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FIRST EXPERIENCE WITH THE VISUS MG OPTICAL VIDEOENDOSCOPIC URETHRAL CATHETER FOR SAFE BLADDER DRAINAGE IN VARIOUS URETHRAL INJURIES

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Introduction. Despite the widespread use of bladder catheterization in both inpatient and outpatient practice, the procedure carries a risk of serious complications, including urethral trauma, strictures, and the development of false passages. According to published data, their incidence ranges from 10.2% to 17.7%. The most common causes of unsuccessful bladder catheterization are anatomical or pathological changes in the urethra, as well as insufficient experience of medical personnel. Repeated attempts at catheterization increase the risk of iatrogenic injuries. In military medicine and emergency care, the problem is aggravated by the high frequency of urethral trauma. Despite the availability of alternative imaging techniques (ultrasound, retrograde urethrography), the choice of the optimal drainage method remains unresolved, particularly in settings with limited access to advanced endoscopic equipment.

Aim. To evaluate the efficiency and safety of the Visus MG optical urethral catheter with a portable endoscopic system (PES) in various types of urethral injuries.

Materials and methods. A prospective study was conducted at the Institute of Urology and Reproductive Health, Sechenov University, and at the S.M. Kirov Military Medical Academy. Eighty-five patients were included (60 and 25 from each institution, respectively). The efficacy and safety of bladder catheterization using the Visus MG optical urethral catheter with PES were assessed after unsuccessful attempts at standard catheterization, and in some cases without prior standard attempts. Indications included acute urinary retention, urethral trauma (combat or iatrogenic), preoperative drainage, and approximation of urethral edges before urethroplasty. The optical catheter provided visual control of urethral passage and enabled successful drainage in the presence of anatomical obstructions.

Results. Patient age ranged from 20 to 86 years (mean: 59.8). The mean prostate volume among non-prostatectomy patients was 33.7 cc, most often between 20–39 cc (42.1%). Bladder catheterization was performed primarily in the operating room (43.5%) or in procedure rooms (37.6%), most commonly under local anesthesia (61.2%). A history of prior urological procedures was documented in 70% of patients. The use of the Visus MG optical urethral catheter with PES achieved successful bladder drainage in 96.5% of cases (82/85) without complications. The main causes of failed standard catheterization were strictures, urethral trauma, and other obstructive conditions.

Conclusion. The Visus MG optical urethral catheter with a PES enabled safe and effective bladder drainage in 96.5% of patients after failed standard bladder catheterization. The method is minimally invasive, provides direct visual control, and reduces the risk of false passages and urethral injury. It may serve as an alternative to cystoscopy in settings with limited access to full endoscopic equipment.

K e y w o r d s: *urethral trauma, stricture, false passage, bladder catheterization, optical urethral catheter, Visus MG, portable endoscopic system*

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Introduction. According to the World Health Organization (WHO), approximately 9 million inpatient surgical procedures and nearly 6 million outpatient interventions are performed annually in the Russian Federation (2021 data) [1]. In clinical practice, a substantial proportion of urinary bladder catheterizations are carried out in the operating room before surgical procedures, in intensive care units, emergency departments, and in outpatient settings. However, this intervention is far from being complication free [2].

Despite the apparent technical simplicity of bladder catheterization, the procedure is frequently associated



Figure 1. Visus MG optical urethral catheter

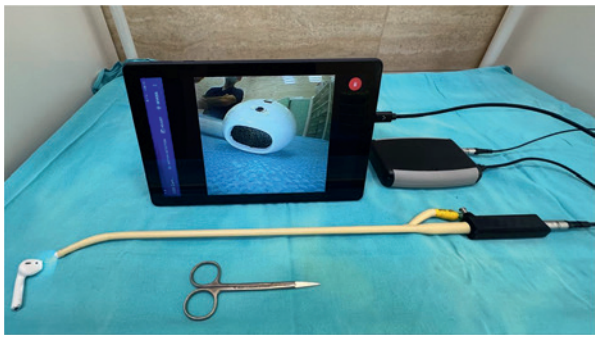


Figure 2. Visus MG optical urethral catheter with portable endoscopic system (PES)

with considerable difficulties, and in some cases technical failure leads to abandoning of the planned surgical intervention. Moreover, an aggressive approach aimed at advancing the catheter "at any cost" may provoke serious complications, including urethrorrhagia, formation of a false passage, delayed urethral stricture, and fistula development [3].

A review of international literature shows that the incidence of catheterization-related complications ranges from 10.2% to 17.7% [4, 5]. Factors contributing to unsuccessful catheterization include increased tone or spasm of the external urethral sphincter due to patient anxiety, inadequate local anesthesia, suboptimal catheter-insertion technique, or insufficient clinical experience of the physician. In addition, several objective anatomic, physiologic, and pathological conditions, such as urethral stricture, benign prostatic hyperplasia, bladder neck sclerosis, or the presence of a false passage, may significantly complicate or render catheterization impossible [6].

At present, traumatic injury to the urethra is the leading cause of urethral stricture. In peacetime, such injuries most commonly result from motor vehicle accidents and occupational trauma, and less frequently from domestic accidents. In military conflict settings, urethral injuries become more prevalent due to the extensive use of high-impact weaponry and heavy military equipment [7–10]. Studies report that complete urethral rupture is observed in 65% of cases, while partial inhury occurs in 35% [11].

Repeated attempts at catheterization after an initial failure greatly increase the risk of urethral trauma and subsequent complications [12, 13]. The literature describes several alternative techniques for repeat bladder drainage when standard catheterization is unsuccessful [14]. For example, Kameda et al. evaluated the efficiency of catheter insertion under transabdominal or transrectal ultrasound guidance [15]. In another study, Kim S.H. et al. proposed urethral catheter placement assisted by retrograde urethrography [16].

The relevance of this issue is underscored by the high frequency of complications associated with failed catheterization in men, as well as the absence of universally effective drainage techniques with a strong evidence base. Moreover, available studies in this field often yield conflicting results. Currently, most research focuses on endoscopic methods of guidance; however, the question of the most effective visualization modality in emergency settings, military field conditions, and other resource-limited environments remains unresolved.

Aim. To evaluate the efficacy and safety of the Visus MG optical urethral catheter used in combination with a portable endoscopic system (PES) in various types of urethral trauma.

Materials and methods. A prospective study was carried out at the Institute of Urology and Human Reproductive Health, Sechenov University, and at the S. M. Kirov Military Medical Academy. Eighty-five men were enrolled: 25 patients from the Military Medical Academy and 60 patients from Sechenov University.

The Visus MG optical urethral catheter was used in the study (*Fig. 1*). Its key feature is the presence of a terminal opening at the distal end. Introduction of a flexible optical cable with a guidewire through the catheter lumen allows catheterization to be performed under direct visual control. The portable endoscopic system (PES) includes a flexible camera with an optical module less than 2 mm in diameter and a unit that converts an analog signal into a digital one. Using a USB-OTG adapter, the device can be connected to a tablet, smartphone or any other compatible display (*Fig. 2*). The compact size of the PES makes it suitable for use in hospital wards, operating rooms, intensive care units and procedure rooms.

This prospective study evaluating the efficiency and safety of catheterization using the Visus MG optical urethral catheter with PES included patients admitted to Sechenov University and the Military Medical Academy who required bladder catheterization due to acute urinary retention, combat-related or iatrogenic urethral trauma, or electively before surgery. If the initial attempted catheterization (performed by a non-urologist) was unsuccessful, the next attempt was performed by a urologist. When the catheter could not be advanced into the bladder, the Visus MG optical catheter with PES was used.

In 10 patients at the Military Medical Academy, bladder catheterization using the Visus MG optical urethral catheter was performed without prior attempts at standard catheterization. The procedure was performed after retrograde urethrography, within the early period (up to 7 days) after injury. Standard catheterization attempts at earlier evacuation stages had been unsuccessful. Indications included alignment of urethral ends prior to future urethroplasty and improved bladder drainage.

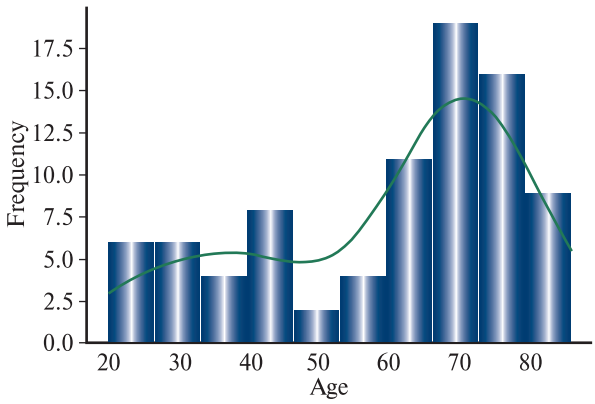


Figure 3. Distribution of patients by age

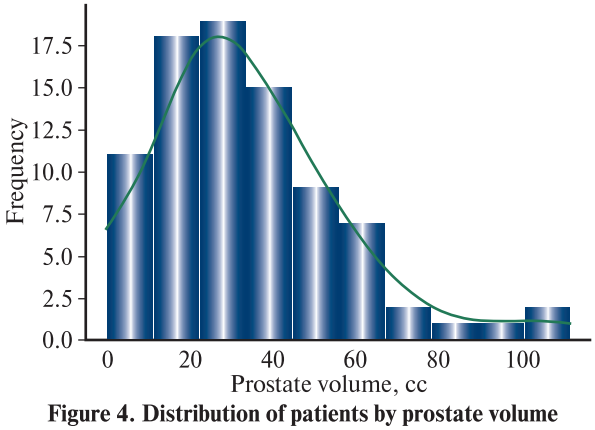


Figure 4. Distribution of patients by prostate volume

Technique. The instruments were assembled as follows: a sterile metal guidewire with connected irrigation was inserted into the main lumen of the Visus MG optical urethral catheter up to the terminal opening. The guidewire with catheter was then connected to the power unit attached to a tablet. After antiseptic preparation of the external genitalia with iodopyrone solution and instillation of lidocaine gel or another lubricant into the urethra, the Visus MG optical catheter with PES and irrigation was advanced. When an obstacle was encountered, it was gently navigated under direct visualization, allowing the catheter to be advanced into the bladder. The guidewire was then removed and the catheter balloon was inflated with 15-20 mL.

Results. The study included 85 men. Patient age ranged from 20 to 86 years. The mean age was 59.8 years and the median was 67 years. The lowest number of cases was recorded at age 50, whereas the highest number occurred in the 70–75-year group, which included 24 patients (*Fig. 3*). The mean prostate volume among patients without prior prostatectomy was 33.7 cc, slightly above the reference values for healthy middle-aged men (*Fig. 4*). The majority of patients had a prostate volume of 20-39 cc (42.1%). Volumes above 80 cc were rare (5.3%).

Catheterization was most frequently performed in the operating room (37 cases, 43.5%) and procedure rooms (32 cases, 37.6%) (*Fig. 5*). In the intensive care unit, catheterization was performed in 12 cases (14.1%). Bedside catheterization was rare (3 cases, 3.5%). The procedure was performed least often in the X-ray room (1 case, 1.2%).

Local anesthesia was used in 52 cases (61.2%) (*Fig. 6*). General anesthesia was used in 22 cases (25.9%). Spinal anesthesia was administered in 11 cases (12.9%), most commonly during pelvic or urologic procedures.

A total of 18 patients (30%) had no history of transurethral interventions of any kind, including urethral catheterization. The remaining 42 patients (70%) had various prior procedures, such as transurethral resection of the prostate, laser enucleation of BPH, prostatectomy, prostate brachytherapy, direct visual urethrotomy, cystoscopy, end-to-end urethroplasty and bladder catheterization.

Successful bladder drainage using the Visus MG optical urethral catheter with PES was achieved in 82 patients, corresponding to a success rate of 96.5%. No complications were observed in any patient. The causes of failed initial catheterization included urethral stricture, benign prostatic hyperplasia, distraction defect of the urethra associated with pelvic fracture, partial or complete urethral rupture, false urethral passage, bladder neck stenosis, iatrogenic urethrorrhagia, urethral obliteration, foreign body in the urethra and other factors.

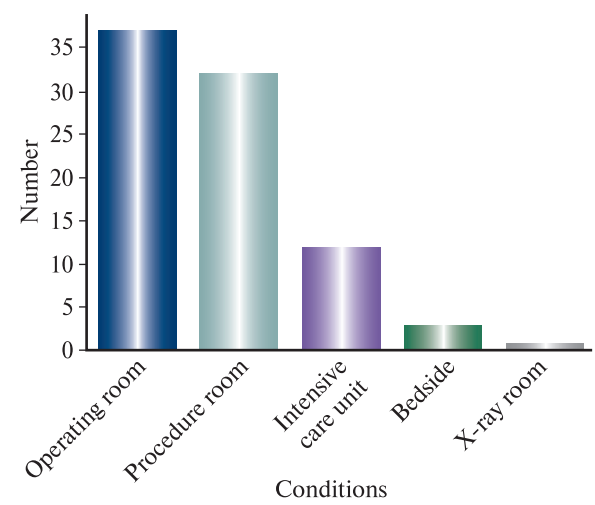


Figure 5. Distribution of patients by frequency and conditions of urinary drainage

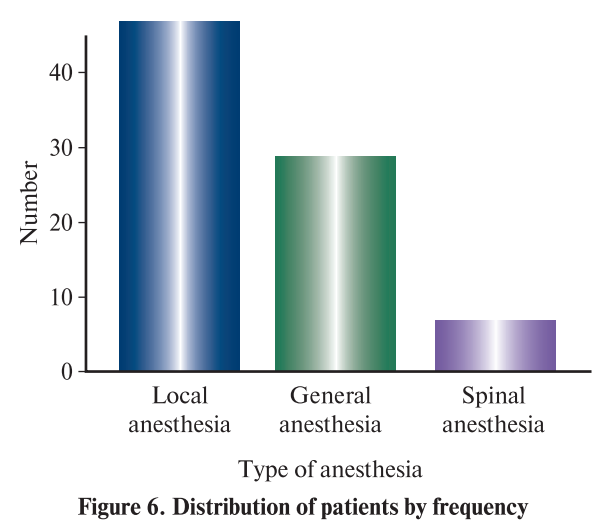


Figure 6. Distribution of patients by frequency and type of anesthesia used

The causes of unsuccessful catheterization with the Visus MG optical catheter and PES were: in 1 case (1%) a severe distraction defect of the urethra following pelvic fracture and in 2 cases (2.3%) extensive mucosal injury with urethrorrhagia and absence of urethral lumen visualization.

Discussion. Our results demonstrate that bladder catheterization in men, predominantly of older age (mean age 59.8 years), is a clinically significant and potentially challenging procedure. Most patients exhibited age-associated changes in the lower urinary tract, including increased prostate volume (mean 33.7 cc), which correlates with a higher prevalence of bladder outlet obstruction.

Catheterization was performed primarily in the operating room (43.5 percent) and in procedure rooms (37.6 percent), indicating the technical complexity of the intervention and the need for strict aseptic conditions and experienced personnel. Local anesthesia was the most frequently used method (61.2 percent), whereas general and spinal anesthesia were reserved for anatomically or technically challenging cases.

Medical history revealed that 70 percent of patients had undergone previous transurethral procedures, confirming the presence of persistent morphological changes that increase the risk of unsuccessful catheterization. The main causes of difficulty included urethral stricture, benign prostatic hyperplasia, distraction injuries and iatrogenic urethral trauma.

Thus, bladder catheterization in this cohort requires an individualized approach that includes a comprehensive assessment of the anatomical and functional state of the lower urinary tract, detailed evaluation of prior urological interventions and selection of optimal procedural conditions and anesthesia. These findings highlight the need for further development of algorithms aimed at increasing the efficacy and safety of catheterization in urological practice.

Conclusion. In this study, bladder drainage using the Visus MG optical urethral catheter with PES was successful in 82 patients, corresponding to an overall success rate of 96.5 percent. These results indicate high clinical efficacy and safety of this catheterization technique in patients with previously unsuccessful attempts at standard bladder drainage.

Successful application of the Visus MG optical urethral catheter with PES in most cases supports its use as a reliable alternative when cystoscopy is unavailable due to technical limitations or logistical constraints. The method combines minimal invasiveness with direct visual control and guided catheter advancement over a wire, which significantly reduces the risk of false passage formation, additional urethral trauma and other iatrogenic complications.

Therefore, the use of the Visus MG optical urethral catheter with PES represents an effective, rational and well-justified option for bladder drainage in patients with difficult catheterization, particularly in settings with limited access to endoscopic equipment.

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