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ФГАОУ ВО ПЕРВЫЙ МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ ИМЕНИ И.М. СЕЧЕНОВА МИНИСТЕРСТВА ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ (СЕЧЕНОВСКИЙ УНИВЕРСИТЕТ)

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RESISTANCE OF ENTEROBACTERALES CAUSING COMMUNITY-ACQUIRED URINARY TRACT INFECTIONS IN THE RUSSIAN FEDERATION IN 2024: DATA FROM THE RESOURSE-2 STUDY

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Introduction. The problem of rational antimicrobial therapy for urinary tract infections (UTIs) remains highly relevant for physicians of various specialties. Knowledge of the level of antibiotic resistance among UTI pathogens is critically important for the choice of empirical therapy, prevention of recurrence, chronic infection, and complications such as urosepsis and stone formation.

Aim. To analyze antibacterial resistance data for the main pathogens causing community-acquired UTIs, namely Escherichia coli, Klebsiella pneumoniae, and Proteus mirabilis, in the Russian Federation in 2024.

Materials and methods. A retrospective analysis was performed on 185,480 urine samples collected in outpatient settings throughout Russia. Microorganism identification was carried out using an automated analyzer and identification systems (VITEK2, MALDI Biotyper). Antimicrobial susceptibility was determined in accordance with the Russian guidelines "Determination of susceptibility to antimicrobial agents" 2024 [14].

Results. Pathogens at a diagnostic titer (⩾104 CFU/mL) were isolated in 23.5% (n=43,550) of the analyzed samples. The distribution of pathogens was as follows: E. coli – 64.1%, K. pneumoniae – 13.1%, P. mirabilis – 3.6%. The resistance profile of E. coli varied substantially depending on the demographic group. The most unfavorable situation was observed in adult men, with resistance to fluoroquinolones exceeding 57% and resistance to third-generation cephalosporins approximately 48%, whereas the most favorable situation was observed in pregnant women. Fosfomycin and nitrofurantoin retained the highest activity against E. coli in women, with more than 96% of strains remaining susceptible. K. pneumoniae was characterized by a markedly higher level of resistance to all major classes of antibacterial agents, including critically low susceptibility to meropenem (70.7%). P. mirabilis retained high susceptibility to carbapenems (98.4%) and third-generation cephalosporins (83.9%).

Conclusions. The obtained data highlight the need to take into account the patient's sex, age, and physiological status when selecting empirical therapy for UTIs. Fosfomycin and nitrofurantoin confirmed their status as first-line agents for uncomplicated UTIs in women. The high resistance of uropathogens to fluoroquinolones and co-trimoxazole necessitates restricting their use. The identified increase in resistance of K. pneumoniae to amikacin requires special attention in the treatment of complicated UTIs.

Key words: urinary tract infections, antimicrobial agents, antimicrobial resistance, antimicrobial therapy, real-world clinical practice, UTI in pregnancy

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Introduction. The problem of rational antimicrobial therapy for urinary tract infections (UTIs) remains highly relevant for physicians of various specialties [1]. In outpatient practice, the most common nosological form of UTI is acute uncomplicated cystitis, which develops predominantly in women of reproductive age. According to Rosstat, approximately 4.1 million cases of diseases diagnosed as "cystitis" (ICD-10 codes N30.0–N30.9) were registered in Russia in 2022 [2]. Acute uncomplicated cystitis may account for up to 60% of all cystitis cases [3]. In the United States, the annual number of visits for acute uncomplicated cystitis is approximately 7 million [4].

The main agents used for the treatment of UTIs in outpatient settings are antimicrobial agents. In most cases, antimicrobial therapy is selected empirically, based on available data on the susceptibility of the main UTI pathogens to antimicrobial agents. Therefore, regular updating of data on antimicrobial resistance among uropathogens is an essential prerequisite for successful empirical treatment of UTIs [5–7].

Gram-negative bacteria of the order Enterobacterales, including Escherichia coli (E. coli), Klebsiella pneumoniae (K. pneumoniae), and Proteus mirabilis (P. mirabilis), play the leading role in the etiology of UTIs [8]. In addition to predominating in the structure of UTI pathogens, these pathogens share common pathogenetic mechanisms of UTI development and are characterized by a high prevalence of resistance to antimicrobial agents. Knowledge of the level of antibiotic resistance in these pathogens is critically important for selecting empirical therapy for UTIs, preventing recurrence and chronic infection, and reducing the risk of complications such as urosepsis and exacerbation of urolithiasis [9].

Aim. To analyze antibacterial resistance data for the main pathogens causing community-acquired UTIs, namely E. coli, K. pneumoniae, and P. mirabilis, in the Russian Federation in 2024.

Materials and methods. The study was approved by the Independent Ethics Committee of the Center for Clinical Research, Immanuel Kant Baltic Federal University (Opinion No. 49 dated December 3, 2024). We analyzed the results of bacteriological urine tests from residents of the Russian Federation performed by the INVITRO laboratory in 2024. Anonymized data were provided by Independent Laboratory INVITRO LLC in accordance with the Cooperation Agreement dated January 18, 2024, concluded between Independent Laboratory INVITRO LLC and Immanuel Kant Baltic Federal University. The transferred data contained no personal patient information, including surname, first name, patronymic, date of birth, or address. Raw laboratory data were exported from the laboratory information system in CSV format and processed using original software in RStudio 2025.09.1+401 for subsequent analysis. The transformed data were stored as two-dimensional tables and analyzed by creating relevant queries written in Python. Patents were obtained for the original algorithm for data transformation and analysis, the software, and the databases containing the processed information [10, 11]. To compare the frequency of resistant E. coli isolates across different patient subpopulations (women, men, pregnant women, and children), binary logistic regression was used. The dependent variable was the susceptibility status of the isolate: resistant (R) versus susceptible and susceptible, increased exposure (S+I). Women aged ⩾18 years were selected as the reference group, as they represented the largest and most clinically relevant population. Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance of differences was assessed using the likelihood ratio test. The Benjamini–Hochberg method was used to correct for multiple comparisons and control the false discovery rate (FDR). Differences were considered statistically significant at an adjusted p value of <0.05.

All urine samples were collected at the outpatient level of care. Midstream urine samples were collected at any time of day, 2–3 hours after the previous urination. A standardized genital hygiene procedure was recommended to avoid possible contamination. Samples were collected in sterile plastic Uri-swab transport containers (COPAN Diagnostics Inc.) and delivered to local offices and laboratories of the INVITRO commercial network. For further transportation of biological samples, V-Monovette vacuum tubes with boric acid, Sarstedt (10 mL/4 mL), were used when delivery time exceeded 24 hours; Rustek MK tubes with boric acid, 10.6 mL, with beige/yellow caps were used when delivery time was less than 24 hours.

Culture was performed manually. Standard culture was carried out using the central streak method with perpendicular loop spreading using a 10-μL loop (non-sector method) on CLED agar (bioMérieux, France). The microbial count was determined by counting the number of colonies (CFU) grown from 10 μL, followed by recalculation per 1 mL (CFU/mL). The inclusion criterion for a sample was bacteriuria at a diagnostically significant titer, defined as ⩾104 CFU/mL. According to international studies and guidelines, lower levels of bacteriuria may also be considered diagnostically significant in patients with overt clinical symptoms of UTI [12, 13]. However, in the present study, it was not possible to assess the presence of UTI symptoms at the time of sample collection in all patients; therefore, bacteriuria ⩾104 CFU/mL was selected as the inclusion criterion. Samples with more than two isolated strains were regarded as contaminated and excluded from the analysis. When analyzing urine samples in which two isolates were detected at a diagnostic titer, the microorganism with the higher bacterial load was considered the primary pathogen.

Microorganism identification was performed using an automated analyzer with VITEK2 systems (bioMérieux, France) and MALDI Biotyper Microflex (Bruker Daltonik GmbH, Germany). Susceptibility to antimicrobial agents was determined in accordance with the Russian guidelines "Determination of Susceptibility to Antimicrobial Agents" 2024 [14]. Susceptibility to parenteral antibiotics was determined for some isolates according to clinical indications. Non-susceptible isolates were defined as bacterial strains resistant (R) to the tested antimicrobial agent or susceptible, increased exposure (I).

When evaluating susceptibility to amoxicillin/clavulanic acid (AMC), interpretive criteria for the oral formulation for all forms of UTI were used; criteria for uncomplicated UTIs were not applied because of limited clinical information that did not allow accurate assessment of UTI type. When evaluating susceptibility to fosfomycin and nitrofurantoin, susceptibility interpretive criteria for uncomplicated UTIs were used [14]. It should be noted that, according to these guidelines, breakpoints for interpretation of susceptibility to fosfomycin and nitrofurantoin are established only for E. coli. Therefore, susceptibility to these agents was not determined for other representatives of the order Enterobacterales (K. pneumoniae, P. mirabilis, etc.). Susceptibility to fosfomycin was determined by the disk diffusion method using disks containing fosfomycin and glucose-6-phosphate, in accordance with Russian guideline requirements and EUCAST criteria [14]. Results were interpreted according to EUCAST v.14.0 breakpoints, whereby E. coli isolates with an inhibition zone diameter ⩾24 mm were classified as susceptible, and those with a diameter <24 mm as resistant.

External quality control procedures of the Center for External Quality Assessment of Clinical Laboratory Testing (FSVOK, Russian Federation, www.fsvok.ru) were used at least twice a year. Internal quality control of culture media for primary pathogen identification was performed for each lot, but at least once a month; quality control of antimicrobial susceptibility testing materials (media and disks) was performed for each new lot at least once a week.

Results. During the study period, a total of 185,480 urine samples were analyzed. The number of patients whose

Table 1

Characteristics of the study population

Patient category	Number of patients	Mean age, years*
All patients	43,500 (100.0%)	45.4±22.9
Women aged ⩾18 years	32,036 (73.6%)	47.2±19.5
Pregnant women	697 (1.6%)	30.1±6.1
Children and adolescents aged 0–18 years	3,962 (9.1%)	5.4±5.3
Men aged ⩾18 years	7,502 (17.3%)	62.2±15.9

*Data are presented as mean ± standard deviation (SD).

samples yielded a pathogen in monoculture with a bacterial load ⩾104 CFU/mL was 43,500 (23.5%). All isolates were grouped according to the patient subpopulation from whose urine samples they were obtained (*Table 1*).

The study population consisted mainly of women aged ⩾18 years, who accounted for 73.6%; among them, 697 had a pregnancy status mark (1.6% of the total population). Men aged ⩾18 years accounted for 17.3%, whereas children and adolescents under 18 years accounted for 9.1%. Mean age differed significantly across patient categories: 47.2 years in women, 30.1 years in pregnant women, 62.2 years in men, and 5.4 years in children and adolescents under 18 years.

Analysis of the structure of identified microorganisms showed that the most frequently isolated pathogen was E. coli (64.1%). Other bacteria of the order Enterobacterales were isolated much less frequently: K. pneumoniae (13.1%) and P. mirabilis (3.6%) (*Table 2*). Susceptibility testing results for E. coli, K. pneumoniae, and P. mirabilis are presented in Tables 3–5. A more detailed analysis of pathogen structure is beyond the scope of this article and has been described in our previous publication [15].

E. coli

Analysis of susceptibility in the overall patient population revealed the following features of E. coli (*Table 3*). In the overall population, susceptibility of E. coli to beta-lactam antibiotics varied substantially. The highest rate of resistant strains was observed for ampicillin (54.3%), followed by third-generation cephalosporins (cefotaxime and ceftriaxone) at 28.7%. Resistance was somewhat lower for the second-generation cephalosporin cefuroxime (12.9%) and amoxicillin/clavulanic acid (AMC) (16.9%), with the lowest level observed for meropenem (0.7%). However, it should be noted that a substantial proportion of strains were classified as I (susceptible, increased exposure) for cefuroxime and AMC: 10.2% and 59.9%, respectively. Thus, the frequency of isolates non-susceptible at standard dosing regimens to cefuroxime and AMC was 23.1% and 76.7%, respectively. Among aminoglycosides, the highest susceptibility was observed for amikacin, with 90.5% of strains susceptible, whereas susceptibility to gentamicin was 88.0%. High resistance rates of E. coli to fluoroquinolones were noted: 34.9% of isolates were resistant to ciprofloxacin. Strains resistant to co-trimoxazole were also frequently isolated (31.0%). The oral antimicrobial agents nitrofurantoin and fosfomycin showed high activity: the frequency of resistant E. coli strains was 3.3% and 2.4%, respectively (*Table 3*).

Analysis of antimicrobial resistance in E. coli revealed differences in susceptibility profiles between individual patient subpopulations. In women aged ⩾18 years, resistance rates were close to those observed in the overall population. At the same time, a higher level of susceptibility to beta-lactam antibiotics was found: resistance to AMC was 15.4%, and resistance to third-generation cephalosporins was 26.4%. Low resistance rates were also observed for nitrofurantoin (2.7%) and fosfomycin (2.2%).

Pregnant women had the most favorable susceptibility profile, with minimal resistance rates to nitrofurantoin (0.3%) and fosfomycin (1.3%). Relatively high susceptibility to third-generation cephalosporins was observed: cefotaxime (78.8%) and ceftriaxone (78.7%), which is important for selecting antimicrobial therapy during pregnancy. Statistical analysis confirmed that the risk of resistance in pregnant women was significantly lower than in non-pregnant women for amoxicillin/clavulanate (OR 0.70; 95% CI 0.50–0.94; adjusted p=0.018), third-generation cephalosporins (OR 0.74–0.75; adjusted

Table 2

Distribution of pathogens causing community-acquired UTIs

Pathogen	N	%
E. coli	27,889	64.1
K. pneumoniae	5,704	13.1
Enterococcus faecalis	2,962	6.8
P. mirabilis	1,564	3.6
Streptococcus agalactiae	721	1.7
Staphylococcus saprophyticus	609	1.4
Pseudomonas aeruginosa	698	1.6
Other bacterial species with an isolation frequency <1%	3,353	7.7
TOTAL	43,500	100

Table 3

Resistance of E. coli isolated from patients with community-acquired UTIs, Russia, 2024

Antimicrobial agent	All patients			Women ⩾18 years			Men ⩾18 years			Pregnant women			Children and adolescents 0–18 years		
	S, n (%)	I, n (%)	R, n (%)	S, n (%)	I, n (%)	R, n (%)	S, n (%)	I, n (%)	R, n (%)	S, n (%)	I, n (%)	R, n (%)	S, n (%)	I, n (%)	R, n (%)
Ampicillin	1,270 (45.7%)	0 (0.0%)	1,512 (54.3%)	1,030 (47.8%)	0 (0.0%)	1,128 (52.3%)	117 (34.5%)	0 (0.0%)	222 (65.5%)	ND	ND	ND	123 (43.3%)	0 (0.0%)	161 (56.7%)
Amoxicillin/ clavulanic acid[1]	7,432 (23.3%)	19,146 (59.9%)	5,387 (16.9%)	6,031 (23.8%)	15,443 (60.9%)	3,902 (15.4%)	667 (19.1%)	1,811 (52.0%)	1,008 (28.9%)	78 (19.5%)	277 (69.3%)	45 (11.3%)	656 (24.3%)	1,615 (59.8%)	432 (16.0%)
Cefuroxime	5,896 (76.8%)	786 (10.2%)	993 (12.9%)	4,682 (77.1%)	670 (11.0%)	720 (11.9%)	651 (76.8%)	40 (4.7%)	157 (18.5%)	ND	ND	ND	521 (73.2%)	75 (10.5%)	116 (16.3%)
Cefotaxime	22,757 (71.2%)	34 (0.1%)	9,166 (28.7%)	18,655 (73.5%)	23 (0.0%)	6,690 (26.4%)	1,813 (52.0%)	8 (0.02%)	1,665 (47.8%)	315 (78.8%)	1 (0.3%)	84 (21.0%)	1,974 (73.0%)	2 (0.0%)	727 (26.9%)
Ceftriaxone	22,588 (71.2%)	31 (0.0%)	9,104 (28.7%)	18,519 (73.5%)	21 (0.0%)	6,640 (26.4%)	1,799 (51.9%)	7 (0.2%)	1,660 (47.9%)	313 (78.7%)	1 (0.3%)	84 (21.1%)	1,957 (73.0%)	2 (0.0%)	720 (26.9%)
Meropenem	1,930 (99.1%)	4 (0.2%)	14 (0.7%)	1,481 (99.0%)	4 (0.3%)	11 (0.7%)	307 (99.0%)	0 (0.0%)	3 (1.0%)	ND	ND	ND	141 (100.0%)	0 (0.0%)	0 (0.0%)
Amikacin	360 (90.5%)	0 (0.0%)	38 (9.5%)	278 (92.1%)	0 (0.0%)	24 (7.9%)	44 (81.5%)	0 (0.0%)	10 (18.5%)	ND	ND	ND	37 (90.2%)	0 (0.0%)	4 (9.8%)
Gentamicin	1,694 (88.0%)	0 (0.0%)	230 (12.0%)	1,345 (89.3%)	0 (0.0%)	161 (10.7%)	228 (82.6%)	0 (0.0%)	48 (17.4%)	ND	ND	ND	119 (85.0%)	0 (0.0%)	21 (15.0%)
Ciprofloxacin	1,975 (65.1%)	0 (0.0%)	1,057 (34.9%)	1,649 (68.5%)	0 (0.0%)	759 (31.5%)	136 (37.0%)	0 (0.0%)	232 (63.0%)	ND	ND	ND	187 (74.5%)	0 (0.0%)	64 (24.5%)
Co-trimoxazole	16,865 (69.0%)	7 (0.0%)	7,571 (31.0%)	13,710 (70.6%)	6 (0.0%)	5,717 (29.4%)	1,517 (57.4%)	0 (0.0%)	1,124 (42.6%)	259 (72.3%)	0 (0.0%)	99 (27.7%)	1,379 (68.6%)	1 (0.0%)	631 (31.4%)
Fosfomycin[2]	28,039 (97.6%)	0 (0.0%)	697 (2.4%)	22,340 (97.8%)	0 (0.0%)	511 (2.2%)	2,980 (95.9%)	0 (0.0%)	127 (4.1%)	394 (98.7%)	0 (0.0%)	5 (1.3%)	2,325 (97.7%)	0 (0.0%)	54 (2.3%)
Nitrofurantoin[3]	30,855 (96.7%)	0 (0.0%)	1,056 (3.3%)	24,641 (97.3%)	0 (0.0%)	695 (2.7%)	3,199 (91.9%)	0 (0.0%)	282 (8.1%)	398 (99.7%)	0 (0.0%)	1 (0.3%)	2,617 (97.1%)	0 (0.0%)	78 (2.9%)

Notes: ND – no data; S – susceptible; I – susceptible, increased exposure; R – resistant.
[1]Interpretive criteria for the oral formulation of amoxicillin/clavulanic acid for all urinary tract infections except uncomplicated UTIs.
[2]Interpretive criteria for oral fosfomycin in uncomplicated UTIs.
[3]Interpretive criteria for nitrofurantoin in uncomplicated UTIs.

p=0.013–0.015), and nitrofurantoin (OR 0.09; 95% CI 0.01–0.39; adjusted p<0.001). No significant differences were identified for the other agents (*Table 4*).

Men had statistically significantly higher resistance rates to most classes of antimicrobial agents: ciprofloxacin (63.0%), third-generation cephalosporins (47.9%), and co-trimoxazole (42.6%). Logistic regression analysis confirmed that the risk of E. coli resistance in men was significantly higher than in women for all tested antibacterial agents except meropenem (*Table 4*). The most pronounced differences were observed for ciprofloxacin (OR 3.71; 95% CI 2.95–4.67; p<0.001), ceftriaxone (OR 2.57; 95% CI 2.39–2.76; p<0.001), and nitrofurantoin (OR 3.13; 95% CI 2.70–3.60; p<0.001).

Children and adolescents showed a heterogeneous resistance profile. Susceptibility to cefuroxime and third-generation cephalosporins was comparable to that in the overall group and ranged from 73.0% to 73.2%. The frequency of E. coli strains resistant to gentamicin was 15.0%, amikacin 9.8%, and co-trimoxazole 31.4%, which was higher than in the overall population. Low resistance rates persisted for nitrofurantoin (2.9%) and fosfomycin (2.3%). Susceptibility to meropenem in this group was 100%. Compared with women, children and adolescents had a significantly higher risk of resistance only to cefuroxime (OR 1.45; 95% CI 1.16–1.78; p=0.001). No significant differences between children and women were found for the other agents. Compared with men, the risk of resistance in children was significantly lower for most agents (OR 0.20 to 0.69; p<0.05) (*Table 4*).

K. pneumoniae

Susceptibility analysis for K. pneumoniae was performed in the overall population and in women and men aged ⩾18 years (*Table 5*). Susceptibility of K. pneumoniae to beta-lactam antibiotics also varied substantially between individual agents. The highest rates of resistant strains were observed for AMC (39.1%), second- and third-generation cephalosporins: cefuroxime, cefotaxime, and ceftriaxone – 35.8%, 39.2%, and 39.2%, respectively. For cefuroxime and AMC, a substantial proportion of strains were classified as I (susceptible, increased exposure): 20.3% and 42.9%, respectively. Thus, the frequency of isolates non-susceptible at standard dosing regimens to cefuroxime and AMC was 56.1% and 82.0%, respectively. An unexpectedly high rate of meropenem resistance was observed in K. pneumoniae isolates: 27.8%. High resistance rates were also observed for other antimicrobial classes: 28.0% for gentamicin, 33.1% for amikacin, 56.0% for ciprofloxacin, and 42.0% for co-trimoxazole.

Sex-stratified analysis revealed substantial heterogeneity in K. pneumoniae resistance profiles (*Table 5*). Men had higher resistance rates to all tested classes of antimicrobial agents compared with women. The most pronounced differences were observed for third-generation cephalosporins: resistance to cefotaxime and ceftriaxone in men (62.9% and 62.6%, respectively) was more than 2.5 times higher than in women (23.3% and 23.5%). Higher resistance rates were also observed in men than in women for AMC (63.1% vs. 24.9%), ciprofloxacin (61.1% vs. 28.4%), gentamicin (54.2% vs. 15.5%), amikacin (45.2% vs. 8.3%), and meropenem (39.0% vs. 8.7%). Resistance to co-trimoxazole was high in both groups, but remained higher in men (84.4% vs. 74.5%).

Data on susceptibility of P. mirabilis to antimicrobial agents are presented in *Table 6*. Analysis for this microorganism was performed in the overall population without stratification by age and sex because of the relatively small number of studied strains. The frequency of resistant P. mirabilis strains was 28.9% for AMC, 12.7% for cefuroxime, 15.8% for cefotaxime, and 16.8% for ceftriaxone. At the same time, 55.7% and 27.2% of P. mirabilis strains were classified as “susceptible, increased exposure” for AMC and cefuroxime, respectively. Meropenem retained high activity, with 98.4% of strains susceptible. Resistant P. mirabilis strains were isolated with the following frequencies: amikacin 12.1%, gentamicin 34.4%, ciprofloxacin 44.0%, and co-trimoxazole 51.7%.

Table 4

Comparative analysis of the odds of isolating antimicrobial-resistant E. coli strains in different patient subpopulations

Antimicrobial agent	Men ⩾18 years vs. women ⩾18 years		Pregnant women vs. women ⩾18 years		Children and adolescents 0–18 years vs. women ⩾18 years	
	OR (95% CI)	*P-value**	OR (95% CI)	*P-value**	OR (95% CI)	*P-value**
Ampicillin	1.73 (1.37–2.21)	**<0.001**	ND	ND	1.20 (0.93–1.54)	0.160
AMC	2.24 (2.06–2.43)	**<0.001**	0.70 (0.50–0.94)	**0.018**	1.05 (0.94–1.17)	0.409
Cefuroxime	1.69 (1.39–2.04)	**<0.001**	ND	ND	1.45 (1.16–1.78)	**0.001**
Cefotaxime	2.55 (2.38–2.74)	**<0.001**	0.74 (0.58–0.94)	**0.013**	1.03 (0.94–1.12)	0.557
Ceftriaxone	2.57 (2.39–2.76)	**<0.001**	0.75 (0.58–0.95)	**0.015**	1.03 (0.94–1.12)	0.573
Meropenem	1.32 (0.30–4.25)	0.680	ND	ND	0.46 (0.00–3.53)	0.540
Amikacin	2.63 (1.14–5.75)	0.025	ND	ND	1.25 (0.35–3.47)	0.698
Gentamicin	1.76 (1.23–2.48)	**0.002**	ND	ND	1.47 (0.88–2.36)	0.136
Ciprofloxacin	3.71 (2.95–4.67)	**<0.001**	ND	ND	0.74 (0.55–0.99)	0.046
Co-trimoxazole	1.78 (1.64–1.93)	**<0.001**	0.92 (0.72–1.15)	0.465	1.10 (0.99–1.21)	0.068
Fosfomycin	1.86 (1.52–2.26)	**<0.001**	0.55 (0.20–1.21)	0.151	1.02 (0.76–1.34)	0.916
Nitrofurantoin	3.13 (2.70–3.60)	**<0.001**	0.09 (0.01–0.39)	**<0.001**	1.02 (0.76–1.34)	0.651

Abbreviations: OR – odds ratio; CI – confidence interval; ND – no data available because the agent was not tested in the respective group or the comparison was not performed; AMC – amoxicillin/clavulanic acid.
Dependent variable: resistance present (R) versus resistance absent (S+I).
Reference group: women aged ⩾18 years.
*p-value adjusted using the Benjamini–Hochberg procedure to control the false discovery rate (FDR) in multiple comparisons.

Table 5

Resistance of K. pneumoniae isolated from patients with community-acquired urinary tract infections to antimicrobial agents, Russia, 2024

Antimicrobial agent	All patients			Women ⩾18 years R, n (%)	Men ⩾18 years R, n (%)
	S, n (%)	I, n (%)	R, n (%)	R, n (%)	R, n (%)
Amoxicillin/clavulanic acid	1,151 (18.0%)	2,744 (42.9%)	2,503 (39.1%)	1,173 (24.9%)	697 (63.1%)
Cefuroxime	278 (43.9%)	129 (20.3%)	227 (35.8%)	199 (42.8%)	67 (60.6%)
Cefotaxime	3,856 (60.3%)	30 (0.5%)	2,507 (39.2%)	1,097 (23.3%)	694 (62.9%)
Ceftriaxone	3,826 (60.3%)	30 (0.5%)	2,486 (39.2%)	1,097 (23.5%)	685 (62.6%)
Meropenem	483 (70.7%)	10 (1.5%)	190 (27.8%)	44 (8.7%)	66 (39.0%)
Gentamicin	430 (72.0%)	0 (0.0%)	167 (28.0%)	68 (15.5%)	56 (54.2%)
Amikacin	101 (66.9%)	0 (0.0%)	50 (33.1%)	21 (8.3%)	22 (45.2%)
Ciprofloxacin	340 (44.0%)	0 (0.0%)	432 (56.0%)	222 (28.4%)	181 (61.1%)
Co-trimoxazole	2,781 (57.8%)	10 (0.2%)	2,022 (42.0%)	1,041 (74.5%)	701 (84.4%)

Notes: S, susceptible; I, susceptible, increased exposure; R, resistant.

Discussion. At present, two types of studies are used to investigate resistance among bacterial infection pathogens: multicenter microbiological projects and analyses of real-world clinical and laboratory practice data.

The RESOURCE-2 study, based on analysis of real-world clinical and laboratory practice data, allowed to assess the current level of antibiotic resistance among the main pathogens of community-acquired UTIs in the Russian Federation and to identify its features in different demographic groups. When interpreting the results, it is important to consider methodological differences between studies based on real-world clinical and laboratory practice data and classical multicenter microbiological projects. Multicenter microbiological projects such as DARMIS have several advantages, including the use of reference susceptibility testing methods (dilution methods), a prospective design, and collection of detailed clinical information [16]. However, they also have limitations. These include the limited number of regions in which material was collected, low frequency of study conduct, and a relatively small number of analyzed strains (30–40 per region). In addition, collection of strains predominantly in specialized medical institutions, including university clinics, may lead to selection bias, favoring inclusion of more complex patients with previous antimicrobial therapy.

P. mirabilis

In turn, the real-world clinical and laboratory practice approach implemented in the RESOURCE-2 project allows analysis of large datasets, allowing to identify features that are not accessible in small samples. These include significant differences in resistance levels depending on sex, age, and physiological status, as well as accurate data on the frequency of isolation of rare pathogens. The main disadvantage of this method is the complexity of processing and standardizing large volumes of heterogeneous data.

The most relevant and representative study for comparison with the obtained results is the DARMIS-2023 national monitoring study of antibiotic resistance among community-acquired UTI pathogens in Russia. Comparative analysis of E. coli susceptibility is presented in *Table 7*.

Comparison of our data with the results of DARMIS-2023 revealed several features. Resistance rates of E. coli to ampicillin, cefotaxime, ciprofloxacin, and co-trimoxazole in our study were comparable to DARMIS data, confirming the persistently high prevalence of resistance to these antimicrobial agents. However, several differences for individual agents are noteworthy. Resistance to fosfomycin in RESOURCE-2 was lower than in DARMIS-2023 (2.4% versus 7.1%); conversely, nitrofurantoin resistance was higher in our study (3.3% versus 0.5%). From a clinical

Table 6

Resistance of P. mirabilis isolated from patients with community-acquired urinary tract infections, Russia, 2024

Antimicrobial agent	S, n (%)	I, n (%)	R, n (%)
Amoxicillin/clavulanic acid	503 (28.9%)	968 (55.7%)	267 (15.4%)
Cefuroxime	128 (60.1%)	58 (27.2%)	27 (12.7%)
Cefotaxime	1,458 (83.9%)	5 (0.3%)	274 (15.8%)
Ceftriaxone	1,435 (83.9%)	5 (0.3%)	271 (16.8%)
Meropenem	120 (98.4%)	0 (0.0%)	2 (1.6%)
Amikacin	29 (87.9%)	0 (0.0%)	4 (12.1%)
Gentamicin	86 (65.7%)	0 (0.0%)	45 (34.4%)
Ciprofloxacin	103 (56.0%)	0 (0.0%)	81 (44.0%)
Co-trimoxazole	648 (48.3%)	0 (0.0%)	693 (51.7%)

Notes: S, susceptible; I, susceptible, increased exposure; R, resistant.

Table 7

Comparison of E. coli resistance rates to antimicrobial agents according to the RESOURCE-2 and DARMIS-2023 studies [16]

Antimicrobial agent	RESOURCE-2, 2024 (n=43 501) P, %	DARMIS-2023 (n=788) P, %
Ampicillin	54.3	58.8
Amoxicillin/clavulanic acid	16.9 (76.7*)	35.3
Cefotaxime	28.7	26.1
Meropenem	0.7	0.5
Amikacin	9.5	0.8
Ciprofloxacin	34.9	31.0
Co-trimoxazole	31.0	30.4
Fosfomycin	2.4	7.1
Nitrofurantoin	3.3	0.5

Note: R – proportion of resistant strains among all isolates tested; * proportion of strains susceptible at increased exposure.

perspective, these differences are not fundamental and may be explained by differences in the susceptibility testing methods used.

A substantial discrepancy was found in the level of resistance to amikacin. In DARMIS-2023, the proportion of resistant isolates was only 0.8%, consistent with the status of amikacin as an effective reserve agent, whereas in RESOURCE-2 this figure reached 9.5%. Substantial differences were also observed in the assessment of susceptibility to AMC. In DARMIS-2023, the frequency of species resistant to this agent was 35.3%, and the "susceptible, increased exposure" category was 0%. In our study, the proportion of resistant strains (R) at standard dosing regimens was lower, at 16.9%; however, when isolates classified as I were taken into account, the proportion of non-susceptible strains increased to 76.7%. These differences may primarily be related to the use of different interpretive criteria for AMC in DARMIS-2023 and RESOURCE-2. Different criteria are provided for this antibiotic for complicated and uncomplicated UTIs [11]; in RESOURCE-2, criteria for complicated UTIs were used. It should be noted that revision of the classification of UTIs into complicated and uncomplicated forms is currently being discussed, with a proposal to use the terms "localized" and "systemic" infection. In the present study, we followed the current classification adopted in the clinical guidelines in force at the time of the analysis.

The results of the present study indicate marked variability in the E. coli resistance profile depending on the patient's sex, age, and physiological status, which should be taken into account when selecting empirical antimicrobial therapy for UTIs. High resistance rates to fluoroquinolones (>57%) and third-generation cephalosporins (~48%) in men reflect the fact that UTIs in men are almost always complicated [17]. By contrast, the resistance profile in adult women corresponds to the classic community-acquired E. coli strain. The persistently high activity of fosfomycin (97.8%) and nitrofurantoin (97.3%) is fully consistent with their position in international [13] and Russian guidelines [3] as first-line agents for the treatment of acute uncomplicated cystitis. Pregnant women deserve special attention, as they had the most favorable resistance profile. Minimal resistance rates to nitrofurantoin (0.3%) and fosfomycin (1.3%), as well as high susceptibility to cephalosporins (>78%), confirm the effectiveness of these agents for treating both asymptomatic bacteriuria and acute cystitis in this patient category [16].

K. pneumoniae is characterized by a complex resistance profile. The frequency of strains resistant to third-generation cephalosporins was 39.2%, which is more than 1.5 times higher than the corresponding value for E. coli (28.7%). High resistance of K. pneumoniae to fluoroquinolones (56.0%), aminoglycosides (28.0–33.1%), and meropenem (27.8%) was also noted (*Table 5*). On the one hand, these data are consistent with the global trend toward widespread dissemination of carbapenemase-producing K. pneumoniae strains [7]. On the other hand, the values obtained are more typical of isolates collected from patients with nosocomial UTIs. This discrepancy may be explained by a substantially higher prevalence of resistant strains among men with UTIs. Our analysis of the frequency of resistant K. pneumoniae strains isolated from men and women confirms this hypothesis: higher resistance rates were identified in men compared with women (*Table 5*). These differences reflect the fact that UTIs in men are most often associated with benign prostatic hyperplasia, which frequently requires transurethral procedures in hospital settings and the use of urinary catheters [17]. By contrast, the resistance profile of K. pneumoniae in women is typical of community-acquired UTIs. In particular, carbapenem- and amikacin-resistant isolates occur in 8.7% and 8.3% of cases, respectively, which is comparable to data obtained in similar studies [16].

P. mirabilis retains a relatively favorable resistance profile to several key antibiotics. Susceptibility to third-generation cephalosporins was 83.9%, allowing these agents to be considered for therapy when the etiology is confirmed. However, high resistance rates of P. mirabilis to co-trimoxazole (51.7%) and ciprofloxacin (44.0%) virtually preclude their empirical use. The low susceptibility to gentamicin (65.7%) and amikacin (87.9%) is noteworthy and limits the use of aminoglycosides as monotherapy. Another feature of P. mirabilis is the high proportion of isolates susceptible to AMC only at increased exposure (55.7%), which requires special attention when selecting the dosing regimen.

The RESOURCE-2 study has several limitations, primarily related to the use of the disk diffusion method for susceptibility testing and the retrospective collection of clinical information. The volume and quality of available clinical information also do not allow clear differentiation of UTI forms, verified diagnosis, or the presence of complicating factors. Use of data from a network of outpatient offices as the data source may introduce a

degree of selection bias, potentially excluding the most severe cases requiring immediate hospitalization.

Future research will focus on two key areas. First, in light of updated international guidelines and the forthcoming resolution of the Consensus Council on the management of patients with UTIs in the Russian Federation, validation of the diagnostic significance of a lower bacteriuria threshold (⩾103 CFU/mL) in different patient subpopulations is needed. Prospective studies allowing comparison of microbiological data with clinical symptoms will help clarify the epidemiology of UTIs and optimize diagnostic criteria. Second, analysis of regional patterns in the prevalence and antibiotic resistance of uropathogens across the Russian Federation appears highly relevant, as it will make it possible to develop differentiated approaches to empirical therapy based on local data.

Conclusion. Representatives of the order Enterobacterales remain dominant in the etiology of community-acquired UTIs in the Russian Federation. E. coli is the leading pathogen (64.1%), followed by K. pneumoniae (13.1%) and P. mirabilis (3.6%). In the overall patient population, high rates of E. coli resistance were recorded for ampicillin (54.3%), fluoroquinolones (34.9%), co-trimoxazole (31.0%), and third-generation cephalosporins (28.7%). Fosfomycin and nitrofurantoin retained the highest activity against E. coli, with 97.6% and 96.7% of strains susceptible, respectively.

The resistance profile of E. coli differs depending on the demographic group. Strains isolated from men showed the highest resistance to most classes of antimicrobial agents, including fluoroquinolones (63.0%) and third-generation cephalosporins (47.9%). Strains isolated from pregnant women were characterized by the most favorable resistance profile, with minimal proportions of non-susceptible strains to nitrofurantoin (0.3%) and fosfomycin (1.3%), as well as higher susceptibility to third-generation cephalosporins (>78%) compared with non-pregnant women. The resistance profile of E. coli strains isolated from children and adolescents was close to that in adult women, except for a higher risk of resistance to cefuroxime.

K. pneumoniae is characterized by a substantially higher level of resistance to all major classes of antimicrobial agents compared with E. coli. High resistance rates were found for carbapenems (27.8% for meropenem) and third-generation cephalosporins (39.2%). Comparison with DARMIS-2023 revealed comparable levels of E. coli resistance to the main antibiotic classes, including ampicillin, cefotaxime, and fluoroquinolones. At the same time, the use of the real-world clinical and laboratory practice data methodology in RESOURCE-2 allowed to identify differences that are not accessible in small samples from multicenter microbiological projects, namely significant differences in resistance levels between demographic groups and higher E. coli resistance to amikacin (9.5% versus 0.8% in DARMIS), which requires further monitoring.

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CARBAPENEM-RESISTANT URINARY TRACT INFECTION IN PATIENTS WITH NEPHROLITHIASIS

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Introduction. Carbapenems belong to reserve antibiotics; however, the frequency of carbapenem-resistant bacterial strains is increasing in hospitals. Resistance of nosocomial Gram-negative strains to carbapenems is a significant problem with a tendency to progress, necessitating close attention to it.
Objective. Analysis of the prevalence of carbapenem-resistant flora in a urology clinic, identifying the most significant factors associated with the resistance of pathogens to medications.
Material and methods. A single-center retrospective study was conducted analyzing 1,720 urine culture results from patients with nephrolithiasis managed at a tertiary care institution in Moscow.
Results. Acquired carbapenem resistance to at least one carbapenem was detected in 5.4% of patients. Carbapenem-resistant Klebsiella pneumoniae (70% of all carbapenem-resistant isolates) and Pseudomonas aeruginosa (13%) were the most frequently identified species. Male sex and age >50 years were identified as significant risk factors. A logistic regression model was constructed to quantify the contribution of major risk factors, demonstrating an area under the receiver operating characteristic curve (ROC-AUC) of 0.88.
Conclusion. The relatively high prevalence of carbapenem-resistant Gram-negative urinary tract infection among patients hospitalized for urological management of nephrolithiasis necessitates further research to identify optimal therapeutic strategies and prevent postoperative infectious complications caused by these pathogens. Moreover, the prevalence rate of carbapenem-resistant bacteria (5.4%) carries important implications for antimicrobial stewardship and pharmaceutical resource allocation in urological inpatient settings.

K e y w o r d s: *carbapenem resistance; nosocomial infection; Pseudomonas aeruginosa; Klebsiella pneumoniae; nephrolithiasis*

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Introduction. The widespread dissemination of antibiotic-resistant bacteria increases the duration of treatment in urological patients and raises the risk of complications such as postoperative pyelonephritis, pneumonia, acute kidney injury, and others. Carbapenems are reserve antibiotics; however, the frequency of carbapenem-resistant bacterial strains is increasing in hospitals. In clinical practice, irrational use of carbapenems should be avoided. Selection of the optimal drug before microbiological test results become available may significantly improve treatment outcomes. A number of published studies have described the overall resistance profile of several Gram-negative bacteria to standard antibiotics, including carbapenems. In the study by T.N. Malorodova et al. in Belgorod, E. coli and Enterobacter spp. predominated among patients with calculous pyelonephritis, with the overall susceptibility of enterobacteria to carbapenems being about 99% [1].

In the study by B.U. Shalekenov et al., carbapenem resistance among urological patients was found mainly in P. aeruginosa [2]. In the work by K.L. Lokshin et al., no resistance to carbapenems was identified among strains isolated from pregnant women with symptomatic or asymptomatic bacteriuria [3].

In the study of nosocomial strains by A.G. Polishchuk et al., carbapenem resistance was observed overall in 5.1% of isolates: K. pneumoniae (5 of 6), E. cloacae (2 of 2), S. marcescens (1 of 1), P. aeruginosa (3 of 3), and A. baumannii (10 of 11) [4]. Carbapenem-resistant strains of P. aeruginosa and K. pneumoniae are of particular concern in hospitals. For the latter, N.S. Kozlova et al. demonstrated a carbapenem resistance rate of 44.2% in a multidisciplinary hospital setting [5]. Thus, resistance of nosocomial Gram-negative strains to carbapenems is a significant and increasingly important problem that requires close attention.

Aim. To analyze the prevalence of carbapenem-resistant pathogens in a urology clinic and to identify the most significant factors associated with pathogen resistance to antimicrobial agents. The objectives of the study were to

assess the frequency of carbapenem-resistant Gram-negative urinary pathogens in urological patients; to identify clinical and microbiological predictors of carbapenem resistance; to determine the relative contribution of the major risk factors; and to develop a predictive model based on them.

Materials and methods. The study was carried out at the Urology Department of City Clinical Hospital No. 31 named after Academician G.M. Savelyeva, Moscow. Over one calendar year, 3250 patients aged 18 to 94 years were hospitalized. Urine culture with antibiotic susceptibility testing was performed in all emergency admissions regardless of diagnosis. A retrospective single-center study was carried out, including 1720 urine culture results obtained from patients treated in the urology department of City Clinical Hospital No. 31, Moscow. Organism identification was performed using standard biochemical methods and MALDI-TOF. Susceptibility was assessed by the disk diffusion method according to EUCAST and standard clinical protocols in the hospital clinical laboratory. Statistical analysis was performed using the scipy and statsmodels libraries in Python 3.11. Since predominantly categorical variables were used in the analysis, chi-square tests were applied for categorical factors and t-tests for comparison of mean age between resistant and non-resistant cases. For pathogen and diagnosis categories, the rarest cases, fewer than 10 per category, were merged into the general category "Other" to improve interpretability. To select the most significant features for the logistic regression model, variables were encoded and screened, autoregressive variables were excluded, and clinically meaningful encoded features were selected. A logistic regression model was built, and odds ratios were estimated for each variable included. Internal validation was performed using the conventional split into a training set, 70%, and a test set, 30%. The following model parameters were selected: C 1.0, class_weight balanced, penalty l2, solver lbfgs. Model performance was assessed by sensitivity, specificity, accuracy, and ROC-AUC.

Results. General characteristics. A total of 1720 urine culture results were analyzed. The proportion of carbapenem-resistant microorganisms was 5.4%, 92/1720, and the proportion of susceptible isolates was 94.6%, 1628/1720. Among all patients with carbapenem-resistant isolates, the most frequently detected species were Klebsiella pneumoniae (70%), and Pseudomonas aeruginosa (13%). Each of the remaining pathogens accounted for less than 17%. These included Acinetobacter baumannii, 4%, Alcaligenes faecalis, 1%, Enterobacter cloacae, 4%, Escherichia coli, 2%, Klebsiella variicola, 2%, and Proteus mirabilis, 4%. Relative prevalence of resistance in individual subgroups was then analyzed in relation to the total number of patients.

Gender factor. The chi-square test showed significant differences between sexes: chi-square 7.2, p=0.007, with a resistance rate of 6.9% in men versus 3.9% in women.

Age factor. Among patients with carbapenem-resistant bacteria, age was a significant factor associated with a higher rate of resistance, ANOVA p=0.006; p<0.05 in post-hoc Tukey comparisons between the 51-65 and 65+ groups versus the 18-35 group. The probability of resistance increased from 0.6% at age 18-35 to 7.3% among patients aged 51-65 years. The most vulnerable groups were 51-65 years and older than 65 years, in whom the risk remained elevated compared with younger patients. *Figure 1* shows the distribution of susceptible and resistant cases by age.

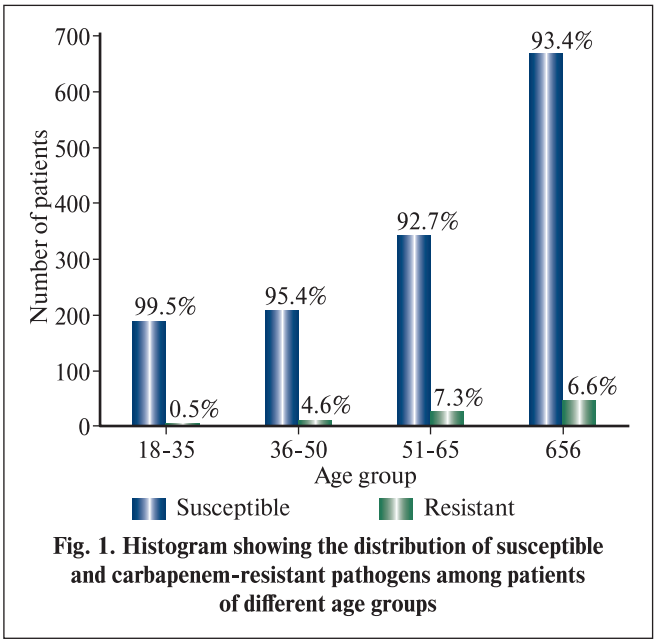

Fig. 1. Histogram showing the distribution of susceptible and carbapenem-resistant pathogens among patients of different age groups

Pathogens. Statistical analysis showed that pathogen species was the main determinant of carbapenem resistance: chi-square 261.6, p<0.0001, underscoring the critical role of microbiological testing. Among common pathogens, the highest relative resistance rate in relation to all tests performed for a specific pathogen was observed in Klebsiella pneumoniae, 18.9%, whereas Escherichia coli, despite being the most common pathogen overall, had the lowest resistance rate, 0.2%. As shown in *Figure 2*, other pathogens with a notable proportion of resistance were Pseudomonas aeruginosa, 12.5%, Enterobacter cloacae, 6.9%, and Proteus mirabilis, 2.3%.

Diseases. No statistically significant differences were found between nosological categories according to ICD classification: chi-square 54.5, p=0.094. Carbapenem-resistant pathogens were detected most often in patients with secondary pyelonephritis, 77% of all treated urological inpatients. Less frequently, carbapenem-resistant pathogens were found in patients with hydronephrosis and chronic urinary retention, *Figure 3*.

Feature selection for the logistic regression model. Variables selected for the logistic regression model were statistically significant, clinically interpretable, and had low autocorrelation. The final set included binary indicators of pathogens, antibiotic, sex, age categories, and an aggregated indicator of diagnoses with the highest proportion of resistance, thus ensuring a balance between interpretability and predictive performance.

Logistic regression. The model showed very good performance on the validation set, reflected by the low number of false-positive and false-negative results, see *Figure 4B*. ROC-AUC was 0.87, accuracy 80.9%, sensitivity 81.5%, and specificity 80.9% on the test set of 1124 observations, with 482 observations in the training set. The strongest predictors according to odds ratios were K. pneumoniae, OR 11.71, P. aeruginosa, OR 5.00, age 51-65 years, OR 1.92, and >65 years, OR 1.92, whereas E. coli was a low-risk factor, OR 0.31, as was age 18-35 years, OR 0.72, *Figure 4B*. ROC curves, coefficients, odds ratios, confusion matrix, and probability distributions are presented below.

Discussion. Treatment of hospitalized urological patients often requires antibacterial therapy. These agents are also

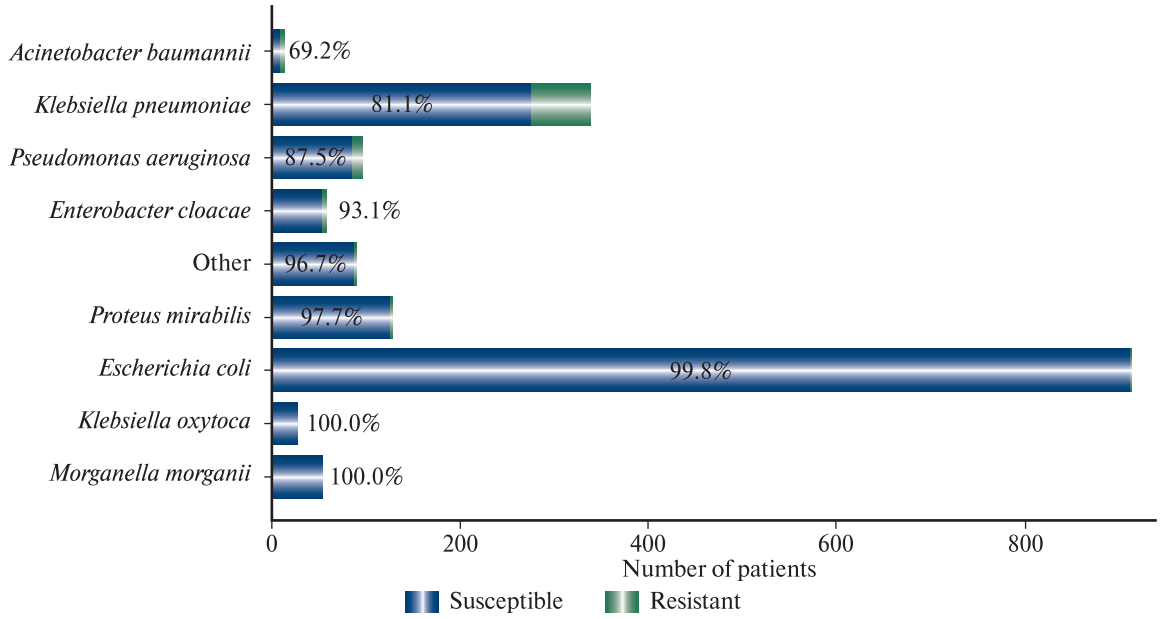

Fig. 2. Distribution of the relative proportion of carbapenem resistance among pathogens identified in microbiological analyses.

used in elective surgery as prophylaxis against postoperative complications.

Almost all patients with nephrolithiasis requiring elective surgery have chronic pyelonephritis. In many cases, the titer of bacteriuria is high. Such patients are usually recommended for outpatient antimicrobial prophylaxis, reduction of bacteriuria, and subsequent elective procedure. When carbapenem-resistant pathogens are detected in urine, the classical management strategy becomes difficult to implement, since there are no oral agents with high efficacy and the choice of optimal antimicrobial therapy is markedly limited. In real-world clinical practice, patients with pan-resistant Gram-negative urinary infection at a high titer are often undergone to elective procedure in the absence of active pyelonephritis despite the relative contraindication of marked bacteriuria. Thus, timely identification of patients with carbapenem-resistant flora,

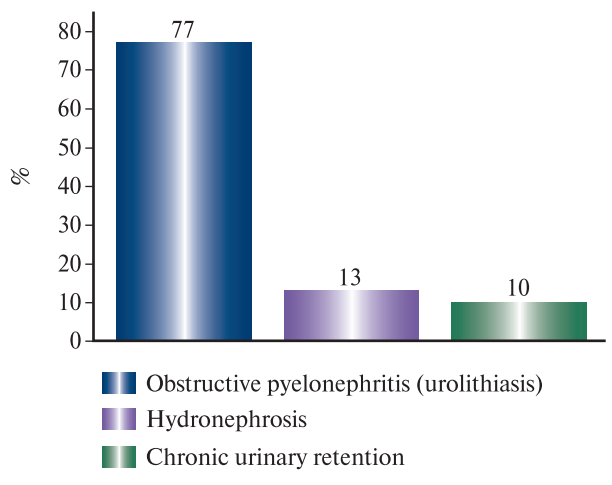

Fig. 3. Absolute frequency of carbapenem resistance among all resistant pathogens according to diagnoses

the search for optimal antibiotic therapy, and systemic approaches to reducing antibiotic resistance are critically important in urological inpatient care [6].

Our findings demonstrate the importance of pathogen type together with several other factors associated with a high risk of carbapenem resistance. These results are consistent with international and domestic literature. Infections caused by K. pneumoniae and P. aeruginosa are associated with the highest likelihood of resistance, whereas infections caused by E. coli are associated with the lowest likelihood, which is in agreement with current reviews of urinary tract infections caused by carbapenem-resistant Enterobacterales (CRE) and global risk estimates [7, 8].

Infections caused by carbapenem-resistant P. aeruginosa, K. pneumoniae, and A. baumannii are associated with unfavorable clinical outcomes, including increased mortality and higher risk of sepsis. Some investigators propose a substantial reduction in carbapenem use. For example, when these pathogens are identified by polymerase chain reaction, which does not provide susceptibility data, although it may indicate the presence of resistance determinants, they recommend immediate use of a drug from another pharmacological class [9-12].

This may seem logical, but alternatives are limited and are usually used in combinations. Carbapenems may be avoided, but this would require empirical use of combinations such as amikacin plus aztreonam or polymyxin plus aztreonam. There are also newer, very expensive, protected cephalosporins such as ceftazidime-avibactam and ceftolozane-tazobactam. Ideally, these should also be combined with another agent, most often amikacin. In fact, the therapeutic options are essentially exhausted at that point. Therefore, the idea of abandoning carbapenems altogether seems unrealistic.

In the present study, resistant K. pneumoniae predominated, whereas according to the literature P. aeruginosa is often emphasized, although K. pneumoniae is also commonly described as a frequent carrier of carbapenem resistance [13-16]. For practical work, this

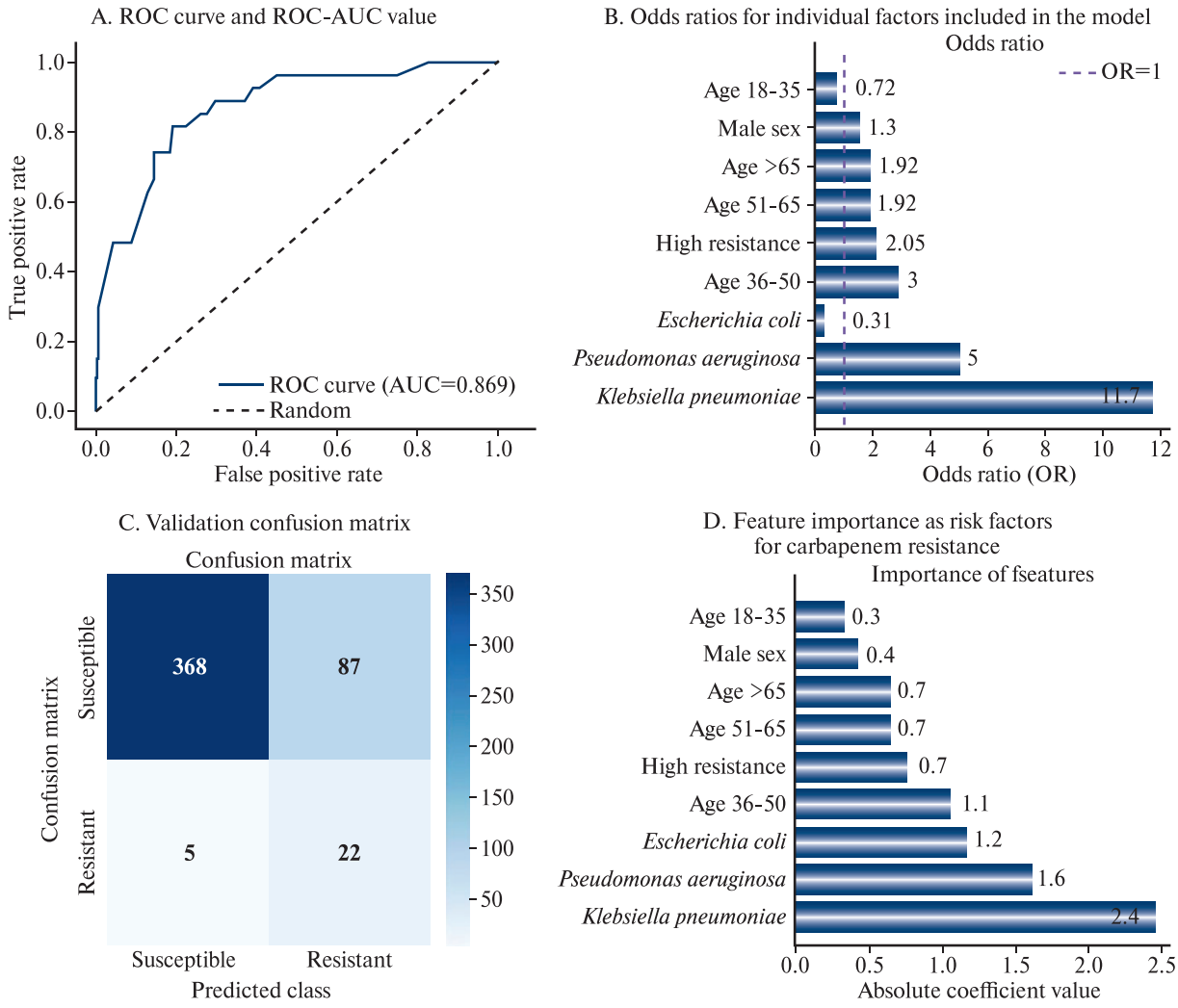

Fig. 4. Main characteristics and performance metrics of the logistic regression model.
A – ROC curve and ROC-AUC value, B – odds ratios for individual factors included in the model, C – validation confusion matrix, D – feature importance as risk factors for carbapenem resistance

information is important and generally encouraging. Tigecycline and fosfomycin may be used against K. pneumoniae, both lacking antipseudomonal activity. On the other hand, K. pneumoniae is capable of forming biofilms on urological devices and catheters, which is a common cause of recurrence. Carbapenem resistance in K. pneumoniae has become a serious problem not only in urology but in clinical medicine as a whole, which underlines the relevance of this issue [17]. Over the past decade worldwide, resistance to third-generation cephalosporins and carbapenems among K. pneumoniae and P. aeruginosa isolates has steadily increased on average from 5.4 to 25% and from 30 to 60%, respectively [18].

The relationship between nephrolithiasis and infection is bidirectional: bacteria are involved in the formation and persistence of infection stones, especially struvite stones, while the presence of stones and associated biofilms increases the risk of persistence and resistance, which is consistent with our findings in which urolithiasis was characterized by the highest rate of carbapenem-resistant bacteria. Literature sources traditionally emphasize the role of urease-producing bacteria; however, an increasing frequency of Gram-negative bacteria not producing this enzyme, including K. pneumoniae and E. coli, has also been demonstrated, and their antimicrobial resistance complicates antibiotic therapy [12, 19, 20].

The identified association with age, increased risk at 51-65 years and older, is consistent with data on age as a risk factor for CRE infections, including after invasive procedures, prolonged hospitalization, and catheterization. To some extent, age may also reflect other risk factors known from the literature that could not be studied in our dataset, such as prior colonization or infection with CRE, prior antimicrobial exposure, and catheter-associated factors [21, 22].

The constructed logistic regression model showed high ROC-AUC, sensitivity, and acceptable specificity. These findings are consistent with the international level of development of predictive models for antibiotic resistance risk [10, 23].

Our results support an empiric therapy approach guided by the hospital microbiological profile: when there is a high probability of P. aeruginosa, K. pneumoniae, or A. baumannii, rapid escalation of therapy and early de-escalation according to microbiological results should be considered, whereas in low-risk situations, E. coli, young patient age, narrower initial

therapy may be possible, which is consistent with current reviews on CRE urinary tract infections [24-27].

This study is limited by its retrospective single-center design, the limited number of A. baumannii observations, and the absence of molecular typing. However, consistency with the literature and the high ROC-AUC of the logistic regression model indicate the practical value of our findings. In the future, the model could be improved by including variables related to colonization and catheterization, as well as the number and recency of prior infections. External validation and assessment of the effect of threshold calibration on clinical outcomes in cohorts with different CRE prevalence would further increase the practical value of the model [28-31].

Conclusion. The relatively high rate of carbapenem-resistant Gram-negative urinary tract infection among patients hospitalized for nephrolithiasis necessitates further research aimed at identifying optimal therapeutic regimens and preventing postoperative complications caused by these pathogens. In addition, the observed prevalence of carbapenem-resistant bacteria, 5.4%, is relevant for planning antimicrobial drug supply in urological departments.

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LAPAROSCOPIC ILEAL URETERAL RECONSTRUCTION

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Restoration of urinary tract continuity using isolated segments of the small intestine is required in cases of extensive ureteral defects of various origins. In recent years, several publications have reported the use of laparoscopic techniques for performing ileoureteroplasty. The aim of the research is to present the outcomes of laparoscopic intestinal ureteral reconstruction.

Materials and methods. From 2001 to 2026, small bowel ureteral reconstruction was performed in 249 patients. Laparoscopic ileoureteroplasty has been carried out by our team since 2013, and during this period we have accumulated experience with 101 such operations (50.2%), involving a total of 109 ureters. Among these patients, there were 44 men (43.6%) and 57 women (56.4%), with a mean age of 48.8±1.6 years. Unilateral ileoureteroplasty was performed in 93 patients (92.1%), and bilateral procedures in 8 patients (7.9%).

Results. Early postoperative complications occurred in 6 patients (5.9%). There were no fatal outcomes. Late complications were followed up in 89 patients over a period ranging from 3 to 254 months (mean 66±2 months) after surgery and developed in 5 patients (5.6%). Urinary tract urodynamics on the operated side improved in all patients. According to nephroscintigraphy, kidney function after ileoureteroplasty improved in 98 patients (97.0%), remained at the same level in 1 (1.0%) and worsened in 2 (2.0%) patients.

Discussion. An isolated segment of the ileum is the best and most versatile substitute for the reconstruction of extensive ureteral defects. In most patients, ileoureteroplasty can be successfully performed using a laparoscopic approach.

Conclusion. Laparoscopic ileoureteroplasty reduces surgical trauma and shortens the duration of hospital stay.

K e y w o r d s. *ureteral stricture/obliteration, laparoscopic ileoureteroplasty, intestinal ureteral reconstruction*

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Introduction. Rectal injury is a serious complication of radical prostatectomy (RP). It has been reported in 0 to 20.39% of cases, with the incidence of rectal injury during RP varying substantially across studies [1]. During retropubic RP, rectal injury may occur mainly during apical dissection when attempting to create the posterior plane between the rectum and Denonvilliers' fascia [2], whereas during perineal RP the critical stage is dissection of the posterior surface of the prostate from the rectum. In contrast, during laparoscopic RP (LRP) or robot-assisted RP (RARP), rectal injury more commonly occurs during dissection of the seminal vesicles and creation of the posterior plane between the prostate and the rectal wall.

Rectal injury may be detected intraoperatively or diagnosed postoperatively after the onset of clinical symptoms. Regardless of the time of detection, rectal injury may significantly increase the risk of early postoperative complications such as peritonitis and sepsis, as well as delayed consequences such as rectourethral fistula (RUF) [3]. The later rectal injury is identified after RP, the greater the likelihood that the patient will require reintervention for temporary or permanent fecal and/or urinary diversion [4].

Given the low incidence of rectal injury during RP, uncertainty remains regarding the predisposing risk factors and optimal management of this complication.

Aim. To analyze the causes of rectal injury during laparoscopic RP and the efficiency of therapeutic measures based on our own experience compared with the published literature.

Materials and methods. The study included 519 patients with prostate cancer who underwent LRP in our clinic between 2014 and 2023. Intraoperative rectal injury was observed in 3 patients (0.58%). At the time of surgery, the patients were 61-71 years old (*Table 1*). In all patients, standard transrectal biopsy revealed prostate adenocarcinoma with a Gleason score of 6-7. Prostate-specific antigen (PSA) levels ranged from 7.1 to 13.2 ng/mL. One patient had previously undergone transurethral resection (TUR) for benign prostatic hyperplasia (BPH).

All these patients underwent LRP via an extraperitoneal approach. In all cases, rectal injury was detected intraoperatively (*Fig. 1*). The bowel defect was closed with a two-layer suture using absorbable polyglactin or polyglycolic 3/0-2/0 sutures (*Figs. 2-3*). The second layer was created with interrupted polyglactin sutures (*Fig. 4*). The vesicourethral anastomosis was then constructed in the usual manner (*Fig. 5*).

At the end of surgery, all patients with rectal injury underwent anal sphincter dilation.

Results. No seminal vesicle invasion, lymph node involvement, or positive surgical margin was found in any of the three patients with rectal injury (*Table 2*). No

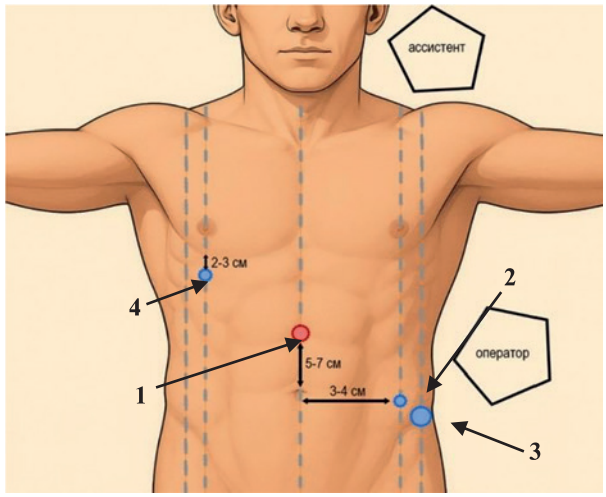

Fig. 1. Diagram showing the position of the urology team and working ports during right-sided ureteral reconstruction using ileal segment (authors' illustration): 1) 10-mm optical trocar placed in the midline 5-7 cm above the umbilicus; 2) 5-mm port placed 3-4 cm to the left of the umbilicus along the left midclavicular line; 3) 12-mm port for the stapling device placed at the level of the iliac crest along the left anterior axillary line; 4) 5-mm port placed 2-3 cm below the costal margin along the right midclavicular line.

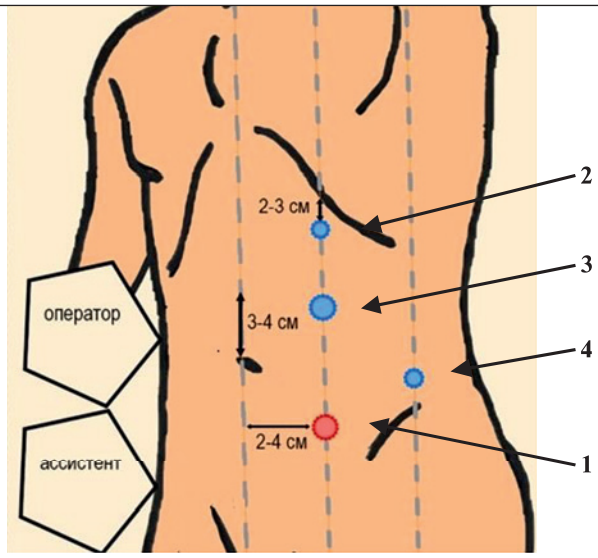

Fig. 2. Diagram showing the position of the urology team and ports with the patient in the right lateral decubitus position during total left-sided ureteral reconstruction using ileal segment (authors' illustration): 1) 10-mm optical trocar placed along the left lateral edge of the rectus abdominis muscle at the level of the umbilicus; 2) 5-mm trocar placed 2-3 cm below the costal margin along the left midclavicular line; 3) 10-mm port placed 4 cm above the umbilicus along the left midclavicular line; 4) 5-mm port placed at the level of the iliac crest along the left anterior axillary line.

Table 1

Techniques of laparoscopic ureteral reconstruction using small bowel segment

Techniques of ureteral reconstruction	Total	
	Abs.	%
I. Unilateral (n=93):		
Ureteroileocystoanastomosis	59	58.4
Pyeloileocystoanastomosis	24	23.8
Calicoileocystoanastomosis	4	4.0
Yang–Monti technique	6	5.8
II. Bilateral (n=8):		
Separate ileal grafts	4	4.0
U-shaped graft	4	4.0
Total	101	100.0

Table 2

Early complications after laparoscopic ureteral reconstruction using ileal segment (n=101)

Early postoperative complication	Number of patients		Clavien–Dindo grade	Treatment
	Abs.	%		
Perforation of the descending colon	1	1.0	IIIB	Laparotomy, suturing of the bowel defect, abdominal drainage
Bleeding from the pelvic veins	1	1.0	IIIB	Laparotomy, ligation of bleeding vessels
Anastomotic leakage	2	1.9	IIIB	Laparotomy. Redo ileocystostomy. Abdominal drainage
Small bowel obstruction by the graft mesentery	1	1.0	IIIB	Laparotomy. Redo ileocystostomy. Abdominal drainage
Bleeding from the enteroenteric anastomosis	1	1.0	IIIB	Laparotomy. Redo ileocystostomy. Abdominal drainage
Total	6	5.9		

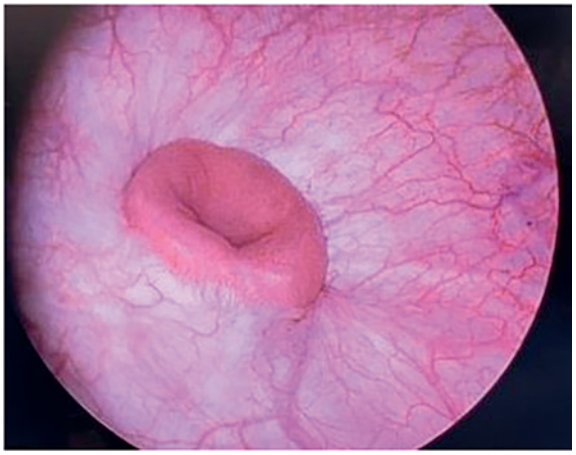

Fig. 3. Cystoscopic view 1 year after bilateral isoperistaltic total ureteral reconstruction using ileal segment

postoperative surgical complications occurred in any patient. In the early postoperative period, all patients received parenteral nutrition for 6-9 days, antibacterial therapy, and low-molecular-weight heparins.

The urethral catheter was removed on postoperative days 9-14 after cystography (*Fig. 6*). The patients were discharged from the hospital on postoperative days 10-15.

During follow-up of 46-113 months, none of the patients developed biochemical recurrence or signs of disease progression.

Fig. 4. Cystogram 1 year after bilateral isoperistaltic total ureteral reconstruction using ileal segment

Fig. 5. CT scan 3 years after laparoscopic left ureteral reconstruction using ileal segment

Fig. 6. CT scan 5 years after laparoscopic right ureteroileocystostomy

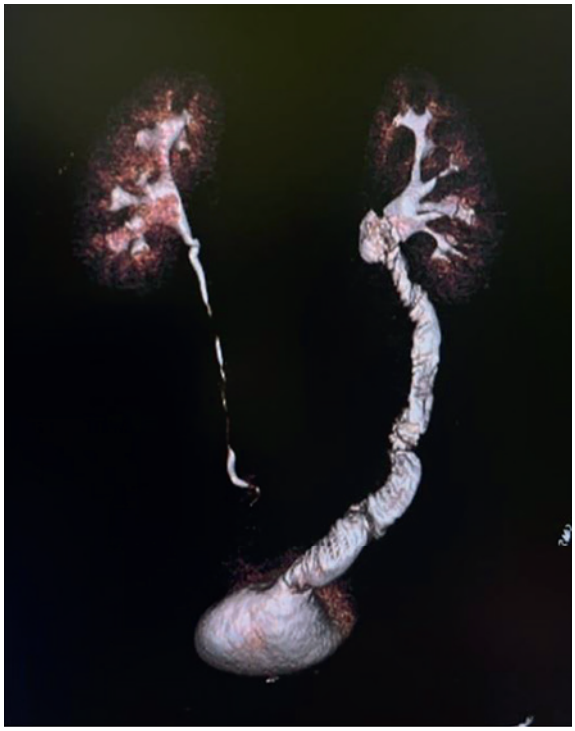

Fig. 7. CT scan 3 years after laparoscopic left pyelocystostomy

Discussion. In a systematic review of 88 selected studies out of 1806, the incidence of rectal injury during RP ranged from 0.10 to 4.71%. The incidence of rectal injury after RP gradually decreased with improvements in surgical technique and increasing experience, from 26% in 2003-2006 to 1.5-5.5% in 2009-2012. In most more recent studies, however, the incidence did not exceed 1% [5, 8, 11]. Moreover, in studies including more than 500 cases, the incidence ranged from 0.52 to 0.59% [1]. In our series, the incidence of rectal injury during LRP was 0.58%.

Some studies reported a higher incidence of rectal injury in patients older than 60 years compared with younger patients [1]. The age of our patients ranged from 61 to 71 years, which can be viewed neither as a contradiction of nor as confirmation of these data.

Although rectal injury may occur regardless of the surgical approach used, meta-analytic data showed that injuries were more frequent during transperitoneal procedures [1]. Other studies have also shown a higher risk of rectal injury in patients undergoing retropubic RP compared with those treated with LRP or RARP [5, 8, 11].

All three patients described above underwent LRP via an extraperitoneal approach, as did the vast majority of RP in our center. Today, the capabilities of conventional laparoscopic procedures, including three-dimensional imaging, 4K resolution with 30° optics or even a flexible-tip camera, make it possible to visualize and dissect the posterior plane at the level of the seminal vesicles, prostate, and its apex under direct vision with no less safety than in robotic surgery. Thus, the risk of rectal injury is minimized. In addition, the extraperitoneal approach substantially facilitates diagnosis if delayed rectal complications occur and partly mitigates their consequences by preventing diffuse peritonitis.

Most studies assessing perioperative outcomes of Retzius-sparing RARP did not specifically address rectal injury. Galfano et al. [19] reported in 2021 a rectal injury rate of 0.2% in a large series of 626 patients undergoing Retzius-sparing RARP, with all injuries detected in patients operated on by surgeons during the learning curve. Similarly, Abdel Raheem et al. [20] in 2018 reported an rectal injury rate of 0.3% in a series of 359 patients treated with Retzius-sparing RARP.

Previous pelvic radiotherapy for prostate cancer or other conditions has been associated with an increased risk of rectal injury. Several authors reported incidences ranging from 2 to 15% in patients undergoing RP [7, 11, 21]. Notably, in a multicenter, multi-surgeon study including 395 patients who underwent salvage RP (186 retropubic RP and 209 RARP), Gontero et al. [7] reported a rectal injury incidence of 2.96% and 0.48%, respectively. None of our patients with bowel injury had undergone prior radiotherapy. At the same time, none of the at least seven patients operated on in our center after brachytherapy sustained rectal injury. This may reflect increased surgical vigilance in such cases.

One of the three patients had previously undergone TUR for BPH. According to meta-analysis, previous surgery for BPH and a large prostate volume were considered additional risk factors for rectal injury [1].

Prostate volume in our patients ranged from 31 to 90 cc. On the other hand, none of the patients treated during the study period with prostate volume greater than 150 cc had bowel injury. This is consistent with the findings of another single-center study by Mandel et al. [11], who found no correlation between prostate volume and rectal injury.

Other factors potentially increasing the risk of rectal injury include prior androgen deprivation therapy, pelvic fractures, and rectal surgery, because periprostatic fibrosis may complicate dissection of the posterior surface of the prostate [9]. In particular, patients with inflammatory bowel disease and prior colorectal interventions, including colostomy closure, have been highlighted. Luciani et al. [22] reported 14 RARP procedures after colorectal surgery without rectal injury, but with conversion to open surgery in 21% of cases. In those cases, the authors used a retropubic approach.

None of our injured patients had prior colorectal surgery. At the same time, in operations on similar patients in our center (five during the study period, including one after extirpation of the rectum), we observed no bowel injuries and did not resort to open conversion. However, it should be noted that an extraperitoneal approach was used in all cases from the outset.

Interestingly, obesity may reduce the risk of rectal injury by increasing the tissue plane between the rectum and the prostate [5]. However, Mandel et al. [11] found no correlation between body mass index and rectal injury.

Based on a large series of 24,178 RP procedures, tumor-related risk factors for rectal injury were proposed: high preoperative total PSA, high Gleason score, lymph node involvement, and positive surgical margin - features typical of locally advanced disease [5, 11, 13]. From this standpoint, our patients did not have tumor-related risk factors. PSA levels ranged from 7.1 to 13.4 ng/mL, Gleason scores were

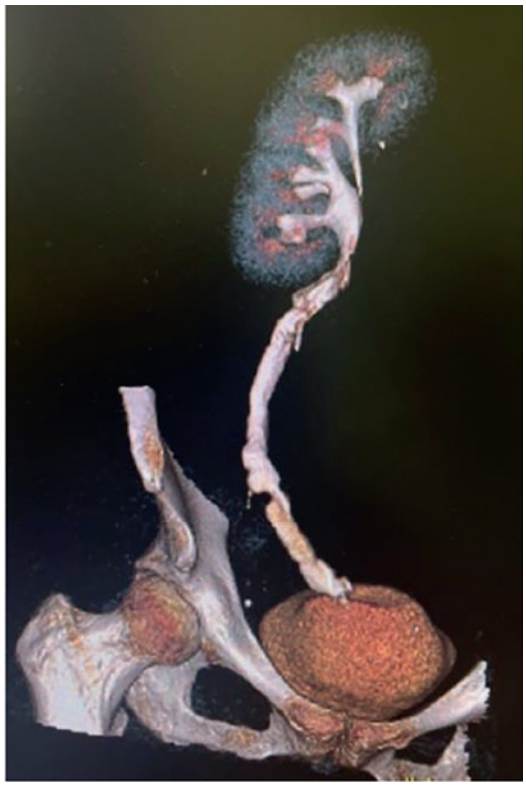

Fig. 8. CT scan in a patient with a solitary right kidney 9 years after laparoscopic pyelocystostomy

Fig. 9. CT scan 2 years after laparoscopic left calicoileocystostomy

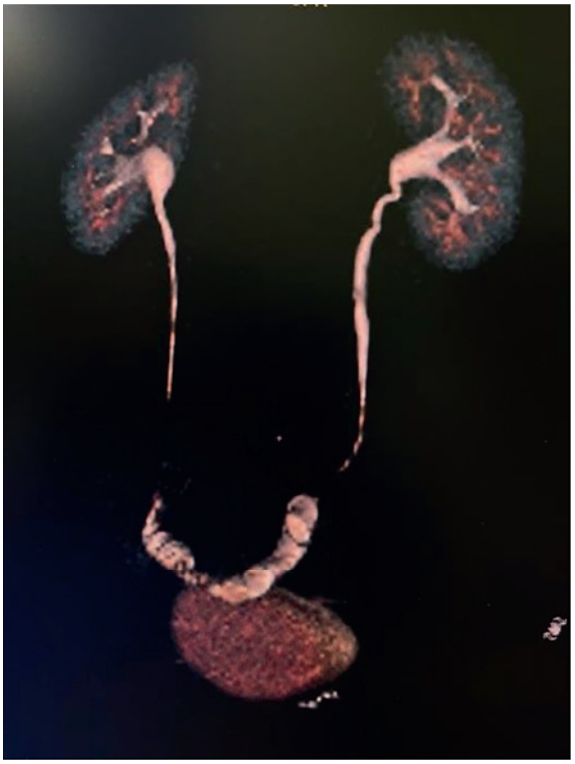

Fig. 10. CT scan 4 years after laparoscopic bilateral U-shaped ureteral reconstruction using ileal segment

Fig. 11. CT scan 7 years after laparoscopic bilateral 7-shaped ureteral reconstruction using ileal segment

Fig. 12. CT scan 1.5 years after laparoscopic bilateral isoperistaltic total ureteral reconstruction using separate ileal segments

6, 6, and 7, respectively, and no positive surgical margin or lymph node involvement was identified in any case.

Current clinical guidelines do not define specific preoperative measures aimed at reducing the risk of rectal injury or minimizing its consequences. Some authors use bowel preparation to reduce the severity of subsequent infectious complications if rectal injury occurs [10, 17]. However, analysis of 35,099 RP cases in the Japanese database between 2007 and 2012 showed that bowel preparation did not affect perioperative complications associated with rectal injury during RP [16, 23]. We currently use bowel preparation before LRP only in patients at high risk of rectal injury: previous colorectal surgery or radiotherapy, stage T3 disease, involvement of more than 50% of the gland or an apical lesion on biopsy or MRI, PSA above 15, and Gleason score 8 or higher. We observed no postoperative surgical complications in any patient after bowel repair during LRP. However, all cases presented here occurred during the period when bowel preparation was routinely used, making it impossible to determine whether it played a significant role in preventing complications.

The management and prognosis of rectal injury after RP differ considerably depending on whether it is detected intraoperatively or postoperatively. Intraoperative detection of rectal injury, as compared with postoperative detection, is strongly associated with a lower risk of severe postoperative complications and subsequent RUF formation [14]. Therefore, all intraoperative measures aimed at preventing and identifying rectal injury should be seriously considered. Careful dissection between the prostate and the rectal wall using cold scissors without monopolar coagulation, visualization of periprostatic fat during extrafascial dissection, and minimizing traction on the rectal wall in the presence of periprostatic adhesions may substantially reduce the risk of rectal injury [25, 26]. These maneuvers become especially important in the presence of extracapsular invasion, locally advanced disease, or pronounced adhesions, sometimes resulting from biopsy [24].

In many centers, including ours, a rectal tube is inserted immediately before the start of procedure to allow subsequent performance of a bubble test, which is mandatory in our center. After removal of the gland and hemostasis, the pelvic cavity is filled with saline. Then 100-150 mL of air is introduced through the rectal tube. The appearance of bubbles clearly indicates rectal injury [12, 27]. In such cases, an additional two-finger digital rectal examination performed by the assistant allows more accurate assessment of the extent of injury [6]. It is also advisable to obtain a swab for identification of potential pathogenic flora and antimicrobial resistance in order to minimize the risk of postoperative infectious complications [25].

During LRP, rectal injury may occur early during mobilization of the seminal vesicles and posterior surface of the prostate. In such cases, some authors recommend immediate repair of the rectum before further mobilization of the prostate [18]. In all our cases, however, the bowel wall was sutured after removal of the prostate and placement of the specimen into a retrieval bag, because this provided much better spatial conditions for bowel suturing. However, regardless of the approach, the rectal defect should be closed before construction of the vesicourethral anastomosis [14]. The defect is usually closed with a two-layer suture using absorbable polyglactin or polyglycolic 2-0 or 3-0 sutures [6, 14]. The use of endoscopic clips and fibrin glue has also been described [28]. In the transperitoneal approach, the omentum or a peritoneal flap harvested from the lateral pelvic wall may be used to separate the rectal suture line from the anastomosis [24, 27]. We did not use additional materials to separate the suture lines, because all LRPs were performed via an extraperitoneal approach. However, none of our patients developed suture failure or fistula formation.

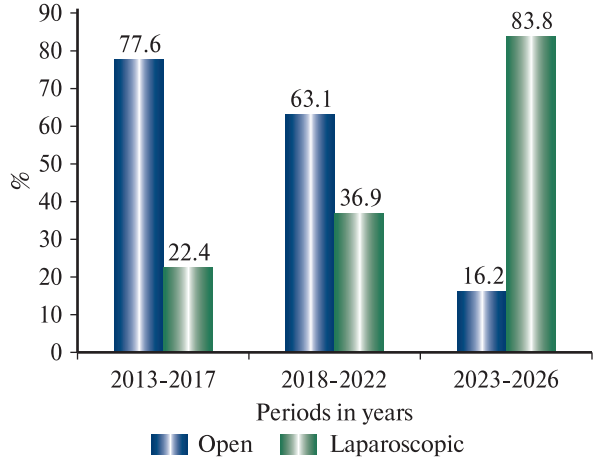

Fig. 13. Trends in open and laparoscopic ureteral reconstruction using ileal segment

There is controversy regarding indications for colostomy in patients with rectal injury during RP. According to some investigators, only 10% of patients with rectal injury underwent colostomy [5, 11, 15]. Primary colostomy should be considered in patients with large rectal defects (>2 cm), prior radiotherapy, or previous surgery for BPH, as well as when infiltration of the rectum by prostate cancer is suspected [27]. However, these features cannot be considered absolute indications for colostomy. One of our patients had previously undergone TUR of the prostate, and in another, used here as an example, the bowel defect was about 5 cm. Nevertheless, simple two-layer closure of the defect was successful in both and did not lead to any surgical complications.

In the postoperative period, some authors recommend a diet consisting of liquids from the first day with gradual expansion after the third day, as well as broad-spectrum antibiotics [11]. In addition, some investigators suggest prolonging catheterization to two weeks or more, followed by cystography [11, 26, 27]. The duration of catheterization in our patients was 10-15 days. We routinely perform cystography before catheter removal in all patients, regardless of intraoperative features or complications.

The greatest risk of severe, potentially fatal surgical complications is posed by rectal injury that is not recognized during RP and is diagnosed later in the postoperative period after symptoms develop. Some marginal bowel injuries caused by modern energy devices, such as impedance-controlled bipolar coagulation or ultrasonic dissectors, may go unnoticed even with a bubble test. These devices may effectively seal the bowel defect, and perforation may occur several days later.

The most severe consequences, including peritonitis, may develop in cases in which RP was performed via a transperitoneal approach [27]. Early symptoms include abdominal pain, fever, tachycardia, tachypnea, hypotension, and even oliguria. These manifestations may be accompanied by leukocytosis, thrombocytopenia, and elevated serum inflammatory markers [29].

Some authors believe that defects smaller than 1.5 cm may be managed conservatively with broad-spectrum antibiotics, prolonged bladder catheterization for 1-3 months, and parenteral nutrition, provided there are no signs of peritonitis or sepsis. However, the development of fever, peritonitis, pelvic abscess, and other infectious complications requires immediate surgical treatment, namely colostomy and closure of the rectal defect [4, 30, 31]. Larger defects or injuries involving the urethral sphincter require surgery from the outset. Nevertheless, a substantial proportion of patients develop rectourethral fistulas in the following weeks both after conservative treatment and after delayed surgical treatment for rectal injury [4, 5, 30, 31].

In one of our patients, the bowel defect measured about 3.5 cm. However, intraoperative closure of the injury, combined with preoperative bowel preparation and parenteral nutrition for 10 days postoperatively, made it possible to avoid subsequent rectourethral fistula formation.

Conclusion. Intraoperative rectal injury during LRP is rare. Previous radiotherapy and rectal surgery are potential additional risk factors for injury. It is possible that LRP performed via an extraperitoneal approach is associated with a lower risk of rectal injury.

Intraoperative detection and closure of the defect are not indications for colostomy and in the absolute majority of cases do not lead to postoperative complications.

The role of preoperative bowel preparation and subsequent parenteral nutrition in preventing suture failure and RUF formation in cases of rectal injury during RP remains insufficiently clarified.

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CONTINENCE RECOVERY AFTER ROBOTIC-ASSISTED RADICAL RETZIUS-SPARING PROSTATECTOMY

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Objective. To assess time to urinary continence recovery after Retzius-sparing robot-assisted radical prostatectomy (RS-RARP) and to describe early perioperative and oncological outcomes.
Materials and methods. A retrospective analysis was performed of patients who underwent RS-RARP in 2022–2024. The primary endpoint was time to complete urinary continence (0 pads/day). Time-to-event analysis (continence recovery) was carried out using the Kaplan–Meier method, with cumulative event probability visualized as (1−S(t)) and 95% confidence intervals calculated.
Results. A total of 344 patients were included. On day 1 after urethral catheter removal, complete continence was observed in 90,1% of patients (0–1 pad/day in 97,3%). Complete continence rates were 92,1% at 1 month and 97,2% at 12 months. Mean time to continence recovery was 0,7 months (95% CI 0,428–0,973). Positive surgical margins were detected in 9% of cases; no biochemical recurrence was recorded during follow-up. Mean operative time was 113 min and mean blood loss was 121 mL.
Conclusions. RS-RARP provides rapid recovery of urinary continence with high early complete continence rates and acceptable perioperative and short-term oncological outcomes. Comparative studies versus standard RARP and comprehensive analyses of oncological and functional outcomes are needed to further clarify the advantages and limitations of this technique.

K e y w o r d s: *prostate cancer, robot-assisted radical prostatectomy, Retzius-sparing, urinary continence, urinary incontinence*

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Introduction. Prostate cancer is the most common malignant tumor in men [1]. Major risk factors include hormonal disorders, age, race-related characteristics, genetic predisposition, family history, and dietary factors, particularly high fat intake [2]. Management of patients with clinically localized prostate cancer is determined by risk stratification and life expectancy. Possible approaches include active surveillance, radical prostatectomy, prostate ablation, and external beam radiation therapy [3]. Laparoscopic radical prostatectomy as a treatment for clinically localized prostate cancer was first described in 1991 [4]. The method became widely adopted because of shorter hospital stay, reduced surgical trauma, lower blood loss, and reduced analgesic requirements compared with open surgery [1, 5]. Standard robot-assisted radical prostatectomy (S-RARP), first introduced by Abbou in 2000, is currently considered the gold standard of surgical treatment for prostate cancer [6]. In this technique, the prostate is approached anteriorly, with bladder mobilization, transection of the medial umbilical ligaments on both sides, urachus division, and dissection in the Retzius space.

One of the most significant complications is postoperative urinary incontinence, which substantially affects quality of life [7]. According to various studies, the rate of urinary incontinence after robot-assisted radical prostatectomy ranges from 4 to 50% at 1 month [8, 9].

Over the past decades, numerous modifications have been developed to improve functional outcomes [1]. These include the periurethral suspension stitch, bladder neck preservation, preservation of the puboprostatic and pubovesical ligaments, nerve-sparing techniques, preservation of urethral length, and anterior and posterior reconstructions aimed at preserving or restoring normal pelvic anatomy. However, the results vary significantly depending on the surgeon's experience [10].

In 2010, Galfano et al. proposed Retzius-sparing robot-assisted radical prostatectomy (RS-RARP). In this modification, dissection begins at the posterior surface of the prostate from the side of the seminal vesicles. When performed correctly, this technique preserves the endopelvic fascia, puboprostatic ligaments, dorsal venous complex, and detrusor apron, which contributes to earlier recovery of urinary continence [11]. In the original series of 200 patients, Galfano et al. demonstrated that 90% of men used 0 or 1 safety pad within 7 days after catheter removal; after 1 year, this figure reached 96% [12].

Aim. To assess the time to urinary continence recovery after RS-RARP and to describe oncological and perioperative outcomes.

Materials and methods. A retrospective analysis was performed of patients who underwent RS-RARP between 2022 and 2024.

The procedure was performed according to the technique proposed by A. Galfano with minor technical modifications: 1) the 12-mm assistant port was placed in the left rather than the right iliac region; 2) the seminal vesicles were not retracted using two separate ligatures passed through the anterior abdominal wall, but were transected after mobilization to the ampullae of the vas deferens; 3) a single suspending ligature was used for retraction of the parietal peritoneum; 4) when improved visualization was required, an additional ligature was passed through the anterior abdominal wall and placed on an appendage of the colon for cranial retraction. After surgery, the urethral catheter was removed on postoperative day 6 provided that cystography showed no signs of anastomotic leakage; subjective continence status was assessed on day 7, and the patients were discharged. In cases of anastomotic leakage, patients were discharged with the urethral catheter in place and instructed to remove it after 7 days. After discharge, telephone follow-up was maintained, and patients were contacted monthly to clarify the number of pads used, subjective urinary function, and severity of urinary incontinence. Patients were included if sufficient data were available, namely complete hospital records and the possibility of postoperative follow-up contact. Patients were excluded if complete medical information was unavailable.

The descriptive analysis included preoperative patient data: age, Gleason score, ISUP group, and total PSA level. Complications were assessed using the Clavien-Dindo classification.

Descriptive analysis was performed using means with confidence intervals for normally distributed data and medians with interquartile ranges for non-normally distributed data. Normality was assessed using the Shapiro-Wilk test. Time to continence recovery was analyzed using Kaplan-Meier survival analysis with censored data. For visualization, cumulative event probability was plotted as the function 1-S(t), reflecting the proportion of patients in whom the event, urinary continence, occurred by the corresponding time point. The event was defined as complete continence, that is, the use of 0 pads/day. Time to event was defined as the interval, in months, from surgery to continence recovery. A 95% confidence interval was also calculated for the function. Median time to continence recovery and the proportion of patients achieving continence at each time interval were assessed. Statistical analysis and graph plotting were performed using IBM SPSS Statistics v. 26.0.00.

Results. Of the 381 patients identified in the database, complete data were available for 344 (90.3%), and these patients were included in the analysis. Preoperative data are presented in *Table 1.*

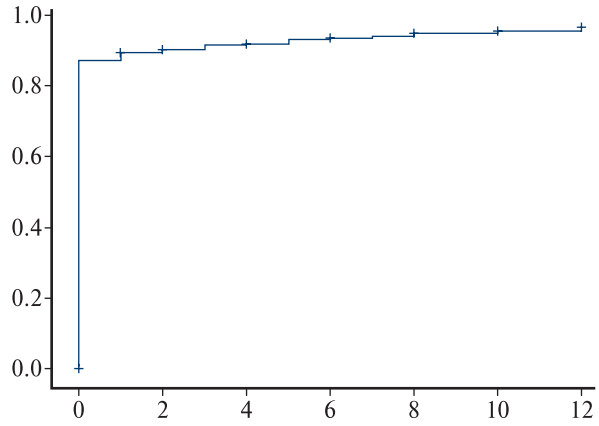
On the first day after urethral catheter removal, complete continence, that is, no need for pads, was observed in 309 patients (90.1%). If continence was defined as the use of one pad, including a safety pad, continence was observed in 335 patients (97.3%) on day 1.

By the end of the first month, complete continence had been achieved in 92.1% of patients; by month 2, in 92.7% (325 patients); by month 3, in 93.3%; and by month 12, in 97.2%.

Positive surgical margins were observed in 31 patients (9%). No biochemical recurrence was detected during follow-up.

Among patients who did not recover continence, four used 1-2 pads per day, and one patient used 3 pads per day. The cumulative probability function is shown in *Figure 1.*

The mean time to continence recovery was 0.7 months (SD=0.139; 95% CI 0.428-0.973). The median time to continence recovery was 0 months. The proportion of patients who regained complete continence by month is shown in *Table 2.*



The x-axis shows the months since surgery, and the y-axis shows the proportion of patients.

Figure. Cumulative probability curve of urinary continence recovery

The mean operative time was 113 minutes (95% CI ±33 minutes), and the mean blood loss was 121 mL (95% CI ±23 mL). The rate of anastomotic leakage with urinary extravasation on cystography was 1.16% (3 patients). No Clavien-Dindo grade III complications were recorded in the early postoperative period. During the entire follow-up period, no patient developed bladder neck stenosis.

Discussion. In our study, urinary continence recovery occurred rapidly during the first month, reaching a plateau and 97.2% continence by month 12. The literature remains contradictory regarding the long-term advantage of this technique over the standard approach in terms of continence. A recent systematic review and meta-analysis reported a significant advantage of RS-RARP [3]. In the study by Davis et al., continence at 12 months was 95.7% in the modified technique group versus 85.7% in the S-RARP group [13]. In the 2022 meta-analysis by Liu et al., based on 11 studies, continence at 12 months was 91.24% versus 83.89% after RS-RARP and S-RARP, respectively [14]. Another meta-analysis by Nunes-Silva et al. assessing salvage RS-RARP demonstrated continence recovery in 95% of patients at 12 months [15]. In the retrospective multicenter study by Galfano et al. in 2021, involving 14 surgeons from 12 countries, 90.3% of patients achieved continence within 1 year.

In reviewing the literature, we noted that the first comparative studies showed an early advantage of RS-RARP that diminished over time and became non-significant by month 12 [5]. This may

Table 1

Preoperative patient characteristics at the time of surgery

Parameter	*n=344*
Age, years	64 (62-72)
PSA level, ng/mL	7.9 (5.8 – 22.725)
Prostate volume, cc	34.2 (26.875 – 75.5)
ISUP, n (%)	
1	123 (35.7)
2	115 (33.4)
3	45 (13.1)
4	34 (9.9)
5	27 (7.8)

Table 2

Change in the proportion of patients without urinary incontinence from the time of surgery

Month	Cumulative proportion of patients without urinary incontinence	
	Estimate, %	Standard error
0	90,1	0,016
1	92.1	0.015
2	92.7	0.014
3	93.3	0.014
4	93.6	0.013
5	94.3	0.013
6	94.7	0.012
7	95.0	0.012
8	95.8	0.011
9	95.8	0.011
10	96.2	0.011
11	96.2	0.011
12	97.2	0.01

be explained by the learning curve, during which tissue handling may be less delicate than after sufficient surgical experience. The learning curve for standard radical prostatectomy is about 40 procedures, which should be taken into account when interpreting these results [16].

The main advantages of this technique are generally considered to be preservation of the anterior supporting structures, such as endopelvic fascia, puboprostatic ligaments, dorsal venous complex, and detrusor apron, which are well described in the literature and associated with urinary continence [17]. However, we identified several procedural features that may contribute to favorable outcomes but are not widely discussed in the literature.

First, in RS-RARP, access is obtained through the parietal peritoneum in the projection of the seminal vesicles. This provides much easier mobilization of the seminal vesicles than the anterior standard approach.

Second, dissection along the posterior surface facilitates control of the prostatic pedicles and neurovascular bundles, which, in our opinion, leads to reduced blood loss.

Third, dissection in the plane between the prostate and Denonvillier's fascia is performed under excellent visual control, allowing better control of the surgical margin and direction of dissection and helping avoid injury to the rectum. In addition, this dissection greatly facilitates visualization of the landmark artery and subsequent nerve sparing [18].

Fourth, improved visualization and easier dissection are achieved through traction and countertraction on the seminal vesicle stumps and ampullae of the vas deferens, and manipulation of the prostate is better than with the anterior approach.

Finally, there is a fundamental difference between standard and modified techniques in anastomosis formation. During RS-RARP, the anterior aspect is approximated first; it lies directly adjacent to the anterior structures that remain undisturbed during procedure and provide natural support for the anterior lip of the anastomosis. Posteriorly, the suture is placed under direct visual control, allowing correction if necessary. In addition, posterior reconstruction techniques proposed for RS-RARP can further reinforce the suture and prevent anastomotic leakage when in doubt, for example, the Rocco modification or Lisbon stitch [19]. After switching to RS-RARP, we observed a marked decrease in anastomotic leakage; in our study, the rate was lower, 4 patients, 1.16%, than in comparable studies of the standard technique [20]. None of our patients developed bladder neck stenosis after surgery, the main risk factors for which are anastomotic leakage with secondary healing and incorrect mucosal approximation [20]. Closure of the peritoneum at the end of the procedure also reduces the risk of peritoneal symptoms in the event of anastomotic leakage.

The first reports and meta-analyses on this technique showed a higher rate of positive surgical margins compared with the standard approach [21], which raised concerns about oncological safety. Galfano et al. reported a reduction in positive surgical margins from 22% in the first 100 patients to 9% in the next 100, underlining the importance of surgical experience [12, 2]. Most positive margins were located in the anterior part of the prostate, indicating the need for careful patient selection when considering this approach [22]. Accordingly, RS-RARP is usually not recommended for patients with predominantly anterior tumors [23].

We believe that with adequate and careful dissection, the rate of positive surgical margins in RS-RARP does not exceed that of S-RARP. In the present study, no biochemical recurrence developed during follow-up, and positive surgical margins were observed in 9% of patients. We perform dissection along the anterior surface of the prostate only after complete mobilization of the posterior and lateral surfaces, which facilitates visualization of the bladder neck. Usually, it is sufficient to begin blunt dissection to identify the plane between the prostate and the bladder, which gradually transitions to sharp dissection near the bladder neck. The transverse striations of the detrusor may be used as a landmark, but this sign may be misleading and should not be the sole factor in decision-making. In the review by Wang et al., most recent studies found no difference between RS-RARP and S-RARP in terms of positive surgical margins, complications, or biochemical recurrence [5]. Therefore, we believe there is no significant difference in positive margin rate between these techniques.

The study by Golubtsova et al. found no significant difference between RS-RARP and S-RARP in operative time or blood loss [24]. We assume that, once the technique is adequately mastered, it is not inferior to but may even surpass S-RARP, although this requires comparative studies in larger cohorts.

Despite the advantages of the technique, its limitations should also be noted, namely reduced working space, absence of typical landmarks, and inability to visualize the ureteral orifices after bladder neck transection [7]. At the same time, these limitations depend on surgical experience and become less important as experience increases. The technique may be difficult to use in

patients with large prostate volume, locally advanced tumors, anatomically narrow pelvis, previous pelvic surgery, or pelvic radiation therapy [3, 10].

The limitations of the study should be emphasized: the absence of comparison with other surgical techniques and the absence of data on postoperative erectile dysfunction. In the future, we plan to continue the analysis in a larger patient population with longer follow-up, including evaluation of pentafecta, that is, both oncological and functional outcomes, as well as comparison with the standard technique and identification of factors allowing patient stratification with respect to the preferred technique.

Conclusion. Retzius-sparing robot-assisted radical prostatectomy may be considered a procedure of choice in patients with localized prostate cancer. The technique allows excellent early functional outcomes. Further studies with evaluation of trifecta and pentafecta outcomes are needed to clarify situations in which this technique is preferable to the standard approach.

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INJURY TO THE RECTUM DURING LAPAROSCOPIC RADICAL PROSTATECTOMY: IS IT A SERIOUS COMPLICATION?

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Introduction. Rectal injury is a serious intraoperative complication of radical prostatectomy (RP), with its reported incidence varying widely in the literature from 0 to 20.39%. Delayed diagnosis of rectal injury increases the risk of peritonitis, sepsis, and rectourethral fistula formation. The optimal strategy for prevention and management of this complication remains a matter of debate.

Aim. To analyze the causes of rectal injury during laparoscopic radical prostatectomy (LRP) and the efficiency of therapeutic measures based on the authors' own experience in comparison with the published literature.

Materials and methods. A retrospective analysis was performed of 519 LRP procedures carried out at a single center between 2014 and 2023. Intraoperative rectal injury was identified in 3 patients (0.58%). In all cases, LRP was performed via an extraperitoneal approach. A bubble test was used for intraoperative diagnosis of rectal injury. All defects were closed with a two-layer suture using absorbable material. Postoperative management included antibiotic therapy, parenteral nutrition for 6-9 days, and prolonged bladder catheterization for 9-14 days.

Results. The length of the rectal defect ranged from 1.0 to 3.5 cm. There was no need for conversion to open surgery or colostomy. No surgical complications, suture failure, or signs of oncological disease progression were recorded during a follow-up period of 46-113 months.

Discussion. Intraoperative rectal injury during LRP is a rare complication. Timely intraoperative diagnosis, including the use of a bubble test, and immediate two-layer closure of the defect make it possible to minimize the risk of severe postoperative complications and rectourethral fistula formation.

Conclusion. Previous radiation therapy and prior surgery increase the risk of rectal injury, whereas intraoperative closure of the defect usually does not require colostomy and rarely results in complications. The role of preoperative bowel preparation and parenteral nutrition in preventing suture failure remains unclear.

K e y w o r d s: *radical prostatectomy, iatrogenic rectal injury, intraoperative diagnosis, extraperitoneal approach*

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Introduction. Rectal injury is a serious complication of radical prostatectomy (RP). It has been reported in 0 to 20.39% of cases, with the incidence of rectal injury during RP varying substantially across studies [1]. During retropubic RP, rectal injury may occur mainly during apical dissection when attempting to create the posterior plane between the rectum and Denonvilliers' fascia [2], whereas during perineal RP the critical stage is dissection of the posterior surface of the prostate from the rectum. In contrast, during laparoscopic RP (LRP) or robot-assisted RP (RARP), rectal injury more commonly occurs during dissection of the seminal vesicles and creation of the posterior plane between the prostate and the rectal wall.

Rectal injury may be detected intraoperatively or diagnosed postoperatively after the onset of clinical symptoms. Regardless of the time of detection, it may significantly increase the risk of early postoperative complications such as peritonitis and sepsis, as well as delayed consequences such as rectourethral fistula (RUF) [3]. The later rectal injury is identified after RP, the greater the likelihood that the patient will require reintervention for temporary or permanent fecal and/or urinary diversion [4].

Given the low incidence of rectal injury during RP, uncertainty remains regarding the predisposing risk factors and optimal management of this complication.

Aim. To analyze the causes of rectal injury during LRP and the effectiveness of therapeutic measures based on our own experience compared with the published literature.

Materials and methods. The study included 519 patients with prostate cancer who underwent LRP in our clinic between 2014 and 2023. Intraoperative rectal injury was observed in 3 patients (0.58%). At the time of surgery, the patients were 61-71 years old (*Table 1*). In all patients, standard transrectal biopsy revealed prostate adenocarcinoma with a Gleason score of 6-7. Prostate-specific antigen (PSA) levels ranged from 7.1 to 13.2 ng/mL. One patient had previously undergone transurethral resection (TUR) for benign prostatic hyperplasia (BPH).

All these patients underwent LRP via an extraperitoneal approach. In all cases, rectal injury was detected intraoperatively (*Fig. 1*). The bowel defect was closed

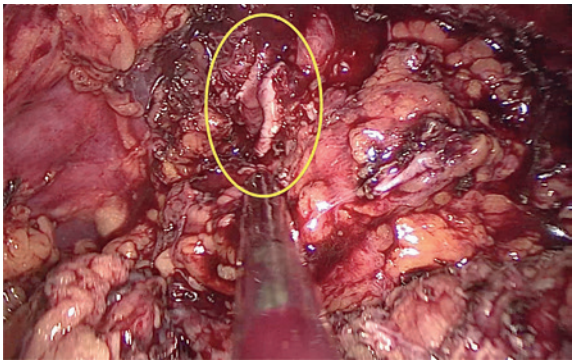

Fig. 1. Rectal injury detected during extraperitoneal LRP

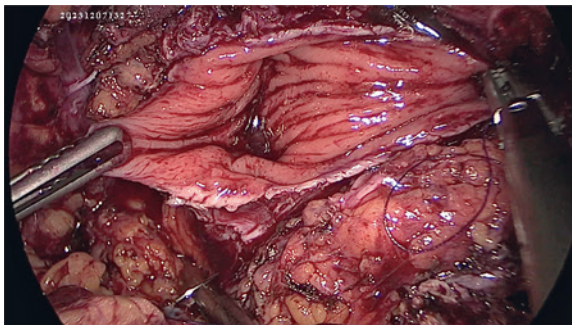

Fig. 2. Intraoperative view. Beginning of the first layer of the bowel suture

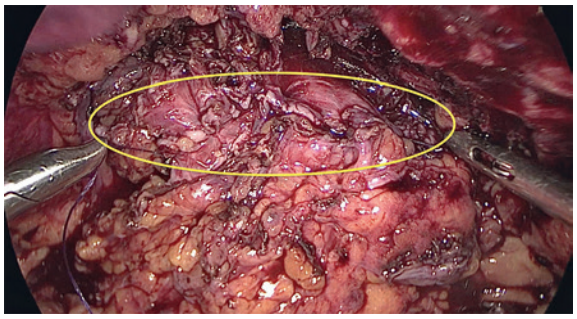

Fig. 3. Intraoperative view. Completion of the continuous suture

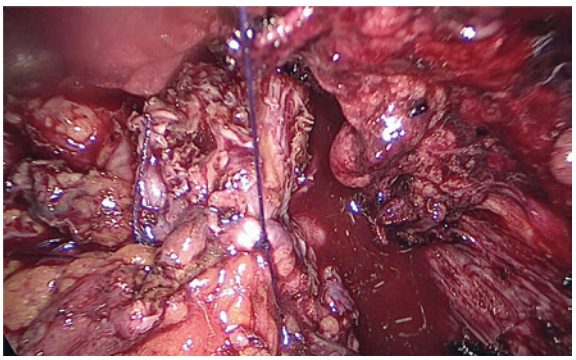

Fig. 4. Intraoperative view. Creation of the second layer with interrupted sutures

with a two-layer suture using absorbable polyglactin or polyglycolic 3/0-2/0 sutures (*Figs. 2-3*). The second layer was created with interrupted polyglactin sutures (*Fig. 4*). The vesicourethral anastomosis was then done in the standard manner (*Fig. 5*).

At the end of surgery, all patients with rectal injury underwent dilatation of the anal sphincter.

Results. No seminal vesicle invasion, lymph node involvement, or positive surgical margin was found in any of the three patients with rectal injury (*Table 2*). No postoperative surgical complications occurred in any patient. In the early postoperative period, all patients received parenteral nutrition for 6-9 days, antibacterial therapy, and low-molecular-weight heparins.

The urethral catheter was removed on postoperative days 9-14 after control cystography (*Fig. 6*). The patients were discharged from the hospital on postoperative days 10-15.

During follow-up of 46-113 months, none of the patients developed biochemical recurrence or signs of disease progression.

Discussion. In a systematic review of 88 selected studies out of 1806, the incidence of rectal injury during RP ranged from 0.10 to 4.71%. The incidence of rectal injury after RP gradually decreased with improvements in surgical technique and increasing experience, from 26% in 2003-2006 to 1.5-5.5% in 2009-2012. In most more recent studies, however, the incidence did not exceed 1% [5, 8, 11]. Moreover, in studies including more than 500 cases, the incidence ranged from 0.52 to 0.59% [1]. In our series, the incidence of rectal injury during LRP was 0.58%.

Some studies reported a higher incidence of rectal injury in patients older than 60 years compared with younger

Table 1

Main characteristics of patients with rectal injury during LRP

Patients	1	2	3
Age, years	61	71	64
PSA, ng/mL	8.4	13.2	7,1
Prostate volume, cc	78	90	31
Gleason score	7 (3+4)	6 (3+3)	7 (3+4)
pTNM stage	pT2cN0M0	pT2cN0M0	pT2bN0M0
Previous pelvic surgery	none	none	TUR of the prostate

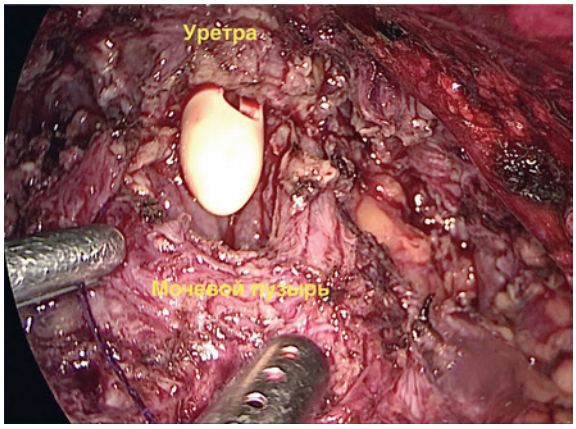

Fig. 5. Intraoperative view. Construction of the vesicourethral anastomosis

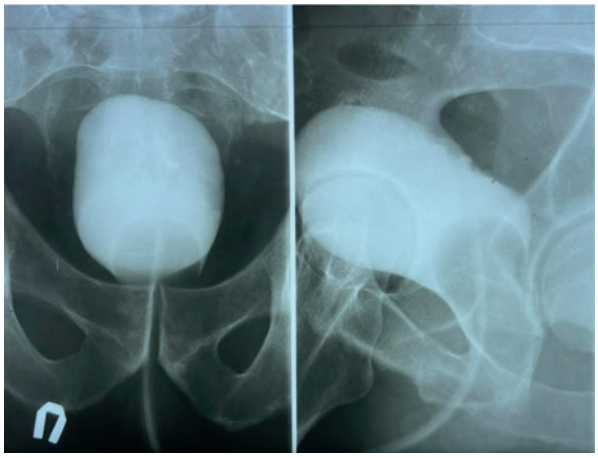

Fig. 6. Control cystogram 10 days after procedure

patients [1]. The age of our patients ranged from 61 to 71 years, which can be viewed neither as a contradiction of nor as confirmation of these data.

Although rectal injury may occur regardless of the surgical approach used, meta-analytic data showed that injuries were more frequent during transperitoneal procedures [1]. Other studies have also shown a higher risk of rectal injury in patients undergoing retropubic RP compared with those treated with LRP or RARP [5, 8, 11].

All three patients described above underwent LRP via an extraperitoneal approach, as did the vast majority of RP in our center. Today, the capabilities of conventional laparoscopic procedures, including three-dimensional imaging, 4K resolution with 30° optics or even a flexible-tip camera, allow to visualize and dissect the posterior plane at the level of the seminal vesicles, prostate, and its apex under direct vision with no less safety than in robotic surgery. Thus, the risk of rectal injury is minimized. In addition, the extraperitoneal approach substantially facilitates diagnosis if delayed rectal complications occur and partly mitigates their consequences by preventing diffuse peritonitis.

Most studies assessing perioperative outcomes of Retzius-sparing RARP did not specifically address rectal injury. Galfano et al. [19] reported in 2021 a rectal injury rate of 0.2% in a large series of 626 patients undergoing Retzius-sparing RARP, with all injuries detected in patients operated on by surgeons during the learning curve. Similarly, Abdel Raheem et al. [20] in 2018 reported a rectal injury rate of 0.3% in a series of 359 patients treated with Retzius-sparing RARP.

Previous pelvic radiotherapy for prostate cancer or other conditions has been associated with an increased risk of rectal injury. Several authors reported incidences ranging from 2 to 15% in patients undergoing RP [7, 11, 21]. Notably, in a multicenter, multi-surgeon study including 395 patients who underwent salvage RP (186 retropubic RP and 209 RARP), Gontero et al. [7] reported a rectal injury incidence of 2.96% after retropubic RP and 0.48% after RARP. None of our patients with bowel injury had undergone prior radiotherapy. At the same time, none of the at least seven patients operated on in our center after brachytherapy sustained rectal injury. This may reflect increased surgical vigilance in such cases.

One of the three patients had previously undergone TUR for BPH. According to meta-analysis, previous surgery for BPH and a large prostate volume were considered additional risk factors for rectal injury [1].

Prostate volume in our patients ranged from 31 to 90 cc. On the other hand, none of the patients treated during the study period with prostate volume greater than 150 cc had bowel injury. This is consistent with the findings of another single-center study by Mandel et al. [11], who found no correlation between prostate volume and rectal injury.

Other factors potentially increasing the risk of rectal injury include prior androgen deprivation therapy, pelvic fractures, and rectal surgery, because periprostatic fibrosis may complicate dissection of the posterior surface of the prostate [9]. In particular, patients with inflammatory

Table 2

Perioperative features in patients with rectal injury

Patients	1	2	3
Length of bowel defect	1 cm	1.5 cm	3.5 cm
Surgical approach	Extraperitoneal	Extraperitoneal	Extraperitoneal
Duration of parenteral nutrition, days	6	7	9
Duration of catheterization, days	9	10	14
Duration of hospitalization, days	10	11	15
Signs of disease progression	none	none	нет
Follow-up period, months	46	113	85

bowel disease and prior colorectal procedures, including colostomy closure, have been highlighted. Luciani et al. [22] reported 14 RARP procedures after colorectal surgery without rectal injury, but with conversion to open surgery in 21% of cases. In those cases, the authors used a retropubic approach.

None of our patients had prior colorectal surgery. At the same time, in interventions on similar patients in our center (five during the study period, including one after extirpation of the rectum), we observed no bowel injuries and did not perform conversion to open surgery. However, it should be noted that an extraperitoneal approach was used in all cases. Interestingly, obesity may reduce the risk of rectal injury by increasing the tissue plane between the rectum and the prostate [5]. However, Mandel et al. [11] found no correlation between body mass index and rectal injury.

Based on a large series of 24,178 RP, tumor-related risk factors for rectal injury were proposed: high preoperative total PSA, high Gleason score, lymph node involvement, and positive surgical margin - features typical of locally advanced disease [5, 11, 13]. From this standpoint, our patients did not have tumor-related risk factors. PSA levels ranged from 7.1 to 13.4 ng/mL, Gleason scores were 6, 6, and 7, respectively, and no positive surgical margin or lymph node involvement was identified in any case.

Current clinical guidelines do not define specific preoperative measures aimed at reducing the risk of rectal injury or minimizing its consequences. Some authors use bowel preparation to reduce the severity of subsequent infectious complications if rectal injury occurs [10, 17]. However, analysis of 35,099 RP cases in the Japanese database between 2007 and 2012 showed that bowel preparation did not affect perioperative complications associated with rectal injury during RP [16, 23]. We currently use bowel preparation before LRP only in patients at high risk of rectal injury: previous colorectal surgery or radiotherapy, stage T3 disease, involvement of more than 50% of the prostate or an apical lesion on biopsy or MRI, PSA above 15, and Gleason score 8 or higher. We observed no postoperative surgical complications in any patient after bowel repair during LRP. However, all cases presented here occurred during the period when bowel preparation was routinely used, making it impossible to determine whether it played a significant role in preventing complications.

The management and prognosis of rectal injury after RP differ considerably depending on whether it is detected intraoperatively or postoperatively. Intraoperative detection of rectal injury, as compared with postoperative detection, is strongly associated with a lower risk of severe postoperative complications and subsequent RUF formation [14]. Therefore, all intraoperative measures aimed at preventing and identifying rectal injury should be seriously considered. Careful dissection between the prostate and the rectal wall using cold scissors without monopolar coagulation, visualization of periprostatic fat during extrafascial dissection, and minimizing traction on the rectal wall in the presence of periprostatic adhesions may substantially reduce the risk of rectal injury [25, 26]. These maneuvers become especially important in the presence of extracapsular invasion, locally advanced disease, or pronounced adhesions, sometimes resulting from biopsy [24].

In many centers, including ours, a rectal tube is inserted immediately before the start of surgery to allow subsequent performance of a bubble test, which is mandatory in our center. After removal of the prostate and hemostasis, the pelvic cavity is filled with saline. Then 100-150 mL of air is introduced through the rectal tube. The appearance of bubbles clearly indicates rectal injury [12, 27]. In such cases, an additional two-finger digital rectal examination performed by the assistant allows more accurate assessment of the extent of injury [6]. It is also advisable to obtain a swab for identification of potential pathogenic flora and antimicrobial resistance in order to minimize the risk of postoperative infectious complications [25].

During LRP, rectal injury may occur early during mobilization of the seminal vesicles and posterior surface of the prostate. In such cases, some authors recommend immediate repair of the rectum before further mobilization of the prostate [18]. In all our cases, however, the bowel wall was sutured after removal of the prostate and placement of the specimen into a retrieval bag, because this provided much better spatial conditions for bowel suturing. However, regardless of the approach, the rectal defect should be closed before formation of the vesicourethral anastomosis [14]. The defect is usually closed with a two-layer suture using absorbable polyglactin or polyglycolic 2-0 or 3-0 sutures [6, 14]. The use of endoscopic clips and fibrin glue has also been described [28]. In the transperitoneal approach, the omentum or a peritoneal flap harvested from the lateral pelvic wall may be used to separate the rectal suture line from the anastomosis [24, 27]. We did not use additional materials to separate the suture lines, because all LRPs were performed via an extraperitoneal approach. However, none of our patients developed suture failure or fistula formation.

There is controversy regarding indications for colostomy in patients with rectal injury during RP. According to some investigators, only 10% of patients with rectal injury underwent colostomy [5, 11, 15]. Primary colostomy should be considered in patients with large rectal defects (>2 cm), prior radiotherapy, or previous surgery for BPH, as well as when infiltration of the rectum by prostate cancer is suspected [27]. However, these features cannot be considered absolute indications for colostomy. One of our patients had previously undergone TUR of the prostate, and in another, used here as an example, the bowel defect was about 5 cm. Nevertheless, simple two-layer closure of the defect was successful in both and did not lead to any surgical complications.

In the postoperative period, some authors recommend a liquid diet starting on postoperative day 1, with gradual dietary advancement after day 3, along with broad-spectrum antibiotic therapy [11]. In addition, some investigators suggest prolonging catheterization to two weeks or more, followed by cystography [11, 26, 27]. The duration of catheterization in our patients was 10-15 days. We routinely perform cystography before catheter removal in all patients, regardless of intraoperative features or complications.

The greatest risk of severe, potentially fatal surgical complications is posed by rectal injury that is not recognized during prostatectomy and is diagnosed later in the postoperative period after symptoms develop. Some marginal bowel injuries caused by modern energy devices, such as impedance-controlled bipolar coagulation or ultrasonic dissectors, may go unnoticed even with a bubble

test. These devices may effectively seal the bowel defect, and perforation may occur several days later.

The most severe consequences, including peritonitis, may develop in cases in which RP was performed via a transperitoneal approach [27]. Early symptoms include abdominal pain, fever, tachycardia, tachypnea, hypotension, and even oliguria. These manifestations may be accompanied by leukocytosis, thrombocytopenia, and elevated serum inflammatory markers [29].

Some authors believe that defects smaller than 1.5 cm may be managed conservatively with broad-spectrum antibiotics, prolonged bladder catheterization for 1-3 months, and parenteral nutrition, provided there are no signs of peritonitis or sepsis. However, the development of fever, peritonitis, pelvic abscess, and other infectious complications requires immediate surgical treatment, including colostomy and closure of the rectal defect [4, 30, 31]. Larger defects or injuries involving the urethral sphincter require immediate surgery. Nevertheless, a substantial proportion of patients develop rectourethral fistulas in the following weeks both after conservative treatment and after delayed surgical treatment for rectal injury [4, 5, 30, 31].

In one of our patients, the bowel defect measured about 3.5 cm. However, intraoperative closure of the injury, combined with preoperative bowel preparation and parenteral nutrition for 10 days postoperatively, allowed to avoid subsequent rectourethral fistula formation.

Conclusion. Intraoperative rectal injury during LRP is rare. Previous radiotherapy and rectal surgery are potential additional risk factors for injury. It is possible that LRP performed via an extraperitoneal approach is associated with a lower risk of rectal injury.

Intraoperative detection and closure of the defect are not indications for colostomy and in the absolute majority of cases do not lead to postoperative complications.

The role of preoperative bowel preparation and subsequent parenteral nutrition in preventing suture failure and RUF formation in cases of rectal injury during RP remains insufficiently clarified.

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OPTIMIZATION OF SURGICAL TREATMENT SELECTION FOR MALE STRESS URINARY INCONTINENCE

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Introduction. Male stress urinary incontinence (SUI) following prostate surgery significantly impairs quality of life. The main surgical treatment options for SUI are male sling (MS) implantation and artificial urinary sphincter (AUS) implantation. The optimal choice of procedure depends on the severity of incontinence. The 24-hour pad test and pad count do not reliably reflect the functional status of the external urethral sphincter (EUS). The Male Stress Incontinence Grading Scale (MSIGS) has been proposed to improve patient stratification.

Objective. To evaluate the effectiveness of preoperative assessment of SUI severity based on a combination of MSIGS and the 24-hour pad test in guiding surgical decision-making in men with post-prostatectomy SUI.

Materials and Methods. From 2016 to 2022, SUI severity in our clinic was determined using only the 24-hour pad test. From 2022 to 2025, the MSIGS was incorporated into preoperative evaluation. Patients with urine loss ⩽200 g/day and MSIGS ⩽2 underwent sling implantation, whereas those with urine loss >200 g/day and MSIGS ⩾3 received AUS implantation.

Results. Between 2016 and 2025, a total of 39 patients underwent surgery: 13 with slings and 26 with AUS. A history of pelvic radiotherapy (RT) was present in 15.4% (2/13) of sling patients and 30.8% (8/26) of AUS patients. After the introduction of combined assessment (pad test + MSIGS), the proportion of AUS implantations increased from 27% (n=3) to 82% (n=23) (OR=12.27; 95% CI 2.53–50.45; p=0.002). Furthermore, sling efficacy improved from 25% to 80% when patient selection was based on the combined approach (OR=12.00; 95% CI 0.67–165.6; p=0.103). Importantly, the higher rate of AUS implantation was not associated with reduced efficacy (p>0.05).

Conclusion. The choice of surgical treatment for SUI depends on incontinence severity and prior RT. Male sling implantation is effective in mild cases but its efficacy is markedly reduced in severe SUI and in patients with prior RT. The AUS remains the gold standard for severe SUI. The combination of MSIGS and the 24-hour pad test improves diagnostic accuracy and optimises implant selection, which is particularly valuable in patients with moderate SUI.

K e y w o r d s: stress urinary incontinence, male incontinence, cough test, MSIGS, radiotherapy

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Introduction. Stress urinary incontinence (SUI) in men is one of the most common complications of prostate surgery and has a substantial impact on patients' quality of life and social functioning [1]. The artificial urinary sphincter (AUS) has been available for approximately 40 years and is recognized as the "gold standard" surgical treatment for moderate-to-severe SUI [2–4]. The male sling (MS) is a less invasive alternative to AUS implantation for the surgical treatment of mild-to-moderate SUI [3].

One of the key challenges in the treatment of male SUI is accurate preoperative stratification of the severity of urine leakage, which plays a crucial role in selecting the optimal implant. Existing methods for assessing the severity of male SUI, including the 24-hour pad test, the number of pads used, and questionnaires, unfortunately do not provide complete preoperative information on the functional status of the external urethral sphincter and therefore make it difficult to select the appropriate type of implant. Incorrect assessment of SUI severity increases the risk of surgical treatment failure. Introduction of the Male Stress Incontinence Grading Scale (MSIGS), based on the cough stress test, into clinical practice allows reliable clinical assessment of external urethral sphincter function, helps avoid errors in implant selection, and may reduce the number of repeat surgical procedures.

Aim. To evaluate the efficacy of preoperative assessment of SUI severity using a combination of the MSIGS and the 24-hour pad test for selecting the treatment strategy in men with SUI.

Materials and methods. A retro-prospective study was carried out. Between 2016 and 2025, a total of 39 patients with SUI of varying severity underwent surgery. The MS group included 13 patients who underwent implantation of a non-adjustable repositioning-compressive AdVanceXP sling (Boston Scientific, Marlborough, MA, USA); 2 (15.4%) had a history of radiation therapy (RT). The main causes of SUI in this group were radical prostatectomy (RP) (n=7), surgery for benign prostatic enlargement (thulium lase enucleation of the prostate, transurethral resection) (n=5), and urethroplasty (n=1).

The AUS group included 26 patients who underwent implantation of an AMS 800 artificial urinary sphincter (American Medical Systems, Minnetonka, MN, USA); 8 (30.8%) had a history of RT. The causes of SUI in this group were RP (n=21), surgery for benign prostatic

enlargement (n=4), and brachytherapy (n=1). The severity of SUI was assessed using a 24-hour gravimetric pad test: mild, 0–100 g/day; moderate, 100–400 g/day; and severe, >400 g/day [3]. Since 2022, we have additionally used the MSIGS based on a cough stress test consisting of a series of four coughs, with scores ranging from 0 (no leakage) to 4 (continuous leakage) (*Table 1*) [5, 6].

Patients with MSIGS scores of 0–2 and a pad-test result ⩽200 g/day were recommended MS placement, whereas patients with MSIGS scores of 3–4 and a pad-test result >200 g/day were recommended AUS implantation. Based on these criteria, 28 implants were placed in patients with SUI of varying severity: in 5 patients MS was chosen and in 23 cases an AUS was placed. Seven men with moderate SUI (25%) demonstrated marked external sphincter insufficiency during the cough stress test (MSIGS ⩾3). These patients subsequently underwent AUS implantation instead of the initially planned MS procedure.

In patients with a compromised urethra, including those with a history of RT or urethroplasty and those with a hypotrophic "fragile" urethra, AUS implantation was performed using a transcorporal technique in 2 cases, while a urethral buttressing through sparing a bulbospongiosus muscle was used in one case.

Surgical correction of urinary incontinence was considered successful when patients achieved pad-free status or social continence, defined as the use of no more than one pad per day. Improvement was defined as the use of no more than two pads per day or a ⩾50% reduction in daily pad use. Treatment failure was defined as the absence of clinically meaningful improvement after implantation.

The International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) was used to assess the severity of urinary incontinence, and the Incontinence Quality of Life questionnaire (I-QOL) was used to assess quality of life. Questionnaires were completed preoperatively and at follow-up after surgical treatment. The resulting data were used for comparative assessment of functional treatment outcomes.

All adverse events were classified according to the modified Clavien–Dindo classification of surgical complications [8].

Statistical analysis was performed using GraphPad Prism 8 (GraphPad Software, USA) and Microsoft Excel (Microsoft Corp., USA). Quantitative variables were compared between independent groups using the Mann–Whitney U test and Student's t-test for parametric data. Fisher's exact test was used to compare qualitative categorical variables. Differences were considered statistically significant at $p<0.05$.

Results. A total of 39 patients with varying degrees of SUI were included in the study and underwent implantation of either an MS (n=13) or an AUS (n=26). Between 2016 and 2022, when only the pad test was used, 11 implants were placed, including 3 AUSs and 8 MSs. Between 2022 and 2025, when the MSIGS cough stress test was used in addition to the pad test, 5 patients underwent MS placement and 23 underwent AUS implantation. The results are summarized in Table 2. Statistical analysis showed that modification of the diagnostic algorithm by introducing the MSIGS resulted in a significant change in the distribution of surgical treatment methods. The proportion of AUS implantations increased from 27% to 82%; OR=12.27; 95% CI 2.53–50.45; p=0.002.

Since 2022, after optimization of antistress technique selection based on the combination of the MSIGS and urine loss measured by the pad test, 5 MS implantations were performed: 4 patients (80%) achieved a satisfactory outcome, improvement was observed in 1 patient (20%), and no failures were recorded. AUS implantation was performed in 23 patients, of whom 20 (87%) achieved complete treatment success, 1 (4.4%) showed improvement, and 2 (8.6%) had an unsatisfactory outcome. One patient with severe hand tremor (n=1) successfully adapted to the use of the AUS and achieved social continence. Implantation outcomes are presented in *Table 2*.

Analysis of the ICIQ-SF and I-QOL questionnaires demonstrated a significant reduction in symptoms and improvement in quality of life in both groups over the entire follow-up period (2016–2025). In the MS group, the ICIQ-SF score decreased by 9.1 points, from 14.8 to 5.7 (p=0.01). The I-QOL score improved by 19.2%, from 49.2 to 58.7 points (p=0.02). In the AUS group, the I-QOL score improved by 29.5%, from 44.8 to 58.0 points (p=0.001), while the ICIQ-SF score decreased by 12.3 points, from 15.7 to 3.4 ($p<0.001$).

Over the entire follow-up period (2016–2025), complications were recorded in 4 patients (30.8%) in the MS group: intrapelvic bleeding in 1 patient (Clavien–Dindo IIIb), MS protrusion into the urethra in 1 (Clavien–

Table 1

MSIGS grades and corresponding quantitative 24-hour pad-test values [5, 7]

MSIGS score	Definition	24-hour pad-test value, g	Severity
0	History of urinary incontinence, with no urine leakage during the test	57	Mild
1	Late dribbling	117.3	
2	Early dribbling without a urinary stream	223	Moderate
3	Early dribbling followed by a urinary stream	385.1	
4	Early and continuous urinary stream	513.3	Severe

Dindo IIIb), perineal skin erosion in 1 (Clavien–Dindo IIIa), and radiation cystitis in 1 (Clavien–Dindo II).

In the AUS group, complications occurred in 7 patients (26.9%): bladder injury in 1 patient (Clavien–Dindo IIIb), external iliac artery injury in 1 (Clavien–Dindo IIIb), extrusion of the connecting tube in 1 (Clavien–Dindo IIIa), exacerbation of radiation cystitis in 1 (Clavien–Dindo II), acute urinary retention in 2 (Clavien–Dindo II), and urethral erosion in 1 (Clavien–Dindo IIIb). Among 6 patients with complications, 3 (50%) had a history of RT.

Discussion. The use of combined preoperative assessment based on the 24-hour pad test and the MSIGS allowed us to optimize implant selection in men with varying degrees of SUI severity and improve surgical outcomes. Thus, patients who underwent MS implantation after assessment using the MSIGS + pad test demonstrated better postoperative outcomes, 80% (n=4), than those whose preoperative assessment of incontinence severity was based on the pad test alone, 25% (n=2), although the difference was not significant (p=0.103).

Our findings are consistent with the literature: MS implantation is primarily effective in patients with mild-to-moderate SUI [9, 10], whereas AUS implantation demonstrates high effectiveness (>90%) in severe SUI regardless of a history of RT [11, 12].

The MSIGS was first described by Morey et al. in 2016 in a prospective study involving 53 men. The authors assessed SUI severity using the MSIGS, with MS implantation performed in men with MSIGS scores of 0–2 and AUS implantation in those with MSIGS scores of 3–4. Patient satisfaction according to the Patient Global Impression of Improvement (PGI) questionnaire was 95% and 96.5% for AUS and MS, respectively [13]. Larger studies are required to clarify the long-term benefits of using this scale in clinical practice. The MSIGS has a strong positive correlation with the 24-hour pad test (r=0.55, p<0.001) [7].

According to the literature, the effectiveness of MS ranges from 54% to 80% [9, 14, 15]. However, several studies have demonstrated a decline in MS effectiveness over time. In the study by Bauer et al., social continence after MS implantation was observed in 66% of patients at 36 months of follow-up [16]. Similar findings were reported in studies evaluating the long-term effectiveness of MS (AdVance/AdVance XP) with follow-up periods ranging from 3 to 10 years. Effectiveness ranged from 42% to 57%, with cure defined as achievement of social continence (0–1 pad/day) [9, 17, 18]. The relatively low effectiveness of MS in these studies may have been associated with insufficient optimization of patient selection according to the actual severity of urinary incontinence. This highlights the need for stricter patient selection and the use of contemporary methods for assessing incontinence severity to improve treatment outcomes.

Regarding AUS effectiveness, most studies consider achievement of social continence, defined as the use of no more than 1 pad per day, to be the main clinically meaningful outcome. According to the literature, this result is achieved in 73–93% of cases. However, complete freedom from pad use, or pad-free status, is a more stringent endpoint and is observed substantially less frequently, in only 15–20% of patients [2, 19, 20]. Therefore, patients should be informed during counseling that the principal goal of implantation is not necessarily complete dryness, but rather achievement of an acceptable level of continence requiring no more than 1 pad per day.

In our study, complications occurring in both groups were predominantly associated with a history of pelvic RT, emphasizing its role as one of the key factors affecting procedure success and prognosis. The impact of RT on functional outcomes was demonstrated by Kim et al., who identified RT, SUI severity, and previous surgery for SUI as predictors of MS failure, whereas neurological disease, including hand tremor, was identified as a predictor of AUS failure [21]. According to other studies, RT substantially reduces MS effectiveness (<50%), whereas after AUS implantation, although overall effectiveness remains high (86–87%), RT significantly increases the risk of specific complications, including erosion, exacerbation of radiation cystitis, periprosthetic infection, and the need for revision or explantation [10–12].

George Webster and his team first described transcorporal AUS cuff placement in 2002 in patients with urethral erosion [22]. Le Long et al., in a retrospective study, demonstrated that TC placement of an AUS cuff provided social continence in 69.7% of patients with a compromised urethra, including those with a history of RT, while 88% of patients remained satisfied with the outcome. Interestingly, the revision rate was significantly lower in irradiated patients (p=0.006), suggesting that transcorporal AUS cuff placement may be a promising primary approach in this patient population [23]. However, data from a multicenter study showed that TC cuff placement does not reduce the risk of urethral erosion [24]. Most authors recommend this technique after previous prosthesis revision for component extrusion or urethral atrophy [23, 25–27]. In our study, one patient who initially achieved a successful outcome, namely social continence, after AUS implantation subsequently

Table 2

Outcomes of AUS and male sling implantation

2016–2022 (PAD-test)	Male sling (n=8)	AUS (n=3)	p-value
Success	2 (25%)	3 (100%)	p=0.045
Improvement	3 (37.5%)	–	
Failure	3 (37.5%)	–	
2022–2025 (PAD-test + MSIGS)	Male sling (n=5)	AUS (n=23)	
Success	4 (80%)	20 (87%)	p=1.0
Improvement	1 (20%)	1 (4.3%)	p=0.314
Failure	–	2 (8.7%)	

developed individual intolerance to the components of the antibacterial-coated implant, including the control pump, cuff, and connecting tubing, 18 months after surgery. This resulted in chronic inflammation followed by cuff extrusion and urethral erosion, requiring prosthesis explantation. According to the literature, urethral erosion occurs in 8.5–15% of cases [28].

The role of comprehensive urodynamic testing in selecting patients for MS implantation remains under discussion. Valsalva leak point pressure (VLPP) is considered an important prognostic parameter. A VLPP >60 cm H2O is associated with a high probability of successful sling surgery, whereas effectiveness decreases at values ⩽60 cm H_2O. A low VLPP (<60 cm H2O) indicates pronounced sphincter insufficiency, and AUS implantation should be considered in such cases [29–31]. The mechanism of action of the MS is based on repositioning and stabilization of the urethra, thereby providing additional support and improving urethral closure function and compensating for sphincter insufficiency. The presence of detrusor overactivity and/or a maximum cystometric capacity <250 mL is also associated with poorer MS outcomes and therefore represents an important factor favoring consideration of AUS implantation [29].

The limitations of the study include: 1) the relatively small sample size, which reduces the statistical power of the analysis; 2) the absence of randomization, which may increase the risk of systematic bias and affect the reliability of the results; and 3) unequal group sizes and baseline characteristics between the pad-test and pad-test + MSIGS groups, which may also introduce bias into interpretation of the findings. These limitations should be considered when interpreting the results and their clinical applicability. Our study is ongoing. We believe that more reliable results in this area will require a larger patient sample, further accumulation of data, and possibly stratification into different patient groups, which may require modification of the surgical technique used for implant placement and may ultimately influence treatment outcomes.

Conclusion. Implementation of the MSIGS+pad-test combination in routine clinical practice allows optimization of preoperative implant selection, identification of patients with relatively low urine loss on pad testing but clinically significant sphincter insufficiency according to the MSIGS, and therefore supports primary AUS implantation in such patients. This approach may help avoid staged surgical treatment and improve the rationale for selecting the surgical strategy in men with SUI.

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FUNCTIONAL AND ONCOLOGICAL OUTCOMES OF ROBOT-ASSISTED AND LAPAROSCOPIC PARTIAL NEPHRECTOMY

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Background. Laparoscopic partial nephrectomy (LPN) and robot-assisted partial nephrectomy (RAPN) are widely used organ-sparing treatment methods for T1 renal cell carcinoma (RCC). Numerous international meta-analyses on this topic have shown that RAPN provides perioperative outcomes comparable to those of LPN, while offering additional advantages such as significantly lower blood loss and a shorter warm ischemia time. However, no superiority of either technique over the other has yet been demonstrated with regard to oncological outcomes and preservation of renal function.
Aim. To compare functional and oncological outcomes of laparoscopic and robot-assisted partial nephrectomy for RCC at A.S. Loginov Moscow Clinical Scientific Center with data from international studies.
Materials and methods. A search of current literature on outcomes of RAPN and LPN was performed using PubMed. The most relevant publications were analyzed and served as the basis for this study. In addition, we retrospectively analyzed the surgical outcomes of 277 patients who underwent surgery for RCC using the Da Vinci robotic surgical system (n=175, group 1) or a laparoscopic technique (n=102, group 2) at A.S. Loginov Moscow Clinical Scientific Center between 2019 and 2024. Functional and oncological outcomes were collected and compared between the two groups.
Results. The postoperative decline in creatinine clearance was significantly greater in patients in group 2. Positive surgical margins and recurrence of RCC were also significantly more common in group 2.
Conclusion. The use of a robotic system for partial nephrectomy is an alternative to the laparoscopic technique, providing reliable functional and oncological outcomes. This is supported both by studies from a number of international centers and by the results obtained at A.S. Loginov Moscow Clinical Scientific Center.

Keywords: robot-assisted partial nephrectomy, laparoscopic partial nephrectomy, renal cell carcinoma, partial nephrectomy outcomes, robotic surgery, laparoscopy

Conflict of interest. The authors declare no conflicts of interest. For citation: Ivanov A.G., Zingerenko M.B., Pervushin V.V., Timaev K.A., Ekhoyan M.M. Functional and oncological outcomes of robot-assisted and laparoscopic partial nephrectomy. Urologiia. 2026;3:19-23.
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Introduction. Partial nephrectomy is one of the most commonly performed urological procedures and has undergone substantial changes over the past quarter century. Current advances in surgical technology have significantly transformed approaches to the treatment of patients with renal diseases. Technological progress in minimally invasive surgery has revolutionized the surgical management of renal disease worldwide. The introduction of laparoscopic and robot-assisted techniques has created new opportunities for both radical nephrectomy and partial nephrectomy.

Minimally invasive approaches, including laparoscopic and robot-assisted surgery, have gained widespread acceptance in clinical practice. Their implementation has reduced surgical trauma and improved patients' quality of life. However, despite the evident advantages of these modern techniques, uncertainty regarding their comparative intraoperative and postoperative outcomes remains an important issue. The relevance of the present study is determined by the need for a detailed assessment of functional and oncological outcomes after laparoscopic and robot-assisted partial nephrectomy. Partial nephrectomy (PN) is currently recommended for the surgical treatment of T1 renal tumors, as accumulated evidence indicates that PN can preserve renal function while providing oncological outcomes equivalent to those of radical nephrectomy (RN) [1–3].

Renal cell carcinoma (RCC), as a specific type of renal tumor, was traditionally treated using open surgery. However, in the 1990s, the first reports emerged demonstrating the feasibility of laparoscopic partial nephrectomy (LPN) for renal tumors <7 cm in size [4–7]. Shortly thereafter, in the early 21st century, with the widespread introduction of robotic surgical systems into clinical practice as an evolution of laparoscopic surgery, robot-assisted partial nephrectomy (RAPN) rapidly gained popularity among urological surgeons [8, 9]. This was related to several specific advantages of robotic systems, including seven degrees of freedom, three-dimensional visualization, tremor filtration, and enhanced surgical dexterity. Several studies have since shown that RAPN may offer advantages over LPN in technically complex cases [10–12].

Findings from international studies on this topic are largely consistent. For example, Xiaohua Zhang et al. reported the following results in their meta-analysis: a total of 766 patients were included, comprising 425 patients in the RAPN group and 341 in the LPN group. No

significant differences were observed between the groups for any demographic variable, including age (p=0.89), sex (p=0.31), malignant pathology (p=0.54), tumor size (p=0.99), or tumor laterality (p=0.06). No differences were found between the groups in operative time (p=0.75), estimated blood loss (p=0.75), conversion rate (p=0.52), positive surgical margin rate (p=0.61), complications (p=0.27), or length of hospital stay (p=0.27). However, warm ischemia time was significantly shorter in the RAPN group than in the LPN group (p=0.01; weighted mean difference, –3.65; 95% confidence interval, –6.46 to –0.83). The authors concluded that RAPN provides postoperative outcomes comparable to those of LPN, with the additional advantage of significantly shorter warm ischemia time [13].

Similar conclusions were reported by Luyao Chen et al. from the Department of Urology, The First Affiliated Hospital of Nanchang University, Nanchang, China. Both RAPN and LPN were found to be safe and feasible approaches for the treatment of renal hilar tumors. Compared with LPN, RAPN may provide better intraoperative outcomes, including lower estimated blood loss and shorter warm ischemia time, as well as better postoperative preservation of renal function, although it may be associated with higher direct costs. RAPN may therefore be a preferable option for renal hilar tumors when technically feasible. The authors emphasized the need for future randomized multicenter studies with larger sample sizes and longer follow-up to confirm these findings [14].

In a prospective randomized study, Christoph Würnschimmel et al. reported the following results. A total of 108 patients were included in the final analysis, with comparable patient and tumor characteristics between groups. No significant difference in renal function at 6 months was observed. The median change in renal function at 6 months was –18.0% (–26.5 to –11.0) in the LPN group and 20.0% (–33.2 to –12.0) in the RAPN group (p=0.3). Mean warm ischemia time was 21.1 (SD 6.1) min in the LPN group and 19.6 (SD 7.7) min in the RAPN group (p=0.2). No positive surgical margins were observed in the LPN group, whereas they occurred in 4.9% of patients (n=3) in the RAPN group (p = 0.099). Renal volume loss at 6 months was 27.5% (22.7–45.7) in the LPN group and 37.5% (13.7–54.2) in the RAPN group (p=0.5). Mean operative time was shorter in the LPN group, 192.3 min (SD 44.5) versus 230.2 min (SD 59.6) (p=0.001). Complications were more common in the LPN group, 31% versus 21% (p=0.075). Blood transfusion rates were 15% for LPN and 11% for RAPN. The authors concluded that LPN with global ischemia and RAPN with selective ischemia provide comparable preservation of renal function. In most patients, functional loss of the operated kidney after nephron-sparing surgery appears not to exceed 25%, irrespective of the surgical approach [15].

Thus, LPN and RAPN are widely used for the treatment of T1 renal tumors. Several international meta-analyses have demonstrated that RAPN provides intraoperative outcomes comparable to those of LPN, with the additional advantages of lower blood loss and shorter ischemia time. However, no definitive superiority of either approach has yet been demonstrated in terms of oncological outcomes or preservation of renal function. Further studies are therefore required.

Aim. To compare the functional and oncological outcomes of laparoscopic and robot-assisted partial nephrectomy for renal cell carcinoma performed at the A.S. Loginov Moscow Clinical Scientific Center with data from international studies.

Materials and methods. A literature search was performed using the international scientific database PubMed. This database was selected as the principal source because of its authority and broad coverage of contemporary medical literature. Studies were selected according to the following criteria: publication in English; evaluation of functional and oncological outcomes of laparoscopic and robot-assisted partial nephrectomy; and publication as a peer-reviewed scientific article. The literature was analyzed using qualitative assessment of publication content, systematization of data according to complication type, comparative analysis of findings across studies, and assessment of the methodological quality of the included studies.

In addition, we retrospectively reviewed patients with histologically verified RCC who underwent surgical treatment using a robotic system (Group 1) or a laparoscopic approach (Group 2) at our institution between January 2019 and December 2024. The study period was 72 months. Functional and oncological outcomes of the two surgical approaches were compared.

Statistical analysis was performed using descriptive and comparative methods. Quantitative variables were presented as medians, and the distribution of variables was assessed using the Shapiro–Wilk test. Quantitative variables in the two independent groups (RAPN and LPN) were compared using the nonparametric Mann–Whitney U test. Categorical variables, including positive surgical margin and recurrence rates, were compared using Pearson's χ^2 test or Fisher's exact test when expected frequencies were low. Progression-free survival was analyzed using the Kaplan–Meier method. Differences were considered statistically significant at $p<0.05$. Microsoft Office Excel 2019 was used for calculations and graphical presentation of the statistical data.

Results. The da Vinci robotic surgical system enables effective partial nephrectomy with favorable functional outcomes. Previous studies have demonstrated significant differences in early changes in creatinine clearance, which have been attributed to shorter renal artery clamping times during RAPN [16–21]. According to published data, RAPN may also provide better functional outcomes in the late postoperative period [22–25]. In our study, the decrease in creatinine clearance was significantly smaller in the RAPN group, supporting better preservation of renal function in these patients (*Table 1*).

Oncological outcomes are also of paramount importance when selecting a surgical approach for renal tumors. In our study, positive surgical margins were significantly more common in the LPN group than in the RAPN group. Accordingly, RCC recurrence was less frequent after RAPN, with 2 recurrences among 175 patients, compared with 3 recurrences among 102 patients after LPN (*Table 2*).

Discussion. Our findings are consistent with international data comparing laparoscopic and robot-assisted partial nephrectomy. In our study, the reduction in creatinine clearance during the postoperative period was significantly less in the RAPN group, with a median of 10.2 versus 17.3 in the LPN group, indicating better

Table 1

Functional outcomes in patients in Group 1 (RAPN) and Group 2 (LPN)

Group	Median decrease in creatinine clearance
RAPN (n=175)	10.2
LPN (n=102)	17.3

Table 2

Oncological outcomes in patients in Group 1 (RAPN) and Group 2 (LPN)

Group	Surgical margin		
	R0	R1	Recurrences in the R1 subgroup
RAPN (n, %)	167 (95.43%)	8 (4.57%)	2 (25.0%)
LPN (n, %)	91 (89.22%)	11 (10.78%)	3 (27.3%)

preservation of renal function with the robotic approach. Similar findings have been reported by other authors, who attribute the advantages of RAPN to shorter warm ischemia time and more precise suturing of the renal parenchyma [16–21].

These findings are supported by the meta-analysis by X. Zhang et al. [13], which demonstrated that RAPN provides perioperative outcomes comparable to those of LPN while significantly reducing warm ischemia time. In the study by L. Chen et al. [14], the robot-assisted approach was also associated with lower blood loss, shorter ischemia time, and better postoperative preservation of renal function, although at higher direct costs. In contrast, the prospective randomized study by C. Würnschimmel et al. [15] found no significant differences in renal function at 6 months, highlighting the inconsistency of the available evidence and the potential influence of the ischemia technique used.

With regard to oncological outcomes, positive surgical margins (R1) were significantly more frequent in the LPN group in our series, 10.78% versus 4.57% in the RAPN group, while RCC recurrence was less frequent after RAPN. This finding is consistent with the concept that three-dimensional visualization, seven degrees of freedom of robotic instruments, and tremor filtration may facilitate more precise tumor excision and reduce the risk of a positive surgical margin [10–12]. Nevertheless, several international studies have found no significant difference in positive surgical margin rates between the two approaches, indicating the need for further investigation in larger cohorts.

The limitations of the present study include its retrospective nature, single-center design, relatively small number of patients in the LPN group, and lack of long-term follow-up data. When considering economic outcomes, the higher cost of robot-assisted procedures should also be taken into account. Prospective multicenter randomized studies with larger sample sizes and longer follow-up are required to confirm these findings.

Conclusion. RAPN represents a preferable alternative to LPN because of shorter warm ischemia time and lower blood loss, while providing reliable functional and oncological outcomes. A detailed understanding of complications associated with both laparoscopic and robot-assisted surgery is essential for further refinement of these techniques and improvement of treatment outcomes in patients with renal tumors.

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RETHINKING THE KNOWN TECHNIQUE OF HETEROTOPIC CONTINENT URODERIVATION AND SEARCHING FOR OPTIMAL WAYS TO IMPROVE FUNCTIONAL RESULTS

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Introduction. The increasing number of performed cystectomies (CE) has significantly heightened the demand for effective urinary diversion methods. The declining use of continent cutaneous urinary diversion (CCUD) leads to an impoverishment of the modern reconstructive urology arsenal and a reduced quality of life for post-cystectomy patients when orthotopic neocystoplasty is not feasible.
Aim. To conduct a comparative analysis of the clinical and functional outcomes of the classic and modified Kock pouch continent cutaneous urinary diversion.
Materials and methods. The results of a consecutive series of 56 patients were analyzed. The patients underwent: open CE with classic Kock CCUD (13 patients, 23.2%), open CE with modified Kock CCUD (27 patients, 48.2%), and laparoscopic CE with modified Kock CCUD (16 patients, 28.6%).
Results. The incidence of resecting a prolapsed valve nipple decreased by 6.2 times with the modified technique. Valve revision was required in 30.8% of patients after the classic procedure compared to 7.0% after the modified procedure, resulting in a 4.4-fold reduction in revision frequency. Reservoir calculi formation was 1.4 times lower in the modified surgery group. Difficult catheterization decreased by 23.9% (a 4.5-fold reduction) in the modified group. Continence rates were 76.9% and 93.1% in the compared groups, respectively, showing a 16.2% improvement (a 1.2-fold increase) with the modified Kock reservoir. The advantages of surgical approaches (open vs. laparoscopic) and diversion modification (modified vs. classic Kock procedure) become apparent only when considering long-term postoperative outcomes (⩾90 days).
Conclusion. Despite the waning popularity of the traditional heterotopic Kock continent urinary diversion, which undoubtedly depletes the arsenal of modern reconstructive urology, its modified version represents a promising tool in the hands of a contemporary urologist.

K e y w o r d s: cystectomy, continent cutaneous urinary diversion, Kock pouch procedure

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Introduction. The increasing incidence of bladder cancer in Russia and worldwide, together with other conditions requiring cystectomy and pelvic exenteration, including tumors of other sites, congenital anomalies, traumatic or inflammatory bladder damage resulting in anatomical and functional failure, severe refractory radiation cystitis, vesicovaginal fistulas not amenable to correction, end-stage interstitial cystitis, and severe neurogenic bladder dysfunction, has substantially increased the need for effective methods of urinary diversion [1–10]. Continent urinary diversion has been successfully used worldwide for more than four decades. In specialized centers, the majority of patients (60–75%) receive this type of urinary diversion. Nevertheless, in routine clinical practice, incontinent urinary diversion is still performed in most patients (60–65%). This discrepancy is primarily attributable to limited experience and training among urologists performing cystectomy, as well as the prevailing belief that continent cutaneous urinary diversion is associated with a higher risk of complications. However, expert centers worldwide have provided evidence refuting this assumption. At the same time, many aspects of this field remain unclear, and high-quality evidence is still limited [11].

Potential disadvantages of continent cutaneous urinary diversion described by some authors include longer anesthesia time and a higher risk of complications that may adversely affect functional outcomes [12], although these concerns have been challenged by other investigators [11]. Patients with continent cutaneous urinary diversion generally demonstrate good continence rates but may experience stomal stenosis, late failure of the continence mechanism, and urinary incontinence. Nevertheless, continent cutaneous urinary diversion is an established treatment option rather than an experimental technique and should be considered a reliable alternative for patients after cystectomy [13–16]. Various forms of continent cutaneous urinary diversion are becoming increasingly uncommon, placing responsibility on training centers and surgeons who continue to perform these procedures regularly to preserve and transfer the experience accumulated over recent decades. This is necessary to ensure that patients are offered the full spectrum of urinary diversion options, particularly given the high satisfaction and quality of life reported by many patients living with continent cutaneous urinary diversion worldwide [11, 17, 18].

Aim. To compare the clinical and functional outcomes of classical and modified Kock continent cutaneous urinary diversion.

Materials and methods. Classical Kock continent cutaneous urinary diversion according to the D.G.

Table 1

Comparison groups according to the type of surgery

No.	Group	Number of patients
I	Open cystectomy + Kock procedure (OC + Kock)	13
II	Open cystectomy + modified Kock procedure (OC + mKock)	27
III	Laparoscopic cystectomy + modified Kock procedure (LC + mKock)	16
	Total	56

Skinner modification was performed in 13 patients. To overcome the limitations identified with this technique, we developed an original method of continent heterotopic umbilical ileocystoplasty (Russian Federation Patent RU 2785265 C1), which was subsequently used for urinary diversion in 43 patients. All 56 patients who underwent heterotopic urinary diversion were retrospectively analyzed and divided into comparison groups according to the urinary diversion technique used, with an additional comparison between open and laparoscopic cystectomy (LC) (*Table 1*).

Thus, classical Kock continent cutaneous urinary diversion was performed in 13 patients (23.2%), whereas the modified technique was used in 43 patients (76.8%). Modified Kock urinary diversion was performed in 27 patients (48.2%) undergoing open cystectomy and in 16 patients (28.6%) undergoing laparoscopic cystectomy. Groups I–II and II–III were compared. Assessment of group homogeneity, clinical characteristics, and postoperative follow-up duration is presented in *Table 2*.

A minor difference in sex distribution was observed between the comparison groups; however, this was not considered to affect the functional outcomes of continent cutaneous urinary diversion. The proportion of patients with comorbidities did not differ significantly among the groups. However, analysis of the age-adjusted Charlson Comorbidity Index showed a greater comorbidity burden in Group III (LC + modified Kock). This group also had a significantly lower estimated 10-year survival.

Differences in mean follow-up duration after urinary diversion were relevant when assessing survival between groups. Nevertheless, follow-up duration in all groups was sufficient for reliable assessment of the functional outcomes of continent cutaneous urinary diversion, which was the primary objective of the study. No significant differences were observed for the remaining variables presented in the table.

It is well established that long-term mortality and loss to follow-up increase with longer observation periods. This was confirmed in our study by multivariable regression and correlation analysis, with correlation coefficients ranging from r=0.17 to r=0.25; however, no significant between-group differences in these parameters were identified (p>0.05, Fisher's F-test). The conditions constituting indications for cystectomy and the frequency of procedures performed in the study groups are presented in *Table 3*.

The prevalence of bladder cancer did not differ significantly among the groups: Group I, 69.2%; Group II, 70.4%; and Group III, 68.7% (p >0.05). Patients with

Table 2

Comparative characteristics of the study groups

Parameter	Groups			p
	I	II	III	
Number of patients (n)	13	27	16	
Men (n/%)	7/53.8	18/66.7	14/87.5	□
Women (n/%)	6/46.2	9/33.3	2/12.5	□
Age of all patients, mean±SD (years)	46.9±17.0	55.4±13.4	58.9±10.9	
Patients with previous abdominal and pelvic surgery (n/%)	6/46.2	12/44.4	5/31.3	
Patients with comorbidities (n/%)	11/84.6	25/92.6	14/87.5	
Age-adjusted Charlson Comorbidity Index, mean±SD (min/max)	1.9±1.3 (0/4)	2.0±1.5 (0/5)	3.0±1.7 (1/7)	□
Estimated 10-year survival, mean±SD (%)	85.5±16.1	82.5±21.6	69.6±33.1	□
Follow-up after urinary diversion, mean±SD (min/max), months	147.8±123.6 (1/285)	109.1±69.9 (7/232)	30.2±24.1 (1/83)	▲□
Early postoperative mortality (n/%) (⩽30 days)	1 (7.7)	0 (0.0)	0 (0.0)	
Late postoperative mortality (n/%) (31–90 days)	0 (0.0)	0 (0.0)	1 (6.25)	
Postoperative mortality (n/%) (⩽90 days)	1 (7.7)	0 (0.0)	1 (6.25)	
Delayed mortality (n/%) (⩾90 days)	5 (38.5)	10 (37.0)	3 (18.8)	
Time to delayed mortality, mean±SD (min/max), months	69.2±96.6 (9/240)	39.7±31.6 (7/96)	29.7±21.9 (5/47)	
Patients lost to follow-up during the entire observation period (n/%)	2 (15.4)	5 (18.5)	1 (6.25)	
Time to loss to follow-up, mean±SD (min/max), months	144.0±162.6 (29/259)	90.5±61.6 (17/149)	17.0±0.0 (17/17)	

▲ - Statistically significant difference between Groups I and II according to Student's t-test (p<0.05).
□ - Statistically significant difference between Groups II and III according to Student's t-test (p<0.05).

Table 3

Indications and types of surgery in the study groups

Parameter	Groups		
	Group I (n=13), OC + Kock	Group II (n=27), OC + mKock	Group III (n=16), LC + mKock
	Number of procedures, %		
Bladder cancer, n/%	9/69.2	19/70.4	11/68.7
Interstitial cystitis, n/%	–	3/11.1	1/6.3
Contracted bladder (post-traumatic/postoperative), n/%	1/7.7	4/14.8	1/6.3
Bladder exstrophy, n/%	3/23.1	–	2/12.4
Neurogenic bladder, n/%	–	1/3.7	1/6.3

non-oncological diseases were also distributed evenly among the groups: Group I, 30.8%; Group II, 29.6%; and Group III, 31.3% ($p>0.05$). Thus, comprehensive analysis of the selected clinical groups confirmed an adequate number of patients in each group and sufficient comparability of the cohorts according to the principal parameters analyzed.

The study included long-term clinical and functional outcomes of a consecutive series of 56 patients who underwent cystectomy and continent cutaneous urinary diversion between 1995 and 2022. Preoperative and postoperative data, including all subsequent visits and questionnaire assessments at 3, 6, 12, and 24 months and thereafter once every 3 years, were standardized and prospectively entered into a single Microsoft Access 2021 database (Microsoft Corporation, USA).

Statistical analysis was performed using Statistica 10.0 (StatSoft, USA) and BioStat 2009 (AnalystSoft Inc., USA). Quantitative variables were described using the mean and standard deviation or median and interquartile range, whereas categorical variables were expressed as frequencies and percentages.

Continuous variables, including differences between study groups, were compared using Student's t-test or nonparametric tests. Descriptive statistics were used to calculate arithmetic means (M), standard errors, and standard deviations (m) for the general characterization of patients in the comparison groups when the variables were normally distributed. In the presence of significant deviations from normality, the Mann–Whitney test was used for independent samples and the Wilcoxon test for paired samples. Categorical variables were compared using the chi-square test based on absolute frequencies in the Nonparametric Statistics module of Statistica 10.0. A value of $p<0.05$ was considered significant.

Results. The mean operative time was 489.4±73.3 min (LQ: 380, UQ: 570) in the open cystectomy + Kock group, 386.2±74.7 min (LQ: 290, UQ: 495) in the open cystectomy + modified Kock group, and 423.4±56.8 min (LQ: 340, UQ: 510) in the laparoscopic cystectomy + modified Kock group. Mean blood loss was 635±228 mL (LQ: 350, UQ: 1050) versus 439±180 mL (LQ: 200, UQ: 700) and 323±81 mL (LQ: 150, UQ: 450), respectively. Mean intraoperative blood loss was significantly lower in the laparoscopic cystectomy + modified Kock group than in the open cystectomy + modified Kock group, 323 and 439 mL, respectively, representing a 1.4-fold reduction (Mann–Whitney test, $p=0.034$).

The frequency and mean volume of blood transfusion were as follows: open cystectomy + Kock, 7 patients (53.8%), 494.3±209.7 mL (LQ: 260, UQ: 730); open cystectomy + modified Kock, 11 patients (40.7%), 408.4±213.3 mL (LQ: 193, UQ: 765); and laparoscopic cystectomy + modified Kock, 2 patients (12.5%), 365.5±47.4 mL (LQ: 323, UQ: 390). The frequency and volume of blood transfusion were lowest in the laparoscopic cystectomy + modified Kock group, at 12.5% and 365.5 mL, respectively, compared with the other groups ($\chi^2=6.57$, $p=0.010$).

The mean length of hospital stay was 22.9±5.1 days (LQ: 17, UQ: 32) in the open cystectomy + Kock group, 18.8±4.2 days (LQ: 13, UQ: 26) in the open cystectomy + modified Kock group, and 13.5±3.4 days (LQ: 8, UQ: 19) in the laparoscopic cystectomy + modified Kock group.

In the laparoscopic cystectomy + modified Kock group, the mean hospital stay was reduced by 5.3 days compared with the open modified Kock procedure, 13.3 versus 18.8 days ($\chi^2=9.51$, df =4, $p=0.022$).

Repeat surgical procedures performed during postoperative follow-up were analyzed in detail (*Table 4*).

Although there were no statistically significant differences between groups in the frequency of repeat surgery during the early and late postoperative periods or in delayed procedures unrelated to urinary diversion, the number of repeat interventions per patient during these periods was lowest in the laparoscopic cystectomy + modified Kock group ($p>0.05$).

Delayed repeat procedures related to urinary diversion included reservoir lithotripsy, excision of prolapsed valve mesh, extracorporeal shock wave lithotripsy of renal calculi, percutaneous treatment of upper urinary tract stones, and valve revision.

Reservoir lithotripsy was performed more frequently in the open cystectomy + Kock group than in the open cystectomy + modified Kock group, with rates per patient of 0.384 (38.4% of patients) and 0.295 (25.9% of patients), respectively. Excision of prolapsed valve mesh was required in 3 patients in the open cystectomy + Kock group (23.1%; 0.231 procedures per patient) and in 1 patient in the open cystectomy + modified Kock group (3.7%; 0.037 procedures per patient). Thus, the frequency of excision of prolapsed valve mesh decreased 6.2-fold with the modified procedure. The most common delayed repeat procedures related to urinary diversion were percutaneous treatment of upper urinary tract calculi and valve revision. The frequency of these procedures per patient was 0.615 in the open cystectomy

+ Kock group (3 patients, 23.1%), 0.185 in the open cystectomy + modified Kock group (3 patients, 11.1%), and 0.125 in the laparoscopic cystectomy + modified Kock group (2 patients, 12.5%). A significant difference was observed between the open cystectomy + Kock and open cystectomy + modified Kock groups ($p<0.05$), with a higher number of procedures per patient in the classical Kock group.

Overall analysis of all delayed repeat procedures related to urinary diversion demonstrated a significant difference in their frequency among the comparison groups ($p<0.05$) (*Table 4*). Valve revision was required in 4 patients (30.8%) following the classical open Kock procedure, compared with 3 patients (7.0%) following the modified procedure, combining the open and laparoscopic modified Kock groups. Thus, modification of the Kock valve formation technique reduced the rate of valve revision 4.4-fold. Overall rates of all delayed procedures clearly demonstrated a significant difference in repeat surgery frequency, which was 3.0-fold higher in the open cystectomy + Kock group than in the open cystectomy + modified Kock group ($p<0.05$) (*Table 4*). A significant difference was also observed between the open cystectomy + modified Kock and laparoscopic cystectomy + modified Kock groups, with a 2.8-fold lower rate in favor of laparoscopic cystectomy + modified Kock ($p<0.05$) (*Table 4*). Analysis of cumulative outcomes over the entire follow-up period demonstrated the same pattern: the number of repeat procedures per patient was 2.9-fold lower in the open cystectomy + modified Kock group than in the open cystectomy + Kock group and 2.7-fold higher than in the laparoscopic cystectomy + modified Kock group ($p<0.05$) (*Table 4*). Readmission within 90 days after surgery was required in all groups: 3 patients (23.1%) in the open cystectomy + Kock group, 3 (11.1%) in the open cystectomy + modified Kock group, and 1 (6.3%) in the laparoscopic cystectomy + modified Kock group. During the delayed postoperative period, the corresponding figures were 8 patients (61.5%), 7 (25.9%), and 2 (12.5%), respectively. The number of hospitalizations was significantly higher in the open cystectomy + Kock group than in the other groups ($p<0.05$), whereas no significant difference was observed between the open cystectomy + modified Kock and laparoscopic cystectomy + modified Kock groups ($p>0.05$).

According to our data, modification of the Kock procedure reduced the rate of reservoir stone formation by 1.4-fold

Table 4

Repeat surgical procedures during the early, late, and delayed postoperative periods

Procedures	Group I OC + Kock (n=13)	Group II OC + mKock (n=27)	Group III LC + mKock (n=16)	p
	I	II	III	
	n / %			
Early repeat procedures (⩽30 days)				
Number of procedures performed	3	2	1	
Number of patients undergoing surgery, n (%)	2 (15.4)	2 (7.4)	1 (6.3)	
Procedures per patient	0.231	0.074	0.063	
Late repeat procedures (31–90 days)				
Number of procedures performed	2	2	-	
Number of patients undergoing surgery, n (%)	2 (15.4)	1 (3.7)	-	
Procedures per patient	0.154	0.074	-	
Early + late repeat procedures (⩽90 days)				
Number of procedures performed	5	4	1	
Number of patients undergoing surgery, n (%)	3 (23.1)	3 (11.1)	1 (6.3)	
Procedures per patient	0.385	0.148	0.063	
Delayed procedures unrelated to urinary diversion (>90 days)				
Number of procedures performed	4	1	1	
Number of patients undergoing surgery, n (%)	3 (23.1)	1 (3.7)	1 (6.3)	
Procedures per patient	0.308	0.037	0.063	
Delayed procedures related to urinary diversion (>90 days)				
Number of procedures performed	16	13	2	▲◆
Number of patients undergoing surgery, n (%)	6 (46.2)	8 (29.6)	2 (12.5)	
Procedures per patient	1.231	0,.481	0.125	▲◆
All delayed procedures, unrelated and related to urinary diversion (>90 days)				
Number of procedures performed	20	14	3	▲◆
Number of patients undergoing surgery, n (%)	8 (61.5)	8 (29.6)	3 (18.8)	
Procedures per patient	1.538	0.518	0.188	▲◆
Overall outcomes for the entire follow-up period				
Number of procedures performed	25	18	4	▲◆
Number of patients undergoing surgery, n (%)	9 (69.2)	9 (33.3)	4 (25.0)	▲
Procedures per patient	1,.923	0.667	0.250	▲◆

▲ - Statistically significant difference between Groups I and II according to Student's t-test ($p<0.05$).
◆ - Statistically significant difference between Groups II and III according to Student's t-test ($p<0.05$).

Figure. Contrast-enhanced computed tomography (MSCT) of a modified continent Kock reservoir at 12 months of follow-up

in the open cystectomy + modified Kock group, with 6 patients (22.2%; 0.222 events per patient), compared with 4 patients (30.8%; 0.308 events per patient) in the open cystectomy + Kock group, although the difference was not significant (p>0.05). Correction of Kock valve insufficiency was required in 1 patient in the open cystectomy + Kock group (7.7%; 0.077 procedures per patient).

The primary objective of the study was to compare the functional outcomes of the classical Kock reservoir (open cystectomy + Kock) and the modified Kock reservoir (open cystectomy + modified Kock and laparoscopic cystectomy+modified Kock). Using clinical investigations, including ultrasonography, contrast-enhanced CT, reservoirography, and endoscopic examination, as well as functional testing with comprehensive urodynamic studies and patient questionnaires, we assessed the functional and anatomical reservoir capacity, intraluminal pressure, frequency of daytime and nighttime self-catheterization, ease of catheterization, and continence characteristics.

Contrast-enhanced CT performed at scheduled follow-up visits for oncological surveillance also enabled assessment of upper urinary tract urodynamics, as well as the configuration, dimensions, and spatial position of the heterotopic reservoirs and ureteroenteric anastomoses, with evaluation for obstructive changes (*Fig.*).

Functional assessments, including patient questionnaires, were performed at 3, 6, and 12 months. Comparative functional outcomes of classical and modified Kock reservoirs at 12 months are presented in Table 5. Immediately after catheter removal, the functional capacity of the classical and modified Kock reservoirs was 80–130 mL (mean 102 mL) and 70–140 mL (mean 96 mL), respectively. At 3 months, the corresponding values were 320–400 mL (mean 356 mL) and 320–390 mL (mean 346 mL); at 6 months, 470–670 mL (mean 550 mL) and 470–640 mL (mean 523 mL); and at 12 months, 470–740 mL (mean 611 mL) and 490–720 mL (mean 592 mL), respectively.

These findings demonstrate a relatively rapid increase in functional reservoir capacity during the first 6 postoperative months, from an initial mean of approximately 100 mL to approximately 550 mL. During the subsequent 6 months, the increase was minor, with reservoir capacity reaching approximately 600 mL and remaining stable thereafter.

Anatomical reservoir capacity was assessed during reservoiroscopy under anesthesia using passive irrigation with fluid warmed to 37.0°C from a height of 40 cm above the reservoir until the flow of irrigation fluid ceased. Mean anatomical reservoir capacity at 12 months did not differ significantly between the comparison groups (p>0.05) (*Table 5*). Comprehensive urodynamic testing was used to objectively assess reservoir peristaltic activity, changes in intraluminal pressure, reservoir capacity, the volume at which the first sensation of filling occurred, and subsequent definite sensations of fullness. Mean baseline filling pressure did not differ significantly between the classical and modified Kock reservoirs and did not exceed 40 cm H_2O in either group at 12 months of follow-up (*Table 5*).

According to urodynamic findings, peristaltic activity with peak increases in reservoir pressure decreased during the first 6 months and became almost negligible by 12 months after surgery, remaining stable thereafter.

Table 5

Functional outcomes of classical and modified Kock continent cutaneous urinary diversion at 12 months

Functional parameter	OC + Kock (n=13)	OC + mKock and LC + mKock (n=43)	p
Functional reservoir capacity, mL	470–740 (mean 611)	490–720 (mean 592)	-
Anatomical reservoir capacity at 40 cm H_2O, mL	520–1650 (mean 744)	530–1700 (mean 727)	-
Mean reservoir filling pressure, cm H_2O	27 (18–33)	25 (15–35)	-
Mean maximum reservoir filling pressure, cm H_2O	46 (39–73)	44 (37–69)	-
Mean interval between catheterizations, h	4–6	4–6	-
Difficult catheterization, n (%)	4 (30.8%)	3 (7.0%)	-
Functional valve insufficiency (urinary leakage through the valve)	⩽1 pad/day – 1 (7.7%) >1 pad/day – 3 (23.1%)	⩽1 pad/day – 3 (7.0%) >1 pad/day – 3 (7.0%)	-
Continence (⩽1 pad/day), n (%)	10 (76.9%)	40 (93.0%)	-

▲ - Statistically significant difference between Groups I and II according to Student's t-test (p<0.05).

At 12 months, the mean interval between catheterizations was 4–6 hours in both groups. Approximately 10% of patients in each group performed self-catheterization every 3–5 hours, 80% every 4–7 hours, and approximately 10% reported intervals of up to 6–10 hours.

Uncomplicated self-catheterization was reported by 9 patients (69.2%) in the classical Kock group and 40 patients (93.0%) in the modified Kock group. Thus, the rate of difficult catheterization decreased by 23.9%, corresponding to a 4.5-fold reduction, with the modified procedure compared with the classical Kock technique.

Functional valve insufficiency, manifested by urinary leakage through the valve, was reported by 4 patients (30.8%) following the classical procedure and by 6 patients (14.0%) following the modified procedure. The modified technique reduced the rate of incontinence by 16.1%, corresponding to a 3.3-fold reduction.

Accordingly, 9 patients (69.2%) in the classical group and 37 patients (86.0%) in the modified group remained completely dry. Functional success was defined as socially acceptable continence with the use of no more than one pad per day. Based on this definition, continence was achieved in 10 patients (76.9%) and 40 patients (93.1%) in the classical and modified Kock groups, respectively, representing an improvement of 16.2% (1.2-fold) with the modified Kock reservoir.

Discussion. Use of the modified Kock continent cutaneous urinary diversion technique during open cystectomy reduced operative time by 1.3-fold, primarily because only one continence valve was constructed instead of the two valves used in the classical procedure. Performing the cystectomy laparoscopically as part of the modified procedure reduced surgical trauma, blood loss, and the frequency and volume of blood transfusion and significantly shortened the mean postoperative hospital stay.

Comparison of complications and associated repeat procedures during the early and late postoperative periods revealed no significant differences between classical and modified Kock continent cutaneous urinary diversion. However, significant differences emerged only during the delayed postoperative period and primarily involved procedures related to urinary diversion. The advantages of modified continent cutaneous urinary diversion over the classical Kock procedure and of laparoscopic over open surgery in reducing complications and associated repeat procedures became apparent only when delayed postoperative outcomes were considered. Such outcomes are not captured in most standard surgical reports.

Most patients in our study achieved intervals of at least 4 hours between self-catheterizations, facilitating good social adaptation. Although the differences were not statistically significant, better functional outcomes were observed with the modified procedure, including long-term reliability of the modified Kock valve, uncomplicated self-catheterization, and improved continence in the vast majority of patients.

Conclusions. Although traditional heterotopic continent Kock urinary diversion is becoming less commonly used, thereby unquestionably narrowing the armamentarium of modern reconstructive urology, its modified version remains a promising option for contemporary urological practice.

Further studies aimed at detailed evaluation of the efficacy and safety of continent cutaneous urinary diversion and comparison with other modern urinary diversion techniques will help define its role in treatment algorithms, optimize outcomes, and improve quality of life in patients requiring urinary diversion when orthotopic urinary diversion is not feasible.

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THE IMPACT OF MUSCLE-NERVE SPARRING TECHNIQUE ON THE INCIDENCE AND SEVERITY OF POST-VOID DRIBBLING AFTER BULBAR URETHROPLASTY

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Aim. To compare outcome of muscle and nerve-sparing bulbar urethroplasty with standard bulbar urethroplasty as regard frequency and severity of postvoid dribbling.

Materials and methods. Our study included 32 patients with bulbar urethral stricture underwent buccal mucosa graft urethroplasty. 18 patients were operated by dorsal onlay urethroplasty (Barbagi technique), 9 patients underwent ventral onlay urethroplasty, 3 patients were operated by Asopa technique and 2 patients underwent urethroplasty by Kulkarni technique. 19 patients were operated by muscle and nerve-sparing bulbar urethroplasty, 13 patients underwent standard bulbar urethroplasty. Follow-up examination of frequency and severity of urinary disorders were matched by questionnaire at 4 mo, 8 mo and 12 mo after surgery.

Results. Postvoid dribbling was demonstrated in 12 patients (37,5%) at 4 mo after surgery. No statistically significant difference of postvoid dribbling was found between the groups of muscle and nerve-sparing and standard bulbar urethroplasty at 4 mo after surgery (p=0,4104). Postvoid dribbling was demonstrated in 6 patients (18,8%) at 8 mo after surgery: in 2 patients who underwent muscle and nerve-sparing bulbar urethroplasty and in 4 patients who underwent standard bulbar urethroplasty. Postvoid dribbling was demonstrated in 4 patients (12,5%) at 12 mo after surgery: in 1 patients (3,1%) who underwent muscle and nerve-sparing bulbar urethroplasty and in 3 patients (9,4%) who underwent standard bulbar urethroplasty.

Discussion. The frequency of postvoid dribbling is lower in patients with muscle and nerve-sparing bulbar urethroplasty compare to standard bulbar urethroplasty, but no statistically significant difference was found between the groups. Sparing the bulbospongiosus muscle during urethroplasty impact on complete emptying of the urethra. The same time the compensatory capabilities of bulbospongiosus musle in patients who underwent non sparing bulbar urethroplasty impact also on complete emptying of the urethra.

Conclusion. Sparing the bulbospongiosus muscle, the central tendon of the perineum, and the perineal nerves during bulbar urethroplasty seem to have a significant impact on improving outcomes. In our experience the muscle and nerve sparing technique seems to be a safe and effective alternative for standard bulbar urethroplasty on follow-up up to 12 mo.

K e y w o r d s: *Urethral stricture, urethroplasty, bulbospongiosus muscle, postvoid dribbling*

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Introduction. Post-micturition dribbling is a specific type of urinary incontinence characterized by involuntary leakage of residual urine after completion of micturition [1]. This condition substantially impairs patients' quality of life and often contributes to dissatisfaction with surgical outcomes even when urethral patency has been successfully restored [2]. The problem is particularly relevant in patients with urethral stricture: before surgery, post-micturition dribbling is reported in 73% of cases, according to a retrospective study involving 614 patients [3]. After anterior urethroplasty, symptoms improve in most patients, with improvement reported in 60%. However, in some patients the condition remains unchanged (32%) or even worsens (8%). Moreover, post-micturition dribbling develops de novo after surgery in 6.3% of patients [3], while other studies have reported rates of up to 18% [4]. The mechanisms underlying post-micturition dribbling are diverse. Most commonly, it is associated with pooling of urine in the bulbar urethra, including in the absence of urethral narrowing [5, 6]. This complication may occur after any type of bulbar urethroplasty [7], and its detection requires specific diagnostic methods, such as voiding cystourethrography, since retrograde urethrography may fail to demonstrate urine retention within the urethra [8]. Particular attention in contemporary urology is given to surgical technique as a factor influencing the risk of post-micturition dribbling. During bulbar urethroplasty, the bulbospongiosus muscle is often divided along the midline. This may result in injury to the perineal muscles and nerves, leading not only to post-micturition dribbling but also to ejaculatory dysfunction [9]. As an alternative, a perineal approach preserving the bulbospongiosus muscles and nerves has been developed. A randomized study by Elkady et al. involving 50 patients demonstrated advantages of this approach [10]: post-micturition dribbling – 4% versus 36% in the conventional approach group (p=0.01); ejaculatory dysfunction – 8% versus 40% (p=0.02); operative time

did not differ between the groups (100 and 105 minutes, respectively). There is also a view that preservation of the bulbospongiosus muscles during urethroplasty does not significantly affect postoperative dribbling compared with non-muscle-sparing urethroplasty at early follow-up [11]. At the same time, bulbospongiosus muscle- and nerve-sparing urethroplasty for bulbar urethral strictures has been suggested to represent a safe and effective alternative to conventional bulbar urethroplasty [10].

In addition, the risk of post-micturition dribbling depends on the type of urethroplasty: 20–28.1% after dorsal onlay urethroplasty; 20–21% after ventral onlay urethroplasty [12–14]. Late complications after the second stage of urethroplasty also include [12–14]: stress urinary incontinence – up to 16%; penile curvature – up to 9%; erectile dysfunction – up to 4%; urethral diverticula – 1%; cold glans syndrome. Another risk factor for complications is the choice of reconstructive material. The use of a penile skin flap is more frequently associated with [15]: superficial penile skin necrosis; penile curvature; penile hypoesthesia; post-micturition dribbling. In addition, harvesting a penile skin flap takes longer than harvesting buccal mucosa, and patient dissatisfaction is higher when a penile skin flap is used [15].

Aim. To compare the incidence and severity of post-micturition dribbling after bulbar urethroplasty performed with and without a muscle- and nerve-sparing technique. The study analyzes the effect of the muscle- and nerve-sparing technique on the outcomes of bulbar urethroplasty.

Materials and methods. In our study, 32 patients underwent substitution urethroplasty using buccal mucosa. Of these, 18 patients underwent dorsal onlay graft placement using the Barbagli technique, 9 underwent ventral onlay graft placement, 3 underwent the Asopa technique, and 2 underwent the Kulkarni technique. A muscle- and nerve-sparing technique was used during urethroplasty in 19 patients, whereas 13 patients underwent urethroplasty without muscle and nerve preservation. The distribution of patients undergoing the muscle- and nerve-sparing technique did not differ significantly between the groups (p=0.3286). Follow-up assessment of the incidence and severity of voiding disorders was performed at 4, 8, and 12 months after surgery using an adapted Guido Barbagli questionnaire [9].

Questionnaire

Do you experience urine dribbling after urination?

A. Yes

B. No

Have you noticed urine stains on your underwear or trousers?

A. Yes

B. No

Do you use pads?

A. Yes

B. No

At the end of urination, do you perform any manipulation of the urethra or perineum to achieve more complete evacuation of urine?

A. Yes

B. No

When performing these maneuvers, are you able to prevent urine dribbling after urination?

A. Yes

B. No

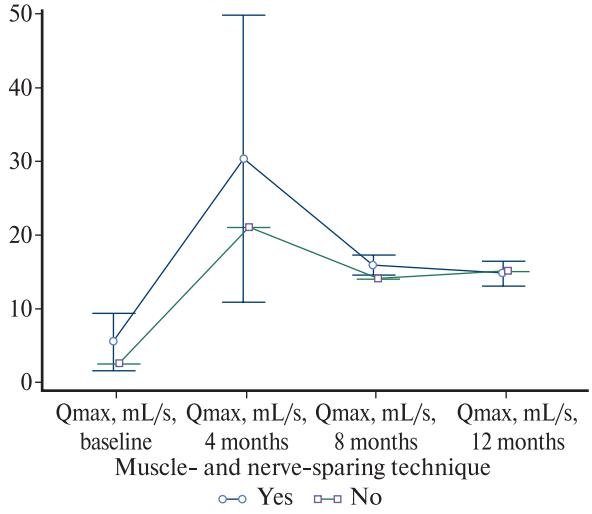

Fig. 1. Changes in maximum urinary flow rate in patients after urethroplasty according to the use of the muscle- and nerve-sparing (MNS) technique

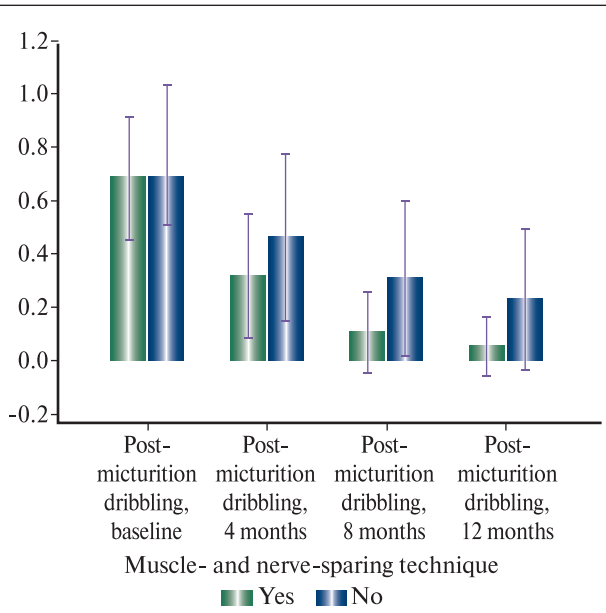

Fig. 2. Changes in the incidence of post-micturition dribbling in patients after urethroplasty according to the use of the muscle- and nerve-sparing technique

Uroflowmetry and urine culture were repeated every 4 months during the first year after surgery. Descriptive statistical methods were used. Differences were considered significant at $p<0.05$. Statistical analysis was performed using MedCalc software (MedCalc® Statistical Software version 20.013).

Results. When the maximum urinary flow rate was compared between patients undergoing urethroplasty with and without muscle and nerve preservation, a significant increase was observed in both groups at 4 months after surgery, followed by a decrease to an average of 15 mL/s, which remained stable through 12 months of follow-up (*Fig. 1*).

When the maximum urinary flow rate was compared between patients undergoing urethroplasty with and

without muscle and nerve preservation, a significant increase in maximum urinary flow rate was observed in both groups at 4 months after surgery, followed by a decrease to an average of 15 mL/s, which remained stable through 12 months of follow-up (*Fig. 2*).

No patient developed recurrent urethral stricture or urine retention in the bulbar urethra on voiding cystourethrography. The following is an analysis of questionnaire items describing the presence and severity of urine dribbling, as well as the need for assistive devices, namely pads. Overall, post-micturition dribbling was detected in 12 (37.5%) patients at 4 months after urethroplasty. No significant difference in the incidence of post-micturition dribbling was found between the muscle- and nerve-sparing and non-sparing groups at 4 months after urethroplasty (p=0.4104).

At 8 months of follow-up, post-micturition dribbling was present in 6 (18.8%) patients. At this time point, dribbling was detected in 2 patients in the muscle- and nerve-sparing group and in 4 patients in the non-sparing group. The difference between the groups was not significant (p=0.1561). At 8 months after urethroplasty, 4 (12.5%) patients used pads. In the muscle- and nerve-sparing group, 17 patients did not use pads, compared with 11 patients in the non-sparing group. There was no statistically significant difference in pad use between the groups at 8 months after urethroplasty (p=0.6879). At 12 months after urethroplasty, post-micturition dribbling was detected in 4 (12.5%) patients. At this time point, urine dribbling was present in 1 (3.1%) patient in the muscle- and nerve-sparing group and in 3 (9.4%) patients in the non-sparing group. No statistically significant difference in the incidence of dribbling at 12 months after urethroplasty was found between the groups (p=0.1408). The incidence of post-micturition dribbling after muscle- and nerve-sparing urethroplasty at 4, 8, and 12 months of follow-up was 31.6%, 10.5%, and 5.3%, respectively, while in those who underwent urethroplasty without muscle and nerve preservation, the respective figures at 4, 8, and 12 months were 46.2%, 30.8%, and 23.1%, respectively.

Discussion. The incidence of post-micturition dribbling was lower in patients who underwent muscle- and nerve-sparing urethroplasty than in those who underwent urethroplasty without muscle and nerve preservation; however, the differences between the groups were not significant. These findings suggest a beneficial effect of the sparing technique on complete evacuation of urine from the urethra, although the compensatory capacity of the bulbospongiosus muscles in patients undergoing non-sparing urethroplasty should also be considered. Among patients in the muscle- and nerve-sparing group, pads were used by 15.6% at 4 months and 6.2% at 8 months of follow-up. By 12 months, none of the patients in the muscle- and nerve-sparing group used pads. In the group of patients who underwent urethroplasty without muscle and nerve preservation, pads were used by 15.6%, 6.2%, and 6.2% at 4, 8, and 12 months, respectively. Thus, both the frequency and duration of pad use were greater in this group than among patients who underwent muscle- and nerve-sparing urethroplasty. This parameter may also serve as a criterion for evaluating the efficiency of a technique designed to minimize injury to the bulbospongiosus muscle. The use of tissue-sparing techniques appears to reduce post-micturition dribbling and the need for pads. Both factors contribute to patients' quality of life after surgical treatment.

Conclusion. Reconstructive urethral surgery continues to evolve. An important direction in its development is the use of less traumatic techniques with an emphasis on functional outcomes. Preservation of the perineal muscles and nerves represents an important advancement in minimally invasive reconstruction of the bulbar urethra. Follow-up for up to 12 months supports the effectiveness of a technique that preserves the muscles and nerves involved in expelling residual urine from the bulbar urethra.

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CONTINUITY OF CARE BETWEEN PEDIATRIC AND ADULT UROLOGISTS

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Introduction. Issues of continuity of care in the treatment of patients with urological diseases are becoming increasingly relevant as the specialty itself advances and high-technology treatment methods are introduced.
Aim. To draw the attention of pediatric and adult urologists to the problems of continuity of care and to the need for establishing a system for transferring patients from pediatric to adult urologists.
Materials and methods. Five male patients were treated at I.M. Sechenov First Moscow State Medical University (Sechenov University), Ministry of Health of Russia, on the basis of Morozov Children's City Clinical Hospital and the Institute of Urology and Reproductive Health. Group I included 3 patients with penoscrotal hypospadias, and Group II included 2 patients with bladder exstrophy. All patients had undergone staged surgical treatment in childhood; however, due to the development of complications in adulthood, reconstructive plastic surgery was required.
Results. The early treatment outcomes in patients from both groups were assessed as good because no complications were observed. The long-term treatment outcomes in all patients were evaluated at 3 and 6 months, and at 1 and 3 years.
Conclusion. The growing recognition of the need for an uninterrupted continuum of care in the treatment of patients with urological diseases in childhood and adulthood highlights the importance of this work for healthcare systems and, above all, for patients. Reconstructive surgery in any person, and especially in a child, requires long-term follow-up, often throughout life.

Key words: continuity of care in urology, hypospadias, exstrophy, treatment outcomes

Conflict of interest. The authors declare no conflicts of interest. For citation: Kozyrev G.V., Gazimiev M.-S.A., Manasherova D.T., Gadzhieva Z.K. Continuity of care between pediatric and adult urologists. Urologiia. 2026;3:84-90.
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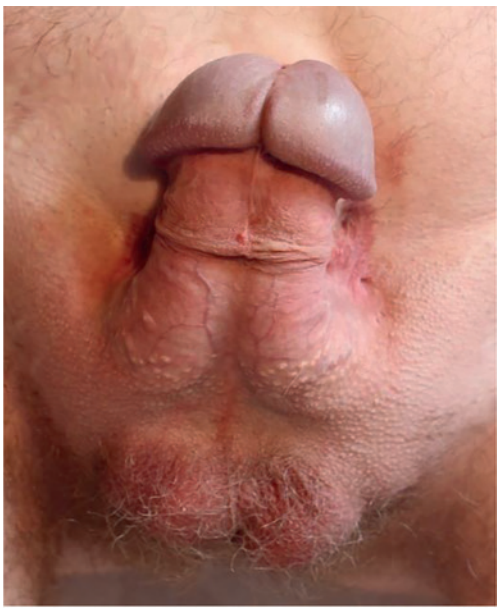
Introduction. Continuity of care for patients with urological diseases is becoming increasingly important as urology advances and high-technology treatment methods are introduced. Children with congenital anomalies of the lower urinary tract, such as hypospadias and bladder exstrophy, require not only surgical treatment at an early age but also mandatory long-term follow-up and, in many cases, staged surgical treatment extending into adulthood. Many years after surgery for hypospadias, late complications such as penile curvature, urethral stenosis, and urethral diverticula may develop in 4.6–9% of patients and require surgical correction in adulthood [1, 2]. Virtually all adults with bladder exstrophy require continued urological follow-up, and some also require further surgical treatment. For example, after bladder augmentation in patients with exstrophy, the risk of stone formation in adulthood ranges from 50% to 74%, necessitating subsequent stone removal [3].

Pediatric urologists follow patients with bladder exstrophy almost from birth, perform their surgeries, have many years of experience communicating with the patients and their parents, and are familiar with the individual characteristics of the disease course [4–6]. Adult urologists, however, often do not receive complete information regarding previous treatment, and patients frequently present to them only after complications have developed. Transition to the adult healthcare system is complicated by the absence of an established mechanism for transferring care [4, 5]. The aim of this study was to draw the attention of pediatric and adult urologists to

A – Ventral surface – urethral defect



B – Appearance of the penis – dorsal curvature

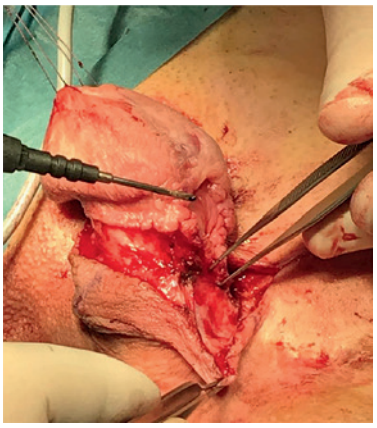
Fig. 1. Appearance of the penis before surgery

the importance of continuity of care and to the need for establishing a structured system for transitioning patients from pediatric to adult urological care.

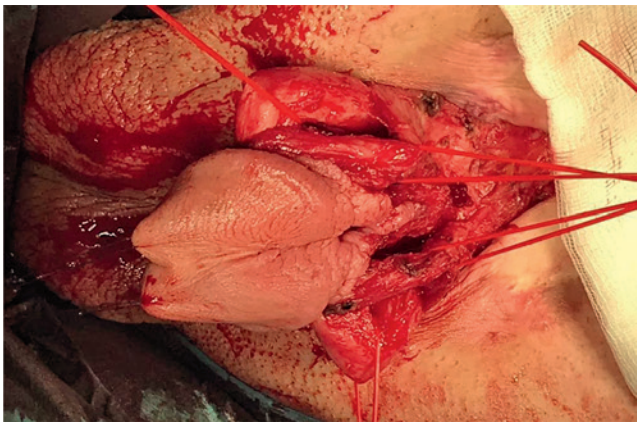
Materials and methods. At Sechenov University, five male patients were treated jointly at the Morozov Children's City Clinical Hospital and the Institute for Urology and Reproductive Health. Group I included 3 patients with penile hypospadias, and Group II included 2 patients with bladder exstrophy. All patients had undergone staged surgical treatment during childhood but subsequently required reconstructive surgery because of complications that developed in adulthood. All patients in Group I with hypospadias had undergone urethroplasty between the ages of 3 and 8 years. They subsequently developed difficulty urinating and were diagnosed with stenosis of the reconstructed urethra. Maximum urinary flow rate was reduced to 6–8 mL/s. During attempted catheterization, only a 10 Ch catheter could be passed through the urethra into the bladder. We performed one-stage augmentation urethroplasty using a buccal mucosal graft, with dorsolateral urethrotomy and placement of the buccal mucosal graft. In Group II, both patients had undergone staged surgical treatment at an early age, including bladder reconstruction with local tissues on days 2–3 of life, iliac osteotomy at 6 months and 5 years of age, urethroplasty and phalloplasty at 2 and 13 years of age, and ureterosigmoidostomy at 6 months and 7 years of age. One patient had liquid stool incontinence and recurrent pyelonephritis and was unable to engage in sexual intercourse because of severe dorsal penile curvature and multiple penile scars. We created a heterotopic continent neobladder with a catheterizable appendicostomy and performed phalloplasty using the Perovic technique. The second patient had almost no penile curvature and reported no episodes of pyelonephritis; however, he had liquid stool incontinence and chronic proctosigmoiditis. In this patient, we created a heterotopic continent neobladder with a catheterizable Monti stoma because he had previously undergone appendectomy.

Clinical case. *Patient Valery K., aged 38 years, was admitted to the Urology Clinic of Sechenov University with the following diagnosis: bladder exstrophy; status after multiple surgical procedures; partial urinary and fecal incontinence; chronic proctosigmoiditis; recurrent pyelonephritis. According to his medical history, bladder reconstruction using local tissues was performed at his place of residence on the second day of life, April 14, 1987. Because of bladder wound dehiscence, cystectomy and ureterosigmoidostomy were performed on October 27, 1987. Right-sided hernia repair was performed on September 12, 1989; osteotomy of the femoral and pelvic bones on June 18, 1992; and phalloplasty on April 13, 2000. At admission to the Sechenov University clinic, urine was diverted into the rectum. The penis was dorsally curved, with multiple skin scars (Fig. 1A, B). During the preceding 2 years, the patient had experienced recurrent episodes of pyelonephritis. Urine and feces were discharged together through the rectum. Partial incontinence of liquid stool was present. Colonoscopy revealed proctosigmoiditis. Conservative treatment of proctosigmoiditis provided only short-term improvement.*

In May 2019, phalloplasty using the Perovic technique was performed. During surgery, the penile skin was mobilized (Fig. 2A), followed by mobilization of the corpora cavernosa and penile neurovascular bundles (Fig. 2B). Urethroplasty and glanduloplasty were performed, and dorsal penile curvature was corrected by medial rotation of the corpora cavernosa, followed by skin reconstruction (Fig. 2C). The urethra was then transposed to the ventral surface of the penis (Fig. 2D). The integrity of Buck's fascia was restored, the glans was fixed to the tips of the corpora cavernosa (Fig. 2E), and skin reconstruction was completed (Fig. 2F). The postoperative period was uneventful. The penis remained straight, and the patient reported preserved erectile function and resumption of sexual activity (Fig. 2G).

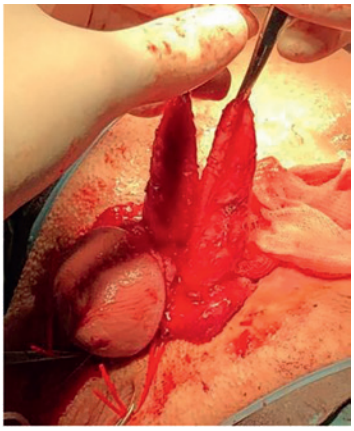


A – Mobilization of the penile skin

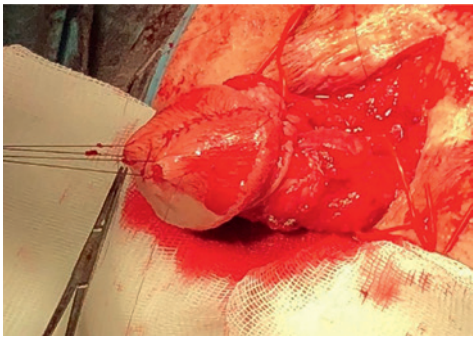


B – Mobilization of the neurovascular bundles and corpora cavernosa

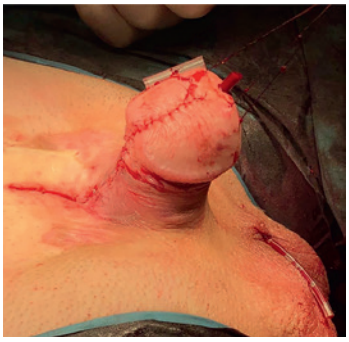
C – Schematic illustration of medial rotation of the corpora cavernosa to correct the curvature



D – Transposition of the urethra to the ventral surface of the penis



E – Restoration of the integrity of Buck's fascia



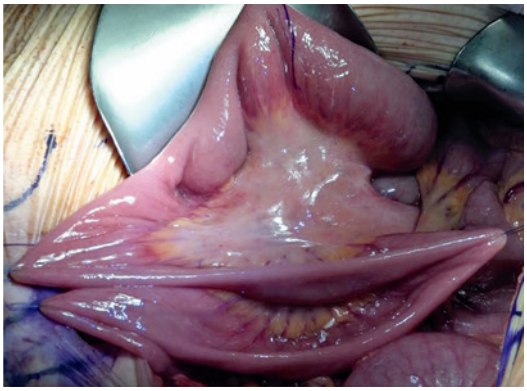
F – Skin reconstruction and appearance of the penis at the end of surgery

G – Appearance of the penis 3 months after surgery

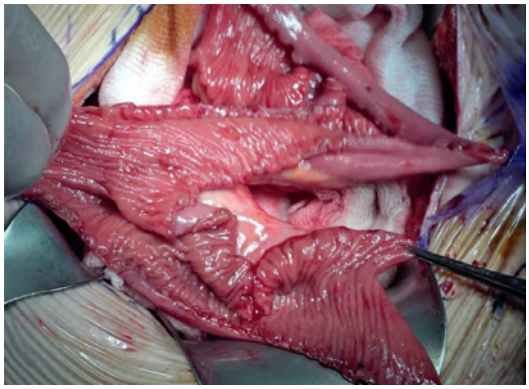
Fig. 2. Stages of phalloplasty

Six months later, the next stage of surgical treatment was performed, consisting of creation of a heterotopic continent neobladder. The procedure began with laparotomy, mobilization of the ureters and their disconnection from the sigmoid colon, followed by mobilization of an ileal segment (Fig. 3A). The isolated segment was then detubularized (Fig. 3B). A neobladder was created, and the ureters were implanted into it (Fig. 3C). The appendix was subsequently mobilized. Its proximal end was implanted into the neobladder (Fig. 3D), while the distal end was brought to the skin to create a Mitrofanoff appendicostomy. Both the early and long-term postoperative periods were uneventful.

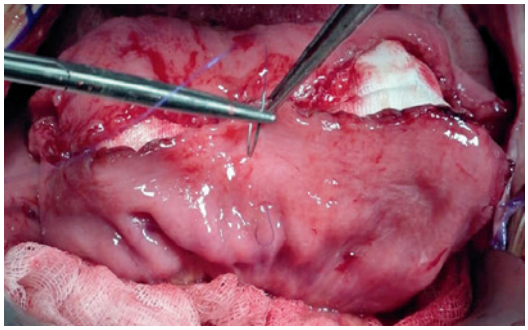
Results. Early treatment outcomes in both groups were considered favorable because no complications occurred. Long-term outcomes were assessed at 3 and 6 months and at 1 and 3 years. In Group I patients with hypospadias, assessment included penile appearance, the presence of pronounced postoperative scars, complications, and uroflowmetry findings. No complications were observed in any patient. All patients had a physiologic penile



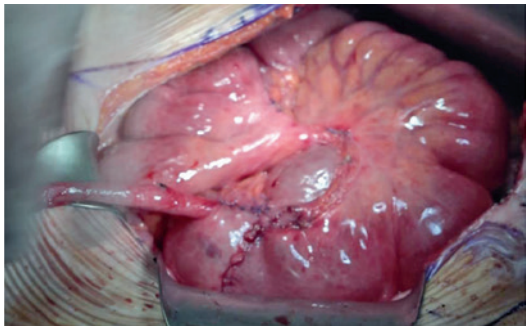
A – Mobilization of an ileal segment



B – Detubularized ileal segment



C – Creation of a spherical neobladder



D – Implantation of the appendix into the neobladder

Fig. 3. Stages of neobladder creation

appearance without pronounced skin scarring. All patients voided without difficulty and had no post-void residual urine, with maximum urinary flow rates ranging from 12 to 16 mL/s.

In Group II patients with bladder exstrophy, outcomes were assessed using ultrasonography of the kidneys and neobladder, biochemical blood tests, urinalysis, and reservoirometry. None of the patients had urinary leakage through the stoma. Neobladder capacity ranged from 420 to 530 mL. Urine was evacuated by intermittent catheterization through the catheterizable stoma 4–5 times daily. No abnormalities were detected in biochemical blood tests. Urinalysis showed mucus and leukocyturia ranging from 30 to 60 leukocytes per field of view.

Discussion. Children with hypospadias and bladder exstrophy who undergo surgical treatment require not only continued follow-up in adulthood but, in many cases, further surgical treatment. According to numerous authors, early outcomes of hypospadias repair demonstrate successful treatment in approximately 90% of cases [1, 2, 5, 7, 8]. However, outcomes may deteriorate over long-term follow-up. In a study by Prat et al. covering the period from 1978 to 2009, 4.6% of 820 patients developed complications during adolescence [1]. In another study involving 5,000 patients, 9% required repeat surgery for complications of hypospadias [2]. Adults who underwent hypospadias repair in childhood may develop complications over time, including urethral stenosis, spraying of the urinary stream, and psychological problems related to a non-physiologic penile appearance [7]. Up to 12% of patients undergo repeat surgical interventions, including repair of penile fistulas, treatment of urethral stenosis, reduction urethroplasty for urethral diverticula, and removal of urethral calculi [8].

Gamidov, Pushkar et al. reported their experience in treating 122 men who had undergone multiple operations for hypospadias during childhood. Urethral stricture was present in 83 patients (74.1%), urethral obliteration in 29 (25.9%), urethral diverticulum in 28 (25%), and urethral fistula in 24 (21.4%). Urethral calculi were detected in 14 patients (12.5%). All patients with urethral calculi had previously undergone repeated lithotripsy or urethrotomy due to stones. Urethral hair was identified in 31 patients (27.6%), who underwent periodic endoscopic hair removal [9].

In patients with bladder exstrophy who undergo augmentation cystoplasty, the risk of multifocal adenocarcinoma may increase to 7.8% [10]. A study by Rubenwolf demonstrated that 49% of men with bladder exstrophy had dorsal penile curvature, 36% had reduced penile sensitivity, and only 30% were satisfied with the appearance of the penis [11]. In a large study of 1,512 patients with bladder exstrophy who underwent bladder augmentation between 2003 and 2023, bladder stones were diagnosed in more than 50% of patients. The mean time to stone formation was 4.4 years after augmentation cystoplasty [3].

Patients undergoing bladder augmentation for exstrophy also have an increased risk of adenocarcinoma. Husmann and Rathbun reported multifocal adenocarcinoma in 7.8% of patients [10]. The clinical case presented above demonstrates the need for reconstructive surgery in an adult patient with bladder exstrophy who had undergone multiple operations during childhood. Many years later, the patient developed recurrent pyelonephritis

and proctosigmoiditis after ureterosigmoidostomy. Continuous exposure of the intestinal mucosa to urine resulted in inflammatory changes.

To achieve social rehabilitation, the patient underwent continent intestinal urinary diversion with creation of a neobladder and catheterizable Mitrofanoff stoma. The need for phalloplasty in a patient previously operated on for epispadias should also be emphasized. The Perovic phalloplasty technique includes mobilization of the corpora cavernosa and neurovascular bundles, followed by medial rotation of the corpora cavernosa. This technique allows correction of dorsal penile curvature. Skin reconstruction was also performed, resulting in an almost physiologic penile appearance and restoration of the ability to engage in sexual intercourse.

Staged surgical treatment performed jointly by pediatric and adult urologists in an adult urological hospital enabled successful social rehabilitation of a patient with bladder exstrophy who had undergone multiple surgical procedures during childhood. The need to establish mechanisms for transitioning children and adolescents into adult healthcare has long been recognized. An entire chapter of Campbell-Walsh Urology is devoted to this issue [5]. In 2003, Rosen defined healthcare transition as the "purposeful, planned movement of adolescents and young adults with chronic physical and medical conditions from child-centered to adult-oriented healthcare systems" [12]. According to Cooley W.C., there are six core elements of healthcare transition (*Table*) [4].

1. Transition to the adult healthcare system may be complicated by reaching adulthood while still receiving care at a pediatric center without an established pathway for transfer to adult services;
2. a young person reaching the age of 18 years and deciding that they no longer wish to engage in their own healthcare;
3. changes in life circumstances, such as finishing school, entering university, or moving to another place of residence [13].

Four potential models of transition to adult healthcare have been described in the literature.

1. A pediatric urologist working within a combined pediatric and adult urology department. This model has two potential advantages. First, the pediatric urologist provides complete continuity of care, with no transfer between departments or physicians. This helps avoid transition-related stress for patients and their parents. Second, it allows the pediatric urologist to follow their own surgical outcomes throughout their career, providing direct feedback, although with a potential risk of subjectivity. The pediatric urologist must have sufficient expertise in adult reconstructive surgery as well as in the management of urolithiasis, endourology, andrology, and oncology. This model also allows adult urologists to become familiar with pediatric aspects of care and vice versa. A single location facilitates joint consultations and surgical procedures [14].
2. Interaction between the pediatric urologist and an adult urology department. This model provides continuity of care and allows the pediatric urologist to work jointly with adult urologists and communicate relevant information regarding the patient when required.
3. Transition from a pediatric urologist to an adolescent/adult specialist with a particular interest in the specific condition. This requires the availability of a local, interested, and appropriately trained adult urologist. It is essential that this physician have experience in managing complex pediatric urological conditions and adult urinary tract reconstruction [15].
4. Direct transfer from a pediatric urologist to an adult urologist [16].

At present, transition to adult care often means that the adolescent patient or their parents must independently identify an adult urology department or team, or the patient presents urgently to an adult clinic only after complications develop. An adolescent urologist managing patients with congenital anomalies should therefore establish a multidisciplinary team around these patients. The principal urological conditions requiring prolonged follow-up and a structured transition to adult care include proximal hypospadias, bladder exstrophy, cloacal anomalies, bladder valve syndrome, and disorders of sex development. Even after successful staged surgical treatment, long-term follow-up remains necessary in adulthood, and further surgical correction is often required [12].

The Russian Federation is developing its own model of continuity between pediatric and adult urologists. At the initiative of Academician P.V. Glybochko, Chairman of the Russian Society of Urology (RSU), the Association of Pediatric Urologists-Andrologists was established and incorporated into the RSU. Continuity in the exchange of clinical experience and scientific developments has been promoted through joint conferences involving pediatric and adult urologists.

At the initiative and with the active participation of Professor M.A. Gazimiev, Executive Director of the RSU, the first conference specifically devoted to continuity of care was held jointly by the Association of Pediatric Urologists-Andrologists and the RSU on March 15, 2024, followed by a second conference on March 14,

Table

Six core elements of healthcare transition

Element	Description
Transition policy	A written policy that can be shared with parents, patients, and staff
Patient registry	A system for registering and tracking young people during the transition period
Transition readiness	A process for assessing readiness for self-management and adult care
Transition planning	A written plan including necessary actions, a medical summary, contact information, and an emergency care plan
Transfer to an adult urologist	Implementation of the adult care model and transfer to an adult urologist
Transfer completion	Completion of the transition process and assessment of outcomes

2025. Leading pediatric and adult urologists participated and discussed differing approaches and experience in the treatment of children and adults with urological diseases. With regard to direct continuity in patient care, pediatric urologists from the Department of Pediatric Surgery and Urology-Andrology at Sechenov University are invited to participate in the treatment of adult patients at the Institute for Urology and Reproductive Health, as demonstrated by the clinical case presented above.

Conclusion. The growing recognition of the need for an uninterrupted continuum of care for patients with urological diseases from childhood into adulthood highlights the importance of this issue for healthcare systems and, above all, for patients. Any reconstructive procedure, particularly one performed in childhood, requires prolonged subsequent follow-up, often throughout the patient's lifetime. Favorable long-term outcomes and good quality of life can be achieved only when continuity of care and treatment are properly organized. The proposed transition models may be implemented in different regions of the Russian Federation.

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LITERATURE REVIEWS

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN UROLOGY: THE HEALTHCARE STRUCTURE OF THE FUTURE

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Introduction. Artificial intelligence (AI) is one of the most innovative and promising fields of modern technology, exerting a significant impact on various areas of medicine, including urology. AI is increasingly being used not only for the diagnosis of urological conditions, but also for their treatment and prognostic assessment. The literature search was performed in the electronic databases PubMed, Web of Science, Scopus, CyberLeninka, and eLibrary. The inclusion criteria were original studies on the application of AI methods in urology and literature reviews on the topic. The exclusion criteria were preliminary studies and conference abstracts. The broad potential of AI methods in various fields of urology has been demonstrated. Machine learning and deep learning algorithms show high accuracy in diagnosing urological diseases based on laboratory and imaging data. AI models can assist surgeons in operative planning and intraoperative navigation. AI has also shown potential in predicting recurrences and complications based on the analysis of clinical data. Successful examples of AI implementation have been reported in urooncology, nephrology, and andrology. Future directions for improving AI models and integrating them into clinical practice are discussed.
Conclusion. Artificial intelligence demonstrates high efficacy across various fields of urology from image analysis to surgical navigation. However, its implementation requires addressing issues of ethics and system validation. With the proper approach, the integration of AI and physicians' expertise can significantly improve disease diagnosis and patient treatment. Further research in this area is promising and may lead to breakthroughs in urological practice.

K e y w o r d s: *artificial intelligence; deep learning; machine learning; urology*

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Introduction. Artificial intelligence (AI) is one of the most innovative and promising areas of modern technology and has a significant impact on various fields of medicine, including urology. AI is increasingly being used not only for the diagnosis of urological conditions [1–5], but also for their treatment [6] and prognostic assessment [7, 8]. Artificial intelligence encompasses various methods and techniques that enable computer systems to learn, analyze information, draw conclusions, and make decisions. One of the key concepts in AI is machine learning, which implies that a system can learn independently through interaction with the environment and receive feedback on the correctness of its actions.

Machine learning is a key component of AI and includes methods and algorithms that enable computer systems to learn from data and experience. Various approaches are used within machine learning, including observation, in which the system studies data; statistical analysis, in which the system identifies patterns in the data; and optimization methods, which enable the system to find the best solutions [9]. Particular attention in medicine is paid to deep learning, a subfield of machine learning that uses neural networks with multiple layers to process and analyze data. Deep learning is capable of recognizing complex patterns and features in data and identifying key characteristics, making it particularly effective for classification, image segmentation, and prediction tasks [10–12].

The role of artificial intelligence in urology and its potential impact on the future structure of healthcare are discussed in the review. Recent advances in the application of AI in urology are reviewed, together with its potential to improve the diagnosis, treatment, and prediction of genitourinary diseases.

The literature search was performed in the PubMed, Web of Science, Scopus, CyberLeninka, and eLibrary electronic databases using combinations of the following keywords: "artificial intelligence," "machine learning," "deep learning," and "urology." Articles published in English and Russian over the past five years were selected.

In addition, the reference lists of the identified articles were searched manually. The inclusion criteria were original studies on the application of AI methods in urology and literature reviews on the topic. Preliminary studies and conference abstracts were excluded.

AI is playing an increasingly important role in urology, providing new opportunities for diagnosis, treatment, and prediction. A recent PubMed search performed by Alexa et al. [13] using the keywords "prostate cancer," "artificial intelligence," and "machine learning" showed that the number of publications in this field had doubled over the past several years, from 24,624 publications in 2018 to 52,987 in 2021. This convincingly demonstrates the considerable potential of AI and, consequently, the opportunities for improving the effectiveness of diagnosis and treatment.

Using machine learning and deep learning methods, AI enables large volumes of data to be analyzed and processed with high accuracy and speed, opening new prospects for urological practice [14].

One of the key areas of AI application in urology is the diagnosis of urological diseases. Machine learning and deep learning algorithms can analyze patients' medical data and assist physicians in detecting and classifying various urological conditions. Several studies have demonstrated the potential of deep learning for diagnosing bladder cancer based on the analysis of cytological specimens [15–17].

AI also enables effective analysis of medical images, which is of considerable importance for the diagnosis and assessment of urological diseases. Deep learning algorithms and neural networks allow automatic processing and interpretation of images obtained using different modalities [18], including computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography [19, 20]. Recently, Yoo et al. [21] presented an advanced AI platform capable of predicting bladder tumor grade based on tumor color using the red/green/blue (RGB) method. Its diagnostic performance was ⩾98% for distinguishing benign tumors from low- and high-grade tumors and >90% for diagnosing chronic nonspecific inflammation.

Robotic surgery is becoming an increasingly widely used approach in urological surgery. The application of AI in this field may improve the accuracy and efficiency of surgical procedures. One of the main areas in which AI makes a substantial contribution is assistance with navigation and planning of robotic procedures. AI algorithms can analyze medical images obtained during surgery and assist surgeons in determining optimal actions, while providing real-time information on the position of instruments and anatomical structures. This may reduce the risk of complications and improve the precision of surgical interventions [22–24]. Ikeda et al. [25] presented a convolutional neural network (CNN)-based support system for accurate diagnosis of bladder cancer using 2,102 cystoscopic images. The developed model distinguished normal tissue images from tumor lesions with high accuracy, with a sensitivity of 89.7% and specificity of 94%.

The use of AI in urology also opens new opportunities for predicting treatment outcomes. Machine learning algorithms can analyze patients' medical data, including clinical characteristics, medical history, and response to treatment, to predict the probability of success of a particular treatment modality or the risk of recurrence. This may help physicians make more informed decisions and develop individualized treatment plans. Several studies have demonstrated the potential of deep learning for assessing kidney stone composition based on imaging characteristics, thereby supporting urologists in clinical decision-making and improving the effectiveness of diagnosis and treatment [26]. The agreement achieved by the algorithms was 95.2% (95% CI 94.9–95.5%) [27]. Längkvist et al. [28] developed a CNN model for detecting ureteral stones on high-resolution computed tomography. The model classified stones with a specificity of 100%, while the false-positive result was only 2.68.

In study [29], postoperative cystography findings were used to predict recovery from post-prostatectomy urinary incontinence in patients with localized prostate cancer using a deep learning model. Another example of AI use was the prediction of unplanned hospitalization among patients treated in urological clinics [30]. Wong et al. [31] used the clinicopathological characteristics of individual patients to develop machine learning algorithms capable of predicting biochemical recurrence after prostatectomy. Hung et al. [33] developed and tested AI algorithms to predict hospital length of stay and recovery of urinary continence after robot-assisted radical prostatectomy. The algorithms achieved an accuracy of 87.2% in predicting hospital stay and a C-index of 0.6 in predicting urinary continence.

Statistics indicate that approximately 70 million women in couples worldwide are unable to conceive, with male infertility considered responsible for 50% of these cases. Male reproductive problems may be caused by various factors, including genetic mutations, lifestyle, and disease. Given these factors, many investigators have combined predictive analytics with AI methods to demonstrate how AI can assist in reproductive urology. In studies [34, 35], AI networks and algorithmic models were used to predict semen quality while accounting for variables such as lifestyle and environmental factors. Both studies demonstrated high accuracy: the first reported an accuracy of approximately 86% for sperm concentration and 73–76% for motility, whereas the second reported an accuracy of approximately 90% for sperm concentration.

Another area of AI application is the selection of effective medications. Cai et al. [36] developed a model to guide antimicrobial selection for the empirical treatment of uncomplicated cystitis in routine urological practice and to predict recurrence of urinary tract infection (UTI). Compared with traditional linear statistical approaches, the model provided a substantial advantage in terms of decision-making and predictive accuracy while adhering to the principles of antimicrobial stewardship in the treatment of UTIs in adult women.

The use of AI in patient education has also been demonstrated. A chatbot was developed to provide information on prostate diseases, diagnostic tests for detecting prostate cancer (PCa), disease stages, and treatment options. Overall, 89% of chatbot users participating in the study reported a marked or moderate increase in their knowledge of PCa after using the chatbot. All participants who tested the chatbot stated that they would be willing to use a medical chatbot again in the future and supported the use of chatbots in clinical practice [37].

Russian publications on the use of AI in urology are currently limited to literature reviews of international studies [38–40].

Prospects for the development of AI in urology

With the continuous development of machine learning and deep learning algorithms, more accurate and reliable AI models are expected to emerge in urology. Improvements in data quality, optimization of neural network architectures, and integration with other signal- and image-processing methods will help achieve high diagnostic accuracy and improve prediction of treatment outcomes. The use of AI will allow more accurate identification of risk factors, prediction of individual treatment response, and development of personalized therapeutic approaches. AI-based analysis of multiple types of data, including genetic, clinical, and environmental data, may provide a deeper understanding of the nature of urological diseases and help optimize treatment strategies.

The development of AI-assisted robotic surgery may improve the precision and effectiveness of surgical procedures [41]. Expanded use of technologies such as augmented reality and neuronavigation in combination with AI may enable physicians to plan and perform surgery more accurately, improving outcomes and shortening patient recovery time. Artificial intelligence may also play an important role in the development of telemedicine and remote patient monitoring [42]. AI algorithms can analyze data obtained from sensors and medical devices to monitor a patient's condition, warn of potential complications, and provide real-time recommendations.

Telemedicine enables remote consultation and diagnosis using communication technologies. The use of AI in telemedicine allows automatic analysis of patient data, such as blood pressure, pulse rate, blood glucose level, and other parameters. AI algorithms can detect abnormalities, warn of possible complications, and provide recommendations for further treatment. This is particularly useful for patients living in remote or difficult-to-access areas, as well as for those requiring continuous health monitoring.

One example of AI use in remote monitoring is the development of a surveillance system for patients with chronic urinary tract disorders. AI algorithms can analyze data on urination, urinary frequency, and other parameters to detect changes and provide warnings of potential problems such as infection or obstruction. This may help patients receive timely treatment and prevent complications.

An important area in the development of AI in urology is the ability to train models on small datasets [43]. This may help overcome limitations associated with the availability of large datasets, particularly in rare or complex diseases. The development of methods suitable for small datasets, such as meta-learning and transfer learning, may facilitate the creation of more applicable and accurate models for urological practice.

The prospects for AI in urology require not only technological development but also successful implementation within the healthcare system. This includes training healthcare professionals to work with AI [44, 45], developing standards and regulations, and addressing ethical and social issues. Successful implementation of AI may improve treatment efficiency and outcomes, increase access to healthcare, and reduce costs.

Full realization of the potential of AI in urology requires active collaboration between researchers, engineers, and clinicians. Such collaboration will facilitate the development of technologies that meet the needs of clinical practice and ensure the translation of AI from the laboratory into real-world healthcare. The development and application of AI in urology promise substantial benefits for patients and healthcare systems. However, further research, development, and implementation are required, with due consideration of ethical, regulatory, and social aspects. AI is expected to continue evolving, creating new opportunities for the prevention, diagnosis, and treatment of urological diseases and for improving patient health.

The examples presented in this review represent only some of the many applications of AI in urology. AI continues to evolve, and new studies and technologies emerge every year, expanding the possibilities for its effective use in urological practice.

Although the use of AI may be challenging, the results and accuracy achieved when it is used appropriately may exceed those obtained with conventional statistical models. AI may also help simplify procedures that are currently performed manually and thereby reduce variability in outcomes related to human capabilities, bias, and methodological errors. Thus, AI-based models can provide clinicians with early, reliable, and personalized information that may support clinical decision-making. However, despite all the advantages and potential applications of AI in urology, several challenges and limitations remain.

The use of AI in medicine, including urology, raises ethical and data privacy concerns. The collection, storage, and analysis of large volumes of medical data may create risks to patient confidentiality. Data protection requirements must therefore be strictly observed, and the anonymity and security of information must be ensured. Four major ethical issues must be addressed to fully realize the potential of AI in healthcare: (1) informed consent for data use, (2) safety and transparency, (3) algorithmic fairness and bias, and (4) data privacy; all of these are important considerations [46]. The procedures used by AI may be sufficiently complex that they remain opaque to an untrained clinical user, while still being readily understandable to a specialist in the field [47]. Artificial intelligence can be a powerful tool, but it should not completely replace the physician or surgeon. In many cases, particularly when dealing with complex diagnoses or treatment decisions, human involvement and expertise remain essential. Physicians should remain active participants in decision-making, relying on their clinical experience and the individual characteristics of each patient [48, 49].

The quality and accuracy of AI depend substantially on the training data and models on which it is based. Insufficient or unbalanced data may lead to biased results or inaccurate predictions. Therefore, high-quality and diverse training datasets must be ensured, together with systematic validation and updating of AI models. Some algorithms or models may have limited applicability, particularly in rare or complex disease settings. It is not always clear how AI arrives at a particular decision or on

what basis it generates its conclusions, which complicates interpretation and may reduce trust among healthcare professionals and patients. In addition, successful AI application requires high-quality and up-to-date information, which may be limited in some situations, particularly when old or insufficiently representative data are used. It should also be recognized that the development and implementation of AI systems require substantial financial and time resources [50].

Overall, despite these challenges and limitations, the use of AI in urology offers substantial potential to improve the diagnosis, treatment, and management of urological diseases. As research and technology continue to evolve, further improvements in effectiveness and expansion of AI applications in urological practice can be expected.

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SYSTEMATIC REVIEW

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COMPARATIVE EFFECTIVENESS OF TREATMENT METHODS FOR FEMALE URETHRAL STRICTURE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Objective. To identify the main surgical treatment methods for female urethral strictures and evaluate their efficacy and safety.

Materials and Methods. A systematic literature review was conducted in accordance with PRISMA guidelines using databases such as PubMed, Embase, and others. The review included studies comparing ⩾2 surgical treatments for female urethral strictures. Eligible studies comprised randomized controlled trials (RCTs), prospective and retrospective cohort observational studies (OS), and case series with ⩾10 patients. Inclusion criteria were: confirmed female urethral stricture, comparison of at least two surgical approaches, and available data on primary outcomes (urethral patency or absence of recurrence) as well as secondary outcomes (recurrence, complications, functional outcomes, patient satisfaction, and quality of life). The quality of evidence was assessed using the GRADE system. A meta-analysis was performed with pooled success rates and heterogeneity analysis (I^2).

Results. A total of 37 studies (including 1 RCT and 36 observational studies) involving 1,279 patients were included. The main surgical interventions were simple dilation, internal optical urethrotomy (IOU), and various urethroplasty techniques. Due to the frequent sequential or combined use of dilation and IOU within single studies, they were grouped under «dilation-based methods» (DM). Urethroplasty approaches included buccal mucosa graft (BMG) urethroplasty, vaginal or labial flaps (e.g., labia minora flap [LMF]), and various graft combinations. In the meta-analysis, urethroplasty demonstrated significantly higher pooled success rates (PSR) or absence of recurrence – 92% (95% CI: 89–95%) with mean follow-up >2 years – compared to dilation (47%; 95% CI: 39–55%). BMG urethroplasty achieved cure rates of 88–95% over 2–3 years of follow-up, with comparable outcomes for vaginal flaps (VF) and LMF (78–94%). Differences between urethroplasty techniques were minor. Combined techniques (e.g., BMG + VF for long strictures) also yielded good patency rates, though data were limited. Urethroplasty significantly improved urodynamic outcomes: mean maximum urinary flow rate (Qmax) increased from 6–8 mL/s to 20–25 mL/s, and lower urinary tract symptom scores (e.g., AUA-SS) decreased from 22 to 6 points. Quality of life also improved significantly. In contrast, dilation-based methods offered only temporary symptom relief, with over 50% of patients experiencing stricture recurrence and requiring repeat interventions within the first year. Meta-analysis showed that the risk of stricture recurrence (RS) after dilation was significantly higher than after urethroplasty (risk ratio 3:1, $p<0.001$). The overall complication rates were low across all groups. The most common complication after urethroplasty was transient stress urinary incontinence (5–15%), typically resolving within ⩽6 months. Donor site morbidity for grafts and flaps was minimal. Comparative analysis revealed no significant differences in complication rates between various urethroplasty techniques.

Conclusions.This systematic review indicates that two primary surgical strategies exist for treating female urethral strictures: dilation-based methods and reconstructive urethroplasty. Both approaches are safe, but only urethroplasty consistently demonstrated high efficacy regardless of the specific technique or tissue used. Further prospective randomized trials are urgently needed to provide more robust evidence on the effectiveness of surgical treatments and long-term outcomes, including direct comparisons between urethroplasty techniques and their impact on urinary function and overall quality of life in women.

K e y w o r d s: *female urethral stricture, female urethral stenosis, female urethral dilation, female urethroplasty, buccal graft, vaginal flap, labia minora flap, female urethral reconstruction, recurrence of urethral stricture, systematic review, meta-analysis*

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Introduction. Female urethral stricture is a rare condition that can nevertheless have a significant impact on quality of life. According to various estimates, true bladder outlet obstruction caused by fibrotic narrowing of the urethra accounts for only 0.1–1% of women presenting with obstructive symptoms [1]. The etiology of female urethral strictures is diverse, with the most common causes including iatrogenic injury, trauma, radiation exposure, and inflammatory diseases [2]. Clinically, strictures present with a weak urinary stream, a sensation of incomplete bladder emptying, straining during urination, and recurrent urinary tract infection. Because of the rarity of the condition and the nonspecific nature of its symptoms, diagnosis is often delayed [3]. Urethrography, uroflowmetry with measurement of post-void residual urine, and urethroscopy are standard methods for confirming the diagnosis and allow assessment of the location and length of the urethral narrowing.

Traditionally, urethral dilation (bougienage), as well as direct vision internal urethrotomy (DVIU), have long been considered the main treatment options for female urethral stricture [1]. These minimally invasive procedures may temporarily restore urethral patency; however, their long-term effectiveness is questionable. In most women with a true fibrotic stricture, recurrence develops after a single dilation and requires repeat procedures [4]. Frequent recurrences lead to a cycle of repeated bougienage, with the associated risk of chronic urethral trauma and deterioration in quality of life.

Over the past two decades, interest in female urethroplasty has increased [5]. Various surgical techniques have been developed, some adapted from experience with male urethral stricture surgery and urethrovaginal fistula repair. The principal approaches include the use of vaginal flaps (VF) or labia minora flaps (LMF) to augment the narrowed urethral segment through either a ventral or dorsal approach, as well as urethroplasty using a buccal mucosal graft (BMG), and less commonly a vaginal mucosal graft (VMG) or labia minora skin graft (LMSG) [6]. A combination of a VF and BMG may also be used. However, because female urethral strictures are uncommon, comparative data regarding the optimal technique remain limited. The literature is dominated by small retrospective series, while direct randomized studies are virtually absent.

Aim. To identify the principal surgical methods used to treat female urethral strictures and to evaluate their efficacy and safety. Particular attention was paid to comparison of dilation techniques and urethroplasty as fundamentally different treatment approaches, as well as to comparison of different urethroplasty techniques using BMG, VMG, LMSG, VF, LMF, and their combinations. We summarized data on primary outcomes, including treatment success and recurrence rates, and secondary outcomes, including functional voiding parameters, complications, patient satisfaction, and quality of life, and assessed the quality of the available evidence using the GRADE framework.

Materials and methods. This study was carried out in accordance with the PRISMA standards for systematic reviews and meta-analyses. A protocol was developed specifying the search strategy, inclusion and exclusion criteria, and methods of analysis. A literature search was performed in PubMed/MEDLINE, Embase, the Cochrane Library, and Web of Science, including abstracts, for the entire available period through March 2025. Combinations of the following English-language keywords were used: female urethral stricture, female urethral stenosis, female urethral dilation, female urethroplasty, buccal graft, vaginal flap, labia minora flap, and female urethral reconstruction. In addition, the reference lists of the identified articles were manually screened to identify additional relevant studies.

Inclusion criteria.

1) Population: women aged ⩾18 years with a diagnosis of urethral stricture based on clinical symptoms and objective confirmation of urethral narrowing.
2) If a study included both men and women, separate results for the female cohort were required. Study design: randomized controlled trials, nonrandomized prospective or retrospective cohort studies, and comparative case series; the minimum sample size was 10 women with urethral stricture.
3) Interventions: any treatment for urethral stricture, including minimally invasive techniques such as intermittent self-catheterization, dilation, bougienage, DVIU, as well as open or vaginal reconstructive proceduresю
4) Mandatory requirement: comparison of at least two different treatment methods, for example dilation versus urethroplasty within the same study or comparison of different urethroplasty techniquesю
5) Outcomes: studies were required to report clinical treatment outcomes, including primary success, defined as the absence of recurrent narrowing or need for repeat procedures, recurrence rates, complications, functional outcomes, satisfaction with surgery, and quality of life.
6) Publication language: English; studies published in other languages were also considered if sufficient information was available to extract and translate the relevant data into English or Russian.
7) Individual case reports and small series (<10 patients) were excluded, as were studies focused on other conditions, such as fistulas or diverticula, in which outcomes specifically related to urethral stricture were not reported separately.

Two independent reviewers screened titles and abstracts for eligibility. Potentially eligible articles underwent full-text review to determine inclusion. Disagreements were resolved through discussion with a third expert. At the identification stage, 512 original publications were retrieved; after removal of duplicates and screening, 54 articles underwent full-text assessment. Of these, 21 were excluded because they did not meet the eligibility criteria. The final qualitative analysis included 37 studies [3, 4–39].

For each included study, the following data were extracted: authors, year of publication, study design; sample size overall and by treatment subgroup; mean age

of the patients; stricture characteristics, including etiology, mean length and location, and the proportion of patients with previous treatment; details of the treatment methods compared, such as dorsal or ventral urethroplasty, type of flap or graft, and dilation regimen, whether scheduled or symptom-driven; definition of treatment success; duration of follow-up, including mean, median, and range; major outcomes, including the proportion of successful cases without recurrence at the end of follow-up, recurrence rates, type and incidence of complications, including Clavien–Dindo grade; functional parameters, including maximum urinary flow rate (Qmax), post-void residual urine volume, and questionnaire scores before and after treatment; and, where available, data on satisfaction with surgical treatment and quality of life. For randomized trials, the methods of randomization, blinding, and other methodological characteristics were additionally recorded.

Study quality was assessed independently by two reviewers. Randomized controlled trials (RCTs) were evaluated using the Cochrane RoB 2.0 tool, including assessment of randomization, blinding, completeness of data, and other domains. Nonrandomized studies were assessed using the Newcastle–Ottawa Scale (NOS), taking into account patient selection, group comparability, and completeness of outcome assessment. Overall, most included studies were retrospective series with the inherent risks of bias associated with this design, including patient selection and missing data.

Outcome data were grouped according to intervention category for qualitative comparative analysis. A quantitative meta-analysis of the principal outcomes was performed, primarily treatment success for the different methods. Because direct comparisons between all included treatment modalities were unavailable, the meta-analysis was performed by calculating pooled proportions of successful outcomes for each treatment group with 95% confidence intervals using the DerSimonian–Laird inverse-variance random-effects method. In addition, pooled relative risks (RRs) of successful outcomes were calculated for several pairs of methods represented in multiple independent studies. Between-study heterogeneity was assessed using the $\chi 2$ test and I2 statistic. I2 values >50% were interpreted as indicating substantial heterogeneity. Sensitivity analyses were performed to assess the robustness of the results, for example by excluding studies with extremely high or low effectiveness estimates.

The quality of the overall body of evidence was assessed using the GRADE approach for the following key comparisons:

a) urethroplasty versus dilation, with recurrence-free status and complications as outcomes;
b) comparison of different reconstructive techniques using BMG, VMG, LMSG, VF, LMF, and their combinations;
c) dorsal versus ventral approaches to urethroplasty;
d) need for additional interventions with different treatment methods.

Where sufficient data were available, risk of bias, inconsistency of results or heterogeneity, imprecision, and publication bias were assessed.

Results. The review included 37 studies published between 2005 and 2025, comprising a total of 1,279 women with urethral strictures. These included 1 RCT, by Heidari et al. (2014) [37], 1 systematic review [36], and 35 nonrandomized studies. Most were single-center observational series with relatively small sample sizes, with a median of 22 patients and a range of 10–117. Only 5 studies included >50 women. Mean patient age ranged from 45 to 65 years. Stricture length generally ranged from 0.5 to 2.5 cm, and the most common locations were the distal and middle thirds of the urethra. A substantial proportion of women had previously undergone unsuccessful dilation; in some series, >50–70% had undergone ⩾1 bougienage procedure. Definitions of a "successful" outcome varied somewhat between studies, but success was generally defined as the absence of a need for repeat intervention, satisfactory voiding, or resolution of symptoms. Mean follow-up was approximately 24 months, with a range from 6 months to ⩾5 years.

With regard to the treatment methods compared, 12 studies included groups treated exclusively with dilation techniques versus urethroplasty; 8 studies compared different urethroplasty techniques with one another, for example flap versus graft urethroplasty; and the remaining 17 studies primarily reported case series involving individual techniques. Only one RCT, by Heidari et al. (2014), compared scheduled dilation with "on-demand" dilation in 86 women [37]. The remaining studies compared the outcomes of endoscopic and open treatment [41]. Several comparative series were reported by experienced reconstructive centers [30, 31, 35].

Dilation techniques included bougienage or balloon dilation under anesthesia and DVIU and were often combined with subsequent maintenance self-catheterization. For example, in several studies all patients initially underwent dilation, after which subsequent management was compared between regular self-catheterization and repeat dilation according to symptoms [16, 37]. In other series, dilation served as the comparator for urethroplasty subsequently performed in the same patients.

Urethroplasty using a VF or LMF was most commonly performed through a ventral vaginal approach [39]. Some modifications involved a lateral vaginal flap according to Orandi [40]. Several studies also described the use of an LMF for substitution urethroplasty [9]. Urethroplasty using an oral mucosal autograft most commonly involved BMG, with both ventral and dorsal onlay techniques reported [9, 24]. VMG was less frequently described, and isolated studies reported the use of a lingual mucosal graft (LMG) [6].

In selected cases of long strictures, more than one flap or graft was used. In particular, a combination of BMG and VMG was used as a staged reconstruction to replace different segments of the urethra [25]. Few such studies were identified, and they were included to demonstrate less common variants of reconstructive surgery. A rare variant of minimally invasive management was continuous intermittent self-catheterization as a separate strategy for maintaining urethral patency after initial DVIU [23].

Dilation without subsequent reconstruction was the least effective approach in terms of long-term maintenance of urethral patency. The pooled success rate of dilation was only 47% (95% CI 39–55%) at a mean follow-up of 2 years. In other words, approximately half of women remained recurrence-free 2–3 years after a single dilation. The remainder developed recurrent stricture requiring

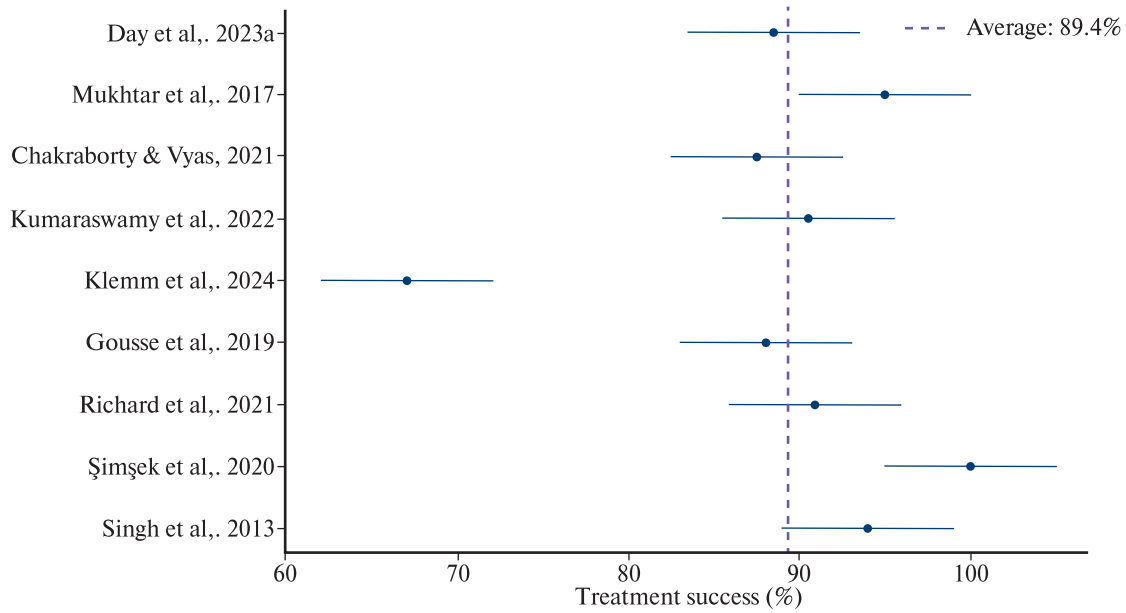

Fig. 1. Forest plot of the efficacy of different female urethroplasty techniques according to the included studies (proportion of patients without recurrence)

another intervention. For example, in the series by Blaivas et al. (2012), only 1 of 17 women (6%) maintained urethral patency after dilation, whereas the remaining 16 (94%) developed recurrence [35]. Similar results were reported by other authors. Osman et al. (2013) reported a long-term success rate of dilation of only 20–30% [36].

The only RCT, by Heidari et al. (2014), showed that with an "on-demand" regimen, i.e. repeat bougienage only after recurrence of symptoms, no recurrences occurred during 6 months of follow-up [37]. However, no recurrences were observed with routine dilation every 2 months either, and this follow-up period was too short to permit definitive conclusions. The authors only noted that symptoms and urinary flow improved after the first dilation in all patients, with Qmax increasing from 8.2 to 12.7 mL/s, and suggested that frequent "prophylactic" dilation was not justified in the absence of symptoms. Nevertheless, at 12 months, a substantial proportion of these patients would probably have developed recurrent stricture based on nonrandomized observations. DVIU demonstrated similar results to those of dilation, with the success rate after a single urethrotomy not exceeding 50%, and therefore being comparable with bougienage [42]. For this reason, we did not analyze DVIU and bougienage separately but combined them under the term "dilation techniques."

All variants of urethroplasty demonstrated substantially better outcomes. The pooled success rate of surgical reconstruction was 92% (95% CI 89–95%) over a follow-up period of 2–4 years. Almost all studies reported superiority of urethroplasty over dilation techniques. For example, in a multicenter study, Lane et al. (2021) showed that women treated with endoscopic procedures alone had a fourfold higher risk of recurrence than those who underwent urethroplasty (OR=4.3; $p<0.001$) [41].

For comparison, in the meta-analysis by Sarin et al. (2021), the proportions of women remaining free from recurrent stricture after different types of urethroplasty were 92% after flap procedures, 89% after BMG urethroplasty, and 87–89% after VMG and LMSG urethroplasty [42]. Our meta-analysis, presented in *Fig. 1,* confirmed that all types of urethroplasty have effectiveness rates of approximately 85–95%, whereas dilation techniques achieve successful treatment in fewer than 50% of cases. Statistically, the relative probability of a durable successful outcome after surgical treatment compared with dilation was 1.8–2.0, meaning that the probability of cure was almost twice as high.

There are no direct randomized comparisons between, for example, BMG and VF. However, several retrospective series have compared these approaches. Kowalik et al. (2014) followed 27 women, including 15 who underwent dorsal BMG urethroplasty and 12 who underwent VF urethroplasty, for a median of 18 months. Both techniques resulted in 100% primary success at 12 months; by 2 years, recurrence had occurred in 2 of 12 women (17%) in the VF group and 0 of 15 (0%) in the BMG group [30]. Given the small sample size, this difference was not statistically significant, although the trend suggested a possible long-term advantage of the buccal graft. Another study, by Hassan et al. (2022), compared 18 BMG cases and 8 VMG cases, with success rates of 88–90% in both groups. Functional outcomes, including increased Qmax and reduced symptoms, improved similarly [38]. Thus, the pooled data did not demonstrate a difference in effectiveness between BMG and VF. Each approach provides high effectiveness of approximately 85–95%, particularly when performed by experienced surgeons. The choice of reconstructive tissue may depend on surgeon preference and the clinical setting. Both approaches appear effective and justified.

Dorsal and ventral approaches to urethroplasty were also comparable. Ventral graft placement provides better vascularization but requires a vaginal approach, whereas dorsal placement through the meatus or a supraurethral approach is somewhat simpler and leaves the vagina intact, although concerns have been raised regarding insufficient graft vascularization [43]. In the analysis by

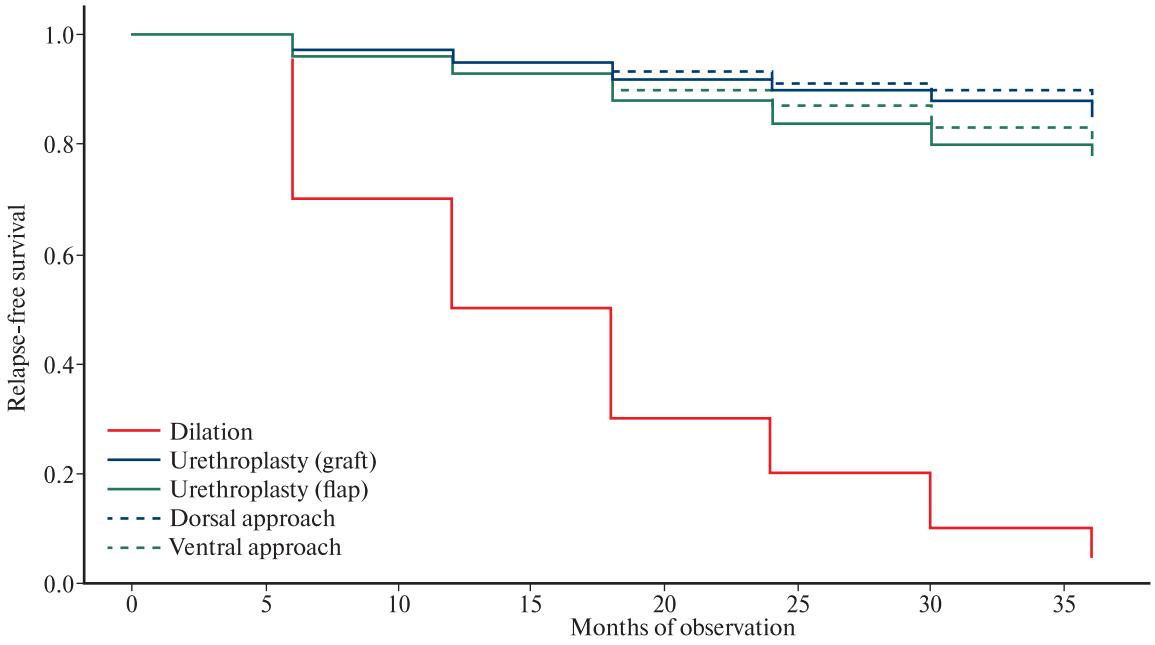

Fig. 2. Kaplan–Meier curves showing the proportion of patients without stricture recurrence during 35 months of follow-up in five treatment groups: urethral dilation, graft urethroplasty, flap urethroplasty, dorsal urethroplasty, and ventral urethroplasty

Sarin et al. (2021), the pooled effectiveness of dorsal versus ventral urethroplasty was 88% versus 95%, with no significant difference because of overlapping confidence intervals [42]. In the largest study, by Gaur et al. (2024), which included 73 patients, the results were virtually identical: effectiveness was 89% with both ventral BMG urethroplasty and the dorsal technique, 89.13% versus 88.89%, respectively (p=0.98) [39]. At the same time, the dorsal approach was associated with less surgical trauma, including shorter operative time and absence of a vaginal incision. Thus, both approaches appear equally effective, and selection depends on surgeon preference. Dorsal onlay BMG urethroplasty may be considered an equally reliable alternative to the ventral approach [39].

Isolated reports have described the simultaneous use of both flaps and grafts for reconstruction of long strictures. Although evidence is limited, these reports demonstrate that different tissues can be combined when necessary to reconstruct extensive urethral defects.

Kalra et al. (2006) reported a series of 18 women who were prescribed regular intermittent self-catheterization (ISC) after initial DVIU. At 16 months, 15 of 18 women (83%) had no clinically significant restenosis or voiding symptoms [23]. In this setting, treatment success may depend on adherence. In the reported series, 3 women discontinued ISC and developed recurrence. Thus, self-catheterization may be considered an option for patients who are unable or unwilling to undergo surgical treatment. However, this strategy requires a high degree of adherence and carries a risk of urinary tract infection.

Based on data from the 37 studies, we constructed curves demonstrating the proportion of women remaining free from recurrent stricture over time for each treatment group (*Fig. 2*). The curves clearly demonstrate the advantage of surgical reconstruction over dilation. The urethral dilation group showed the most rapid decline in recurrence-free survival, because most patients developed recurrence within the first 1–2 years. In contrast, after urethroplasty, whether using a graft or flap, a high proportion of women remained free from recurrent stricture even at longer follow-up.

Table 1 presents the median time to recurrence and the proportion of women remaining recurrence-free at 1, 3, and 5 years for each treatment group. The superiority of open reconstructive methods is evident. After urethroplasty, median recurrence-free survival exceeded 5 years, with more than half of patients remaining recurrence-free throughout the observation period, whereas after a single dilation the median was approximately 1 year.

At 1 year, 90–100% of patients remained recurrence-free after urethroplasty, substantially exceeding the 50% rate observed after dilation. Three- and five-year recurrence-free rates after various urethroplasty techniques remained ⩾80%, whereas after minimally invasive procedures they declined rapidly to <20% by 3 years and <10% by 5 years. Statistical comparison of the curves using the log-rank test showed that any form of urethroplasty provided significantly longer recurrence-free survival than dilation (p<0.001). Differences between urethroplasty techniques, including graft versus flap and dorsal versus ventral approaches, were not significant (p>0.05), reflecting the similarity of their long-term outcomes.

In virtually all studies, surgical reconstruction resulted in significant objective improvement in urodynamic parameters. After urethroplasty, Qmax increased more than twofold compared with baseline. Preoperative Qmax was generally 4–10 mL/s, whereas after urethroplasty it increased to 15–30 mL/s. All analyzed studies reporting this parameter demonstrated significant improvement in Qmax. The mean increase was approximately 15–20 mL/s. The improvement in urodynamics was sustained.

At 5 years after reconstruction, mean Qmax remained approximately 25 mL/s, which was comparable with early postoperative values. For example, Chakraborty and Vyas (2021) reported an increase in mean Qmax from 6.3 to 25.1 mL/s after dorsal VMG urethroplasty [28]. Similarly, Kumaraswamy et al. (2022) reported an increase in Qmax from 7.7±2.2 to 22.6±5 mL/s after BMG urethroplasty. Post-void residual urine volume also decreased substantially, often from 100–150 mL to physiological values <50 mL [13].

Subjective symptoms were assessed using different scales, including the American Urological Association Symptom Score (AUA-SS), a validated questionnaire for assessing the severity of lower urinary tract symptoms, and the International Prostate Symptom Score (IPSS), which is identical to the AUA-SS but includes an additional mandatory eighth quality-of-life question. Overall, relief of obstruction was associated with a 60–70% improvement in scores on both scales compared with baseline. In particular, Hassan et al. (2022) reported a decrease in mean AUA-SS from 22 to 6 after reconstruction [38], whereas Kalra et al. reported a decrease in IPSS from 24 to 4 [23]. Thus, urethroplasty results in significant and durable restoration of normal voiding.

Reconstructive procedures were generally well tolerated. The proportion of patients experiencing any complication was approximately 4–10%, with most complications classified as Clavien–Dindo grade I–II. Several series reported no postoperative complications at all. No life-threatening complications were reported in any study. The most commonly reported complication was transient stress urinary incontinence in the early postoperative period. However, it was temporary in almost all cases. For example, Mukhtar et al. (2017) reported that 1 of 22 patients (4.5%) developed mild de novo stress urinary incontinence, which resolved completely within 6 months [8]. Similar findings were reported by other authors: stress urinary incontinence occurred in 0–15% of patients, depending on the extent of urethral dissection and the need for meatal enlargement, and all cases resolved spontaneously within 6–12 months. To prevent persistent urinary incontinence, some surgeons combined urethroplasty with simultaneous placement of a suburethral sling in high-risk patients [35].

After BMG harvesting, prolonged paresthesia or numbness of a portion of the buccal mucosa was reported in 2–5% of patients. No nerve injury or salivary duct injury was reported. VF procedures may be associated with minor blood loss and vaginal discomfort. Scar-related narrowing of the vaginal introitus, dryness, or dyspareunia were extremely rare and were described in only a few studies. Urinary tract infections (UTIs) occurred in the early postoperative period in the presence of a urethral catheter. The incidence of postoperative cystitis was 10–20%. All UTIs resolved with antibiotic therapy and did not affect treatment outcomes. Large flap reconstructions were occasionally associated with urethral diverticulum or urethrovaginal fistula formation, although such events were extremely rare among the several dozen women undergoing surgery. Yuemin et al. (2013), for example, reported that one patient required correction of a small urethral diverticulum after flap urethroplasty [7]. Across all 37 studies, these complications occurred in <2% of patients. The dilation group also had a low incidence of postoperative complications. Rarely, urethral perforation or mucosal trauma during bougienage was reported, as well as chronic UTI secondary to repeated catheterization.

Many studies did not formally assess treatment satisfaction, but the absence of complaints and patterns of subsequent treatment suggest that most women with successful urethroplasty were satisfied with the outcome. Elliott et al. (2020) reported that all patients in their series rated the result as “much improved” on the Patient Global Impression of Improvement (PGI-I) scale [32]. Romero-Maroto et al. (2018) reported high satisfaction after lateral vaginal flap urethroplasty, with all women becoming catheter-free and returning to normal voiding [40].

Regarding quality of life (QoL), substantial improvement was observed after treatment. Lane et al. (2021) showed that after surgical treatment, the mean QoL score based on the Urogenital Distress Inventory-Short Form (UDI-6) improved from 4.2 to 1.3 ($p<0.01$) [41]. The review by Sarin et al. (2021) emphasized that successful elimination of the stricture results in a substantial improvement in quality of life, approaching that of healthy women [42]. Sexual outcomes were rarely evaluated. However, Blaivas et al. (2012) reported that sexual function was not impaired after vaginal flap harvesting, and patients resumed sexual activity without changes [35].

With regard to heterogeneity and quality of evidence, the meta-analysis demonstrated substantial variability between studies. Studies differed markedly in design, definition of treatment success, and duration of follow-up. Clearly, a 95% success rate at 6 months is not equivalent to a 95% success rate at 5 years, yet not all studies reported long-term outcomes.

Our meta-analysis of proportions showed substantial heterogeneity in the urethroplasty groups, with I2 values of 60–80%, reflecting differences in study populations and methodologies. We hypothesized that much of this variability was related to follow-up duration. With follow-up <1 year, most series report success rates approaching 100%, because recurrent strictures may not

Table

Pooled Kaplan–Meier estimates of recurrence-free outcomes for different treatment methods

Treatment group	Median recurrence-free time	1-year recurrence-free rate	3-year recurrence-free rate	5-year recurrence-free rate
Dilation techniques	12 months (very short)	50%	15%	<10%
Graft urethroplasty	>60 months (median not reached)	95%	90%	85%
Flap urethroplasty	>60 months (median not reached)	100%	88%	78%
Dorsal urethroplasty	>60 months (median not reached)	100%	95%	90%
Ventral urethroplasty	>60 months (median not reached)	100%	85%	80%

yet have developed, whereas with 3–5 years of follow-up, effectiveness generally decreases to approximately 80%. Indeed, long-term follow-up was not available in all studies. Blaivas et al. (2012), for example, reported >5 years of follow-up, with 78% of patients remaining recurrence-free [35]. Klemm et al. (2024) reported follow-up exceeding 66 months, with 67% remaining recurrence-free [17], somewhat lower than the average recurrence-free rate of approximately 90% during the more commonly reported 2-year follow-up. Thus, late recurrences may occur with longer follow-up, and long-term outcomes beyond 2 years require further evaluation. Nevertheless, even after accounting for this limitation, urethroplasty remains substantially more effective than dilation. Heterogeneity was also evident in the assessment of symptoms and QoL, because standardized questionnaires were not used in many studies, limiting the possibility of quantitative synthesis.

The methodological quality of the only RCT, by Heidari et al. (2014), was associated with a moderate risk of bias because of lack of blinding and short follow-up. Nonrandomized studies had an obvious risk of selection bias. For example, surgeons were more likely to refer patients with more severe recurrent disease for surgery, whereas less complex cases may have undergone dilation. This could potentially underestimate the apparent effect of surgical treatment. Despite this, the benefit of urethroplasty remained evident, suggesting a large treatment effect. According to the GRADE framework, we rated the evidence supporting urethroplasty over dilation techniques for treatment success as being of moderate quality, downgraded because of the absence of large RCTs but upgraded because of the consistency of findings and large effect size. Evidence comparing different urethroplasty techniques was of low quality, being based on small retrospective series with less than 30 participants and wide confidence intervals. Evidence regarding complications was also of low quality, because complications were not systematically recorded in all studies and minor adverse events may have been underestimated.

Overall, confidence in the estimates was moderate for the principal conclusion that surgical reconstruction is superior to dilation and low for differences between individual surgical techniques.

Discussion. This review summarizes the currently available evidence on treatment of female urethral strictures. We confirmed that surgical urethral reconstruction is substantially superior to all forms of dilation in terms of long-term effectiveness. This finding is consistent with experience in the treatment of male urethral strictures and with expert opinion that dilation may be used as an initial treatment option, including in patients at high surgical risk, but usually does not provide definitive cure. In the event of recurrence, urethroplasty should be considered.

We may also conclude that reconstructive techniques provide high cure rates of approximately 90% or higher. Notably, because the female urethra is short and surrounded by the sphincter complex, there is no direct equivalent in women of anastomotic urethroplasty as performed in men. Instead, flaps and grafts are used to augment the urethral lumen.

Vaginal flaps, including the Blandy technique and other variants, were the main reconstructive approach from the 1970s through the late 1990s and achieved success rates of approximately 80–90%. In the 2000s, techniques using buccal mucosa instead of a flap emerged, initially as isolated case reports [42] and by approximately 2010 as a standard approach in several centers.

Our analysis did not demonstrate a fundamental advantage of buccal mucosa over vaginal flaps; both were similarly effective. For example, the review by Osman et al. (2013) reported success rates of 94% for BMG and 91% for VF [36]. More recent data from Gaur et al. (2024) indicate that even the surgical approach, dorsal through the meatus or supraurethrally versus ventral through the vagina, did not influence the final outcome, with effectiveness of approximately 89% in both groups [39]. This provides surgeons with flexibility in selecting their preferred technique. Thus, ventral BMG urethroplasty allows avoidance of a vaginal approach, which may be important for sexually active women, without reducing the likelihood of success [39]. On the other hand, VF is an excellent alternative when BMG cannot be used. A combination of flaps and grafts may be the only feasible solution for long, previously treated strictures, although such cases are extremely uncommon.

The safety of reconstructive surgery was high. Unlike in men, urinary incontinence after female urethroplasty was rarely reported, possibly because of the short length of the reconstructed segment and preservation of the sphincter. Mild transient incontinence occurred but usually resolved spontaneously. Infections were readily treated with antibiotics. Thus, female urethroplasty has a favorable complication profile.

Quality of life in women with urethral strictures improves substantially after relief of obstruction. Before treatment, many patients experience difficulty urinating, a sensation of incomplete bladder emptying, persistent urgency, and recurrent infection, all of which may restrict social activity and contribute to depression. Restoration of normal urinary flow and resolution of symptoms allow patients to return to normal daily activities. It is therefore unsurprising that most women described in the available studies reported high satisfaction with surgery.

Our review combined data from heterogeneous studies and applied a meta-analytic approach to the treatment of female urethral strictures. A similar meta-analysis was previously performed by Sarin et al. (2021) [42]. Our findings confirm their results and add studies published between 2020 and 2025. In particular, we included data from the largest series, including SUFU 2020 [41] and Gaur 2024 [39], thereby strengthening the evidence base.

One practical recommendation arising from the meta-analysis is that urethroplasty should be considered for recurrence after dilation. Repeated dilation should be limited because it does not provide durable improvement and merely delays definitive treatment.

The specific urethroplasty technique should be individualized. For short distal strictures, simple urethrotomy or meatoplasty may provide good results [1], whereas for longer lesions, augmentation of the urethra using a flap or graft is preferable. Buccal mucosa is a versatile reconstructive material, particularly for strictures of the proximal and middle urethra. A vaginal flap is well suited to distal strictures and simultaneous correction of urethral hypermobility, and may be combined with a sling when indicated. A labia minora skin graft represents an alternative when BMG harvesting is not possible.

In experienced hands, all of these approaches achieve freedom from stricture in >90% of cases.

Patients in whom surgery is contraindicated or who decline surgical treatment for personal reasons should be offered a self-catheterization program after initial dilation. As demonstrated by Kalra et al., this approach may maintain satisfactory urethral patency over the long term in some patients [23]. Patients should be carefully instructed in self-catheterization technique and informed of the importance of adherence to the schedule and aseptic technique.

Long-term follow-up is required after any form of stricture treatment because recurrence may occur many years later. Annual clinical assessment, symptom evaluation, uroflowmetry, and urethroscopy when indicated are recommended.

Conclusion. Based on the present study, two principal approaches to the surgical treatment of female urethral strictures can currently be identified: dilation techniques and reconstructive procedures. The dilation group included intermittent catheterization, bougienage, and DVIU because, although these minimally invasive methods differ fundamentally from one another, they demonstrated similar long-term outcomes. Reconstructive procedures, by contrast, comprised a broad range of surgical techniques. All reconstructive techniques demonstrated similarly high effectiveness and a low risk of complications regardless of the specific method used. This allows the choice of surgical technique to be individualized according to stricture length and location, surgeon experience, and patient preference.

Given the limited quality of the available evidence, we consider the overall certainty of this meta-analysis to be low to moderate. Nevertheless, the overall body of evidence indicates that reconstructive surgery is superior to dilation for achieving durable urethral patency and improving patients' quality of life.

Further prospective randomized studies are urgently needed to provide more reliable estimates of surgical effectiveness and long-term outcomes, including direct comparisons between different urethroplasty techniques and assessment of their impact on genitourinary function and women's overall quality of life.

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