5%)
Grade III	67 (64.4%)	25 (62.5%)
Grade IV	17 (16.4%)	12 (30.0%)
Total ureters	104 (100%)	40 (100%)
$\chi^2 = 5.18$; critical χ^2 ($p<0.05$) = 5.99; $p>0.05$; $p=0.075$ (no significant difference)		

Table 8. Distribution of patients by VUR activity type.

VUR activity type	SG (n=78)	CG (n=32)	Total (n=110)
Active	15 (19.2%)	5 (15.6%)	20 (18.2%)
Passive	6 (7.7%)	3 (9.4%)	9 (8.2%)
Mixed	57 (74.1%)	24 (75.0%)	81 (73.6%)
Total	78 (100%)	32 (100%)	110 (100%)

Both groups were comparable with respect to sex, age, VUR grade, laterality, reflux activity type, and disease duration, confirming the validity of intergroup comparisons.

Open Antireflux Surgery — Control Group

Table 9. Surgical techniques employed in the CG by VUR grade.

Surgical technique	No. of operations	Grade II	Grade III	Grade IV
Lich-Gregoir	21 (65.6%)	2 (6.3%)	13 (40.6%)	6 (18.8%)
Politano-Leadbetter	6 (18.8%)	—	2 (6.3%)	4 (12.5%)
Cohen	5 (15.6%)	—	2 (6.3%)	3 (9.4%)
Total	32 (100%)	2 (6.3%)	17 (53.1%)	13 (40.6%)

In the CG, 32 patients underwent operations on 40 ureters. The Lich-Gregoir extravesical technique was preferred (21 patients; 65.6%), as it avoids bladder opening and permits precise, minimally traumatic tunnel creation. Cohen's cross-trigonal reimplantation (5 patients; 15.6%) was reserved for more severe grades; the Politano-Leadbetter technique (6 patients; 18.8%) was used for high-grade VUR.

Table 10. Duration of surgical intervention by technique in the CG.

Surgical technique	Duration (min, mean ± SEM)
Lich-Gregoir (n=21)	48.3 ± 3.6*
Politano-Leadbetter (n=6)	63.7 ± 2.5**
Cohen (n=5)	76.2 ± 3.7
Mean across all techniques	55.0 ± 2.93

*Note: * p<0.01 compared with the other two techniques; ** p<0.05 compared with Cohen technique.*

All procedures were performed under endotracheal anaesthesia. Intra-operative ureteral drainage was placed on the affected side(s); catheters were removed on days 12–14.

In the postoperative period, CG patients experienced pain for a mean of 5.7±1.5 days, requiring analgesic medication. Haematuria was observed for up to 17 days (macrohematuria on day 1; 21.4±0.3 erythrocytes/HPF on days 7–10; 4.1±2.1 on days 14–17). Hyperthermia persisted for a mean of 5.7±2.3 days. Leukocyturia in the postoperative period reached 11.5±2.3 leukocytes/HPF on days 7–10, indicating induction of an inflammatory response by open surgery.

Postoperative complications in the CG included: haemorrhage from the new ureteral anastomosis in 2 (6.2%) patients (resolved with conservative management); anastomositis in 3 (9.3%); relapse of VUR requiring reoperation in 1 (3.1%; following Politano-Leadbetter technique); and postoperative cystitis/pyelonephritis in 7 (21.9%). Mean postoperative hospital stay was 16.7±3.3 bed-days. Overall treatment efficacy was 81.2%.

Endoscopic Correction of VUR — Study Group

ECVUR was introduced at this institution in 2012. In the SG, 26 (33.3%) patients had bilateral VUR, resulting in a total of 104 ureters treated. Grade III VUR predominated (67 ureters; 64.4%). Pre-operative cystoscopy identified ectopia of the ureteric orifice in 4 (5.1%) and lateroposition in 3 (3.8%) patients. The following ureteric orifice morphologies were identified: slit-shaped (33.6%), oval (26.0%), horseshoe-shaped (20.2%), punctate (11.5%), and socket-shaped (8.7%).

Table 11. Duration of surgical intervention in the SG versus CG.

Group	Unilateral VUR (min ± SEM)	Bilateral VUR (min ± SEM)	Mean operative time (min ± SEM)
CG (n=32)	51.7 ± 3.4 (n=24)	75.4 ± 5.1 (n=8)	57.5 ± 2.87
SG (n=78)	15.3 ± 2.4* (n=52)	21.1 ± 3.1* (n=26)	17.3 ± 1.16

*Note: * p<0.01 compared with CG (SG operative time was >3-fold shorter in both unilateral and bilateral VUR).*

Operative duration in the SG was significantly shorter than in the CG for both unilateral (15.3±2.4 vs. 51.7±3.4 min; p<0.01) and bilateral (21.1±3.1 vs. 75.4±5.1 min; p<0.01) procedures, a reduction of more than 3-fold.

Intraoperative efficacy was monitored by repeat hydrodistension: the inability of the ureteric orifice to dilate confirmed successful coaptation. Bolus formation was confirmed by ultrasonography on the first postoperative day (Figure 1 — sonogram showing bulging boluses forming the obturator mechanism).

Table 12. Postoperative outcome indicators in the SG versus CG.

Effectiveness criterion	CG	SG
Duration of pain syndrome (days ± SEM)	5.7 ± 1.5	1.1 ± 0.2*
Time to temperature normalization (days ± SEM)	5.7 ± 2.3	0.7 ± 0.4*
Length of hospital stay (bed-days ± SEM)	16.7 ± 3.3	5.2 ± 1.2*

*Note: * p<0.001 for all comparisons (SG vs. CG).*

Postoperative pain duration in the SG was significantly shorter (1.1±0.2 vs. 5.7±1.5 days; $p<0.001$). Time to temperature normalization was reduced from 5.7±2.3 to 0.7±0.4 days ($p<0.001$). Hospital stay decreased from 16.7±3.3 to 5.2±1.2 bed-days ($p<0.001$). In the SG, haematuria was observed only on the first postoperative day; thereafter it resolved completely, compared with persistence for up to 17 days in the CG. Leukocyturia at days 7–10 was near-single in the SG versus 4.1±2.1 leukocytes/HPF in the CG at days 14–17 ($p<0.05$), confirming the lower inflammatory burden of the endoscopic approach.

ECVUR Efficacy

After a single ECVUR session, VUR was completely eliminated (grade 0 on follow-up VCUG) in 55 (70.5%) patients with grades II–III. Grade reduction (III→I in 9 patients; IV→II in 3 patients) was documented in 12 (15.4%) patients. Single-session efficacy was thus 85.9%.

Of the 11 (14.1%) patients with unsatisfactory outcomes after a single session (all with bilateral grades III–IV VUR), 5 (6.4%) showed one-grade reduction and 6 (7.7%) showed no change. These 11 patients underwent repeat ECVUR at 6–12 months; 6 (54.5%) achieved complete VUR elimination. The remaining 5 (45.5%) underwent open surgery at parental request due to ongoing pyelonephritis episodes. Overall cumulative ECVUR efficacy was 93.6%. Pyelonephritis attacks were relieved in 71 (91%) patients.

Table 13. Follow-up observation periods by treatment group.

Follow-up period	CG (n=32)	SG (n=78)	Total (n=110)
Up to 1 year	17 (53.1%)	43 (55.1%)	60 (54.5%)
2–3 years	8 (25.0%)	21 (26.9%)	29 (26.4%)
4–8 years	2 (6.3%)	4 (5.1%)	6 (5.5%)
9–10 years	3 (9.4%)	5 (6.4%)	8 (7.3%)
Total examined	30 (93.8%)	73 (93.6%)	103 (93.6%)

Of 110 patients, 103 (93.6%) were available for long-term follow-up assessment. Results were classified as good (complete resolution of symptoms, negative VCUG, no UTI), satisfactory (significant symptom reduction, grade reduction on VCUG, rare controlled UTI episodes), or unsatisfactory (no symptom reduction, progressive structural change, or need for reoperation).

Table 14. Comparative analysis of surgical treatment outcomes by group.

Outcome	SG (n=78)	CG (n=32)
Good	61 (78.2%)	21 (65.6%)
Satisfactory	12 (15.4%)	5 (15.6%)
Unsatisfactory	5 (6.4%)	6 (18.8%)
Good + Satisfactory (total efficacy)	73 (93.6%)	26 (81.2%)

Compared with the CG, the SG demonstrated a 12.6 percentage-point increase in the rate of good outcomes (78.2% vs. 65.6%), a 2.9-fold reduction in unsatisfactory results (6.4% vs. 18.8%), and overall treatment efficacy of 93.6% versus 81.2% for open surgery.

Discussion

Open antireflux surgery for VUR in children is associated with a range of significant disadvantages: the need for endotracheal anaesthesia, high operative trauma, prolonged ureteral drainage, induction of the urinary tract inflammatory response, prolonged postoperative pain, risk of complications, extended hospital stay, and a prolonged rehabilitation period. These factors increase the burden on patients and their families and motivated the introduction and evaluation of minimally invasive endourological alternatives at our institution.

Analysis of treatment outcomes demonstrates the clear superiority of ECVUR in the SG compared with open surgery in the CG. Mean operative duration was reduced more than threefold (17.3±1.16 vs. 57.5±2.87 min; $p<0.01$). Leukocyturia at days 7–10 post-

ECVUR approached single values, whereas in the CG this indicator remained significantly elevated at days 14–17 (4.1±2.1 leukocytes/HPF; p<0.05), confirming the lower inflammatory response associated with the endoscopic approach.

Haematuria in the SG resolved within the first postoperative day; in the CG, haematuria persisted for up to 2 weeks. Pain duration was markedly shorter in the SG (1.1±0.2 vs. 5.7±1.5 days; p<0.001), as was time to temperature normalization (0.7±0.4 vs. 5.7±2.3 days; p<0.001). These findings confirm the substantially less traumatic nature of endoscopic correction.

The efficacy of ECVUR, assessed by reduction or elimination of reflux and cessation of pyelonephritis attacks, reached 85.9% after a single session and 93.6% overall — consistent with published meta-analytic data reporting success rates of 85–90% [8]. The use of the comprehensive diagnostic-treatment algorithm developed at our clinic contributed to a significant increase in the proportion of good outcomes (78.2% vs. 65.6%) and a 2.9-fold reduction in unsatisfactory results. Hospital stay was reduced from 16.7±3.3 to 5.2±1.2 bed-days (p<0.001), with a 3.2-fold improvement in the economic efficiency coefficient.

The main limitation of the present study is the non-concurrent, non-randomized design arising from the era-based treatment allocation. The introduction of endoscopic technique in 2012 divided the patient cohort into two temporally separate groups, introducing potential confounding from secular trends in anaesthesia, imaging, and peri-operative management. While baseline demographic and disease characteristics were statistically comparable between groups, residual confounding cannot be entirely excluded. Future prospective, randomized or propensity-score-matched studies are warranted to confirm these findings with higher-level evidence.

Conclusion

The results of this study confirm the high efficacy and safety of minimally invasive endourological ECVUR compared with open antireflux surgery in the treatment of VUR in children. Endoscopic correction significantly reduces operative time, postoperative pain, fever duration, haematuria, inflammatory response, hospital stay, and treatment costs while achieving superior overall treatment efficacy (93.6% vs. 81.2%). The diagnostic-treatment algorithm developed at the Specialized Pediatric Surgical Clinic of Samarkand State Medical University provides a structured, evidence-based pathway for the management of paediatric VUR using contemporary endourological techniques.

Acknowledgements

Ethics approval: Protocol No. 12, 15 January 2023, Ethics Committee of Samarkand State Medical University. All procedures conform to the Declaration of Helsinki (2013).

Consent to participate: Written informed consent obtained from parents/guardians of all participants. Retrospective data were de-identified prior to analysis.

Competing interests: All authors declare no competing interests.

Funding: Research Plan No. 01980006703, Samarkand State Medical University (2020–2024). The funder had no role in study design, data analysis, or publication decisions.

Authors Contributions: AA and ZM: study conception, surgical treatment (CG), manuscript revision. JSh: data analysis, statistics, manuscript drafting. AA (Aslam), MO, TS, AK: critical revision, international methodological input. All authors approved the final manuscript.

Acknowledgements: None.

Disclosure of AI Use: The authors declare that no AI or AI-assisted technologies were used in the writing of this manuscript.

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