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INFECTIOUS COMPLICATIONS OF UROLOGICAL INTERVENTIONS FOR UROLITHIASIS. LITERATURE REVIEW

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Abstract

Introduction. The problem of infectious complications of urological interventions for urolithiasis is very relevant today. This is primarily due to the sharply increased number of endoscopic interventions in recent years, the uncontrolled use of antibiotics, and the increasingly significant growth of so-called multidrug-resistant strains of microorganisms.

Purpose of the study: to determine the main infectious complications of urological interventions for urolithiasis

Search strategy: A literature review of publications from the past 10 years was conducted in the PubMed, CyberLeninka, and Google Scholar databases. The main keywords included: urolithiasis, infectious complications, antibiotic resistance, and postoperative complications.

Results: We have reviewed the literature on this topic. Currently, scientists distinguish two main ways of penetration of microorganisms into the urinary tract: endogenous and exogenous ways. With an exogenous route of infection, the sources of UTIs are patients with purulent-septic forms of urogenital and other surgical diseases, bacteria carriers among patients and medical personnel. With the endogenous route of infection, pathogenic microorganisms penetrate the urinary tract from closely located organs (often the pelvic organs): vagina, rectum. Often, infectious complications occur at the hospital stage in patients who have undergone surgical interventions or diagnostic manipulations, including for urolithiasis. The management of patients with similar nosocomial infections of the genitourinary system (NIMPS) and infections of the surgical field (IOP) is quite difficult, since their causative agents, as a rule, are gram-negative microorganisms with increased resistance to antimicrobial drugs.

Conclusions. According to many researchers, the frequency of infectious and inflammatory complications after endoscopic interventions for urolithiasis depends on many factors, the main of which are the presence of an initial urinary tract infection. Therefore, patients with baseline BMI, intra- and postoperative complications during endoscopic interventions for urolithiasis should be carefully analyzed, taking into account all the risks of surgical intervention. This review of the literature touches upon the main points in the infection pathway, the main pathogens and various approaches to the treatment and prevention of infectious complications of urological interventions for urolithiasis.

Keywords: *urolithiasis, infectious complications, antibiotic resistance, postoperative complications*

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Резюме

ИНФЕКЦИОННЫЕ ОСЛОЖНЕНИЯ УРОЛОГИЧЕСКИХ ВМЕШАТЕЛЬСТВ ПО ПОВОДУ МОЧЕКАМЕННОЙ БОЛЕЗНИ. ОБЗОР ЛИТЕРАТУРЫ.

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Введение. Проблема инфекционных осложнений урологических вмешательств по поводу мочекаменной болезни на сегодняшний день очень актуальна. Связано это в первую очередь, с резко возросшим за последние годы, количеством эндоскопических вмешательств, бесконтрольным приемом антибиотиков, все более значительным ростом, так называемых, полирезистентных штаммов микроорганизмов. Все это делает борьбу с послеоперационной инфекцией сложнее из года в год.

Цель исследования: определить основные инфекционные осложнения урологических вмешательств по поводу мочекаменной болезни

Стратегия поиска: Был проведен обзор литературы за последние 10 лет в базах данных PubMed, CyberLeninka и Google Scholar. Ключевые запросы: мочекаменная болезнь, инфекционные осложнения, антибиотикорезистентность, послеоперационные осложнения.

Результаты. В настоящее время, учеными выделяются два основных пути проникновения микроорганизмов в мочевыделительный тракт: эндогенный и экзогенный пути. При экзогенном пути инфицирования источниками ИМВП являются больные с гнойно-септическими формами урогенитальных и других хирургических заболеваний, бактерионосители среди пациентов и медицинского персонала. При эндогенном пути занесения инфекции патогенные микроорганизмы проникают в мочевыводящие пути из близко расположенных органов (зачастую органы малого таза): влагалища, прямой кишки. В свою очередь, уролитиаз почти всегда протекает в связке с инфекциями мочеполовой системы (ИМПС) или, которые могут быть как причиной, так и следствием мочекаменной болезни. Часто, инфекционные осложнения возникают на госпитальном этапе у пациентов, перенесших хирургические вмешательства или диагностические манипуляции, в том числе и по поводу уролитиаза. Ведение пациентов с подобными нозокомиальными инфекциями мочеполовой системы (НИМПС) и инфекциями операционного поля (ИОП) достаточно сложно, так как их возбудителями, как правило, являются грамотрицательные микроорганизмы с повышенной резистентностью к антимикробным препарата.

Выводы. По мнению многих исследователей, частота инфекционно-воспалительных осложнений после эндоскопических вмешательств по поводу уролитиаза зависит от множества факторов, основными из которых являются наличие исходной инфекции мочевых путей. Поэтому больных с наличием исходной ИМТ, интра- и послеоперационными осложнениями при выполнении эндоскопических вмешательств по поводу уролитиаза следует тщательно анализировать, учитывая все риски оперативного вмешательства. В данном обзоре литературы затронуты основные моменты в пути инфицирования, основные возбудители и различные подходы к лечению и профилактике инфекционных осложнений урологических вмешательств по поводу мочекаменной болезни

***Ключевые слова**: мочекаменная болезнь, инфекционные осложнения, антибиотикорезистентность, послеоперационные осложнения*

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Түйіндеме

ЗӘР ТАС АУРУЫ КЕЗІНДЕГІ УРОЛОГИЯЛЫҚ АРАЛАСУДЫҢ ИНФЕКЦИЯЛЫҚ АСҚЫНУЛАРЫ. ӘДЕБИЕТТІК ШОЛУ.

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Кіріспе. Урологиялық араласудың инфекциялық асқынулары мәселесі бүгінгі күні өте өзекті. Бұл, ең алдымен, соңғы жылдары эндоскопиялық араласулар санының күрт артуы, антибиотиктерді бақылаусыз қолдану және микроорганизмдердің көп дәріге төзімді штаммдарының айтарлықтай өсуіне байланысты.

Зерттеу мақсаты: урологиялық араласудың негізгі инфекциялық асқынуларын анықтау.

Іздеу стратегиясы: Соңғы 10 жылдағы жарияланымдарға PubMed, CyberLeninka және Google Scholar дерекқорларын іздеу жүргізілді. Негізгі іздеу сұраулары: уролитияз, инфекциялық асқынулар, антибиотикке төзімділік және операциядан кейінгі асқынулар.

Әдістері: Біз осы тақырып бойынша әдебиеттерді қарастырдық. Қазіргі уақытта ғалымдар микроорганизмдердің зәр шығару жолына енуінің екі негізгі жолын ажыратады: эндогендік және экзогендік жолдар.

Нәтижелері: Инфекцияның экзогендік жолы кезінде ЖЖИ көздері несеп-жыныс және басқа хирургиялық аурулардың іріңді-септикалық түрлерімен ауыратын науқастар, науқастар мен медицина қызметкерлері арасында бактерия тасымалдаушылар болып табылады. Инфекцияның эндогендік жолы арқылы патогендік микроорганизмдер зәр шығару жолына жақын орналасқан мүшелерден (көбінесе жамбас мүшелерінен) енеді: қынаптан, тік ішектен. Көбінесе инфекциялық асқынулар хирургиялық араласулардан немесе диагностикалық манипуляциялардан өткен науқастарда, соның ішінде уролитияда аурухана сатысында пайда болады. Несеп-жыныс жүйесінің (NIMPS) ұқсас ауруханаішілік инфекциялары және хирургиялық өріс инфекциялары (IOP) бар науқастарды емдеу өте қиын, өйткені олардың қоздырғыштары, әдетте, микробқа қарсы препараттарға төзімділігі жоғары грам-теріс микроорганизмдер болып табылады.

Қорытындылар. Көптеген зерттеушілердің пікірінше, уролитияға арналған эндоскопиялық араласудан кейін инфекциялық және қабыну асқынуларының жиілігі көптеген факторларға байланысты, олардың негізгілері зәр шығару жолдарының бастапқы инфекциясының болуы. Сондықтан бастапқы BMI бар емделушілерге, уролитияға арналған эндоскопиялық араласулар кезінде операция ішілік және операциядан кейінгі асқынуларға хирургиялық араласудың барлық тәуекелдерін ескере отырsп, мұқият талдау қажет. Әдебиеттердің бұл шолуы инфекция жолындағы негізгі сәттерді, негізгі патогендерді және уролитияға арналған урологиялық араласудың инфекциялық асқынуларын емдеу мен алдын алудың әртүрлі тәсілдерін қозғайды.

Түйінді сөздер: *уролития, инфекциялық асқынулар, антибиотиктерге төзімділік, операциядан кейінгі асқынулар*

Дәйексөз үшін:

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Introduction.

The problem of infectious complications of urological interventions for urolithiasis is very relevant today. This is primarily due to the sharply increased number of endoscopic interventions in recent years, the uncontrolled use of antibiotics, the increasing growth of so-called multidrug-resistant strains of microorganisms. All this makes the fight against postoperative infection more difficult year after year.

Objective of the study: to determine the main infectious complications of urological interventions for urolithiasis

Search strategy: A literature review of the last 10 years was conducted in PubMed, CyberLeninka and Google Scholar databases. The main keywords were urolithiasis, infectious complications, antibiotic resistance and postoperative complications.

Source Selection Algorithm.

The source selection algorithm included:

1) literature search in PubMed, CyberLeninka, Google Scholar databases using the keywords "urolithiasis", "infectious complications", "antibiotic resistance", "postoperative complications";

2) selection of publications for the last 10 years

3) application of inclusion (description of endoscopic methods of urolithiasis treatment) and exclusion criteria (exclusion of articles with data on patients with nephrostomies, cystostomies, stent catheters);

4) final analysis and selection of relevant publications for review.

Methods

The aim of this literature review is to comprehensively analyse existing data on infectious complications in patients with urolithiasis undergoing endoscopic surgery. The review considers risk factors, prevalence of complications, the impact of antibiotic resistance and approaches to antibiotic prophylaxis. The scientific rationale for this review is based on the need to objectively summarise current data and identify the most significant factors affecting the outcomes of endoscopic surgery in patients with urolithiasis.

Given the specificity of the topic and the limited number of publications, authoritative and frequently used databases in medical research were selected for the search: PubMed, CyberLeninka and Google Scholar. These sources provide access to both international and domestic publications, allowing a comprehensive assessment of the problem and consideration of results from different countries and clinical settings. The depth of the search was 10 years, allowing us to focus on current approaches to the prevention and treatment of complications. However, due to the relatively small volume of publications on this topic, the review also includes earlier works, starting from 1982, which contain fundamental information related to treatment methods and concepts of antibacterial prophylaxis in urological diseases.

The review was based on strict inclusion and exclusion criteria designed to maximise the relevance of the data. The inclusion criteria included the selection of publications that included data on patients with urolithiasis who underwent endoscopic surgery such as ureteroscopy with contact laser lithotripsy, percutaneous nephrolithotripsy and retrograde intrarenal surgery. Only studies concerning infectious complications, their prevention and the role of antibiotic resistance in these processes were included. Publications describing patients with genitourinary fistulas (e.g.

nephrostomies or cystostomies) and stent catheters were excluded because their cases require specific approaches to prevention and treatment that are not the subject of this review.

To perform a structured search, key queries were developed: "urolithiasis", "infectious complications", "antibiotic resistance", "postoperative complications", as well as terms related to specific endoscopic techniques such as "ureteroscopy", "percutaneous nephrolithotripsy", "retrograde intrarenal surgery". The use of these search words allowed us to focus on publications relevant to the clinical aspects of the management and prevention of complications of endoscopic surgery.

After the initial search, 68 publications were found and further screened. The included publications were analysed according to the criteria of methodological quality, scientific significance and reliability of the data presented. Based on the analysis of publications, the information was systematised to identify the main categories for summarisation: types of infectious complications, identified risk factors, antibiotic prophylaxis regimens and their efficacy, and the impact of antibiotic resistance on treatment outcomes.

The methodology of this review is based on the concept of a systematic and structured approach that brings together disparate data and identifies significant clinical patterns. This approach not only provides a holistic picture of the state of the problem, but also contributes to the development of recommendations to improve the practice of endoscopic interventions and prevention of infectious complications in patients with urolithiasis.

Results

In situations of exogenous contamination, sources of urinary tract infections include individuals suffering from purulent and septic urogenital infections, as well as bacterial carriers among patients and health care workers. The transfer of pathogens in such conditions is accomplished through medical instruments, dressing materials, and direct contact with the hands of health care personnel. If the endogenous route of infection is activated, pathogens enter the urogenital tract from nearby organs such as the vagina and rectum.

Many variables affect the risk of developing urinary tract infections.

Internal factors that increase the risk of infection include anatomical abnormalities in patients, such as stenoses and fistulas, which increase the possibility of infections from the external environment. Other factors include the presence of foreign objects and stones in the body, low blood pressure, bladder and ureter hypotonia, neurogenic bladder, diabetes, immune deficiency states, post-kidney transplantation, postpartum period, complications of female childbirth, HIV infection, spinal cord injury and central nervous system damage.

In contrast to internal factors, external factors are often associated with medical procedures, including instrumental diagnostics and surgical procedures such as transurethral resection of the prostate gland, prostate biopsy, as well as the use of catheters and urinary drainage systems and other therapeutic manipulations. In addition, the use of intracavernous injections for the treatment of erectile dysfunction is also mentioned among external factors. [6].

In turn, the prevalence of urolithiasis (urolithiasis) ranges from 1% to 20% worldwide, depending on geographical, climatic, ethnic and genetic factors, and recur within the first five years in 26% of individuals with first-time stones [7,8,10].

According to *Romero V., Akpinar H., Assimos D.G.* (2010) the prevalence of urolithiasis is relatively high (>10%) and has increased by more than 37% between 1983 and 2010 in countries with a higher standard of living where a large proportion of the society follows a high-protein diet [9,11-13].

Studies of scientists *Romero V., et al.* (2010), and *Lopez M., et al.* (2010) concluded that not the least role in the pathogenesis of urolithiasis is played by changes in metabolic processes due to diseases or disorders such as obesity, diabetes, metabolic syndrome, etc. [9,10].

The expected financial cost of treating patients with urolithiasis in Germany in 2000 exceeds €500 million per year [14]; in the United States, this approximate cost in 2007 (adjusted for inflation to 2014) was $3.79 billion, then it is expected to exceed $4.5 billion per year by 2030 [15].

Urinary tract stones, if left untreated, can cause life-threatening consequences such as obstructive uremia, hypertension, acute and recurrent urinary tract infections, pyelonephritis followed by septicaemia and septicaemia, renal failure, acute and chronic renal failure (ARF and CKD) and so on [16,17].

Urolithiasis almost always occurs in conjunction with genitourinary infections (UTIs) or, which can be both a cause and a consequence of urolithiasis. Often, infectious complications occur at the hospital stage in patients who have undergone surgical interventions or diagnostic manipulations, including for urolithiasis. Management of patients with such nosocomial genitourinary infections (NIMPS) and surgical site infections (SSI) is quite difficult, as their causative agents are usually Gram-negative microorganisms with increased resistance to antimicrobials [18,19,20]. Consequently, identifying risks and developing techniques to predict severe non-infectious complications after surgery and postoperative infections may play a key role in reducing the risks and possibly preventing the occurrence of postoperative infectious complications in patients who undergo invasive procedures due to urolithiasis.

According to the research conducted by *A.Ch. Usupbaev, B.A. Kabaev and their colleagues* (2018) [24], the wide spread of infectious complications after surgical interventions in the practice of urology puts the issue of their prevention in the forefront. Such complications are especially common in patients who underwent surgery for urolithiasis, which is explained by the interaction of intrinsic and extrinsic risk factors.

The study analysed 116 episodes of postoperative complications. It was recorded that 42 of these patients, equivalent to 36.2% of the total, developed infections after surgical intervention in the aria (OH). The division of infections according to the depth of the lesion showed that 31 patients had superficial infections, 8 had deep infections, and three had infections localised in the area of the operated organ or cavity. In the remaining surgical cohort, 17 patients (14.7%) developed pyelonephritis, while 24 (20.7%) developed urethritis after surgery. The researchers identified different nosological forms of infectious complications in patients undergoing different types of urolithiasis treatment.

A number of common infectious sequelae following surgical interventions performed as part of urolithiasis therapy can be identified:

-Infections in the surgical area - 36.2% of cases,

-Acute inflammation of the urethra - 20.7%,

-Acute variant of pyelonephritis - 14.7%,

-Inflammation of perirenal fibre - 9.5%,

-Acute orchitis combined with appendiceal inflammation - 7.8%,

-Acute inflammation of the bladder - 6%,

-Purulent inflammation of the kidneys - 3.4%,

-Infectious lesion with penetration into blood - 1.7%.

The following microorganisms are the most common pathogens associated with health care services:

1.Escherichia coli - in 43% of cases,

2.Proteus - in 9.5% of cases,

3.Staphylococcus spp. including Staphylococcus aureus - in 8.3% of cases,

4.Various microorganisms - in 11.9% of cases.

A study of the pattern of resistance to beta-lactam antibiotics among members of the Enterobacteriaceae family revealed that Escherichia accounted for 63.2% of the total, Proteus 21%, and Klebsiella 15.8%.

The researchers' presentations emphasise the importance of scientific work aimed at analysing the distribution of treatment-resistant forms of microorganisms, applying more accurate and sensitive tests and monitoring these processes. Such measures contribute to improving the results of therapeutic interventions, reducing the likelihood of the spread of drug-resistant strains and reducing the incidence of healthcare-associated infections. [24].

A study of surgical outcomes performed by *F.A. Akilov and Sh.I. Giyasov (2017)* [25] revealed multiple factors that contributed to the development of postoperative pyelonephritis in 115 patients. These include the presence of primary urinary tract infection before surgery, despite preoperative preparation, as well as various problems that occurred during and after surgery.

Researchers emphasise that the chance of infection and inflammatory reactions from endoscopic urolithiasis surgery is related to both the presence of an initial urinary tract infection and the number of complications that occur during and after surgery. Those patients who already have a urinary tract infection and experience additional difficulties during and after endoscopic interventions for stone management should be considered at increased risk for postoperative infectious and inflammatory complications. Studies show that complicated pyelonephritis is a consequence of endoscopic removal of upper urinary tract stones in about 11.2% of cases.

In the majority of patients, 82.6%, complicated pyelonephritis was successfully managed with conservative treatment, while 17.4% of patients required additional invasive procedures and intensive care. This resulted in a 60% longer hospitalisation compared with the average [25].

Ф. Sadulloev studied the incidence of hospital-acquired infections, taking into account the severity of the primary disease, the extent and number of surgical and other urological manipulations, including invasive and endoscopic ones, as well as their regularity and duration. In addition, it analysed how individual clinical manifestations affect the overall dynamics of urinary tract infections and took into account patients' gender and age as factors within the study [26]. In a microbiological study of urine, drainage contents and wound secretions, the research team analysed the bacterial spectrum to determine the mechanisms of infection. A total of 268 chicken, wound and drainage fluid samples from 122 patients affected by hospital-acquired infections were studied, leading to the identification of more than 300 diverse microbial cultures. The diversity of causative agents of urinary tract infections was extensive, with ten predominant bacterial types identified. Among patients with infections, microorganisms from the following genera were most frequently detected:

-Escherichia - 24%,

-Proteus - 10.7 per cent,

-Ps.aeruginosa - 17.6%,

-Klebsiella - 5.8 per cent,

- totalling 58.1% of the total number of strains isolated.

-Bacteria of the Micrococcaceae family including the genera Staphylococcus, Streptococcus and Enterococcus occupied 30.9%.

-Fungi of the genus Candida, predominantly Candida albicans, were found in 3.7% of cases,

-associations of different microorganisms amounted to 3.3%,

-and other microbes accounted for up to 4%.

Infections that occurred in the hospital setting during diagnosis or treatment of patients were identified by microbiological analysis of drainage fluids, purulent secretions and urine, which revealed many bacterial strains that were not present at the time of admission. The author suggests that the underlying cause of nosocomial infection in patients suffering from urolithiasis and treated by various methods is most often Gram-negative bacteria. Among Gram-positive microorganisms, E.coli (24%) and Ps.aeruginosa (17.6%) and staphylococci (19.3%) were the most common. In most cases, Gram-negative bacteria cause inflammatory processes in the kidneys and upper urinary tract, whereas Gram-positive microorganisms are more commonly associated with lower urinary tract inflammation (26).

M Charton, G Vallancien, B Veillon, J M Brisset studied the bacteriological results of 126 cases of percutaneous renal stone extraction. 107 patients had sterile urine preoperatively and intentionally did not receive antibiotics prophylactically so that the mechanisms of urinary tract infection after percutaneous nephrolithotomy could be studied [27]. Of these patients, 37 (35%) had postoperative urinary tract infection, usually caused by Escherichia coli, Streptococcus or Staphylococcus aureus. The pathogen was isolated in bladder urine only in 22 cases, in the nephrostomy tube in 2 and in both localisations in 13. Eleven patients (10%) had a fever of 38.5°C or higher. All infected patients received appropriate antibiotic therapy and there were only 2 positive cultures at long-term follow-up (5%). The risk of clinical infection after percutaneous nephrolithotomy is low, even though 35% of patients develop bacteriuria in the postoperative period, provided that a thorough preoperative bacteriological examination is performed and patients with urinary tract infection are adequately treated. These results are in favour of short-term prophylactic antibiotic therapy adapted to the bacterial ecology [27].

In modern urological practice retrograde intrarenal surgery occupies an increasing share in the treatment of kidney stones.

A research team led by *Dong Soo Kim, Koo Han Yoo, Seung Hyun Jeon, and Sang Hyub Lee* evaluated the risk factors for febrile urinary tract infections (UTIs) resulting from retrograde intrarenal surgery (RIRS) to remove kidney stones [28]. The study was based on a retrospective review of medical files of patients with renal concretions ranging in size from 10 to 30 millimetres who underwent RIRS between January 2014 and July 2017. Parameters such as age, gender, patient's body mass index, stone size and location, and duration of surgery were taken into account in the evaluation. It is noted that all surgical interventions were performed by a single surgeon and no preoperative ureteral stenting was performed. A total of 150 patients were included in the study, out of which 17 (11.3%) patients had febrile UTI after RIRC. The mean age of the patients was 56.64 ± 13.91 years, both sexes were evenly distributed. The mean stone size was 14.16 ± 5.89 mm.The mean operative time was 74.50 ± 42.56 minutes.

Dong Soo Kim, Koo Han Yoo, Seung Hyun Jeon, Sang Hyub Lee [28] stated that age, sex, body mass index, comorbidities, preoperative bacteriuria, hydronephrosis, kidney stone characteristics, and time of surgery were not associated with febrile UTI after retrograde intrarenal surgery. Preoperative pyuria was the only risk factor for infectious complications after retrograde intrarenal surgery.

Thus, the authors recommend careful management after RIFC, especially when preoperative urinalysis shows pyuria [28].

Hospital-acquired infection, which includes so-called catheter-associated infection, also deserves special attention. *Tsewaeng Badamsuren* points out that the main foci of hospital infections in urology are associated with activities in the dressing (54.1%) and cystoscopy (34.2%) departments [29]. The main mechanism of transmission of infections to the urinary system is still associated with catheter use, where the risk of developing infection increases depending on: Type of drainage system used and In situations where open catheterisation is used, infectious manifestations are reported in all patients by day five. In situations where a closed catheterisation system is used, infection is recorded in half of the patients on day ten and reaches one hundred percent prevalence within a month:

-In situations where open catheterisation is used, infectious manifestations are recorded in all patients by day five. In situations where a closed catheterisation system is used, infection is reported in half of the patients on day ten and reaches one hundred percent prevalence within a month.

Badamsuren also highlights factors that may contribute to the accelerated spread of catheter-associated infections:

-Catheter insertion outside of the operating theatre setting;

Catheterisation performed late in the patient's hospital stay;

-Position of the drainage catheter above the level of the bladder;

-The need to open urological drains to empty them (contamination of systems);

-Inappropriate manipulation of the drainage system;

-Practice of regular replacement of urinary catheters without strict indications.

F.F. Ercole, T.G. Macieira, L.C. Wenceslau emphasise that the use of intermittent catheterisation is associated with a reduction in complications and infectious processes compared with continuous catheter use [30]. Catheter removal within the first 24 hours after surgery, as well as the use of antimicrobial-treated or hydrophilic-coated catheters, helps to reduce the risk of urinary tract infection [30].

In exceptional cases, when the catheter is colonised by multiple resistant microorganisms, it may cause urosepsis due to urinary catheter infection. An American research group that studied the incidence of nosocomial infections in patients at 15 US hospitals (based on data from the Duke Infection Control Outreach Network) between 1 January 2010 and 30 June 2012 found that incidents of catheter-associated infections were the second most common after surgical infections, at 26% [31].

A study by *S.S. Bansal, P.W. Power and A.S. Sawant* shows that the risk of inflammation with subsequent urosepsis exists even in minimally invasive surgical procedures such as percutaneous nephrolithotripsy. The presence of large stones larger than 25 mm, intraoperative haemorrhages requiring blood transfusion, and surgical duration exceeding 120 minutes have been identified as factors that increase this risk. [32].

Several authors suggest that urologists should be very specific when choosing antibiotic treatment. Based on a study by *Ahmed A. Shokeir, Abdulla A. Al Ansa*ri [33], they argue that antibiotics should be administered to patients with a stented ureter as if there were clinical signs of infection and to patients with a high probability of infection. In endourological strategies, antibiotic prophylaxis is indicated in cases of contaminated stones, preoperative UTI or long-term strategies [33].

The authors *Chuan Peng, Zhaozhao Chen, Jun Xu* studied risk factors for MPS infection in patients undergoing retrograde lithotripsy of upper urinary tract stone [34]. The researchers found that Escherichia coli (62.90%) was the most common bacterium in patients with urinary tract infection. Female gender, age >50 years, diabetes mellitus, stone diameter ≥2 cm, duration of ureteral catheter placement ≥3 days, and duration of surgery ≥90 minutes were independent risk factors for postoperative urinary tract infection in patients with upper urinary tract retrograde lithotripsy. In patients undergoing retrograde lithotripsy of the upper urinary tract, countermeasures targeting these risk factors are needed to prevent and reduce postoperative urinary infection in the clinical setting [34].

Adam Cole, Jaya Telang, Tae-Kyung Kim [35] analysed 1817 cases of ureteroscopy from 11 hospitals. In hospitalised patients, the causative organisms were Gram-negative (61.5%), Gram-positive (19.2%), yeast (15.4%) and mixed (3.8%) microorganisms. Key elements influencing hospitalisation due to infectious diseases included an elevated Charlson comorbidity index, previous recurrence of genitourinary tract infections, stone size, complications during surgery, and procedures in which stone fragments were not retrieved.

The authors state that one in 40 patients is re-hospitalised with an infectious complication after ureteroscopy.

In order to reduce the incidence of postoperative complications, the authors recommend urinalysis and bacteriological examination of urine in the postoperative period [35].

Futoshi Morokuma, Eiji Sadashima, Soutaro Chikamatsu, and Tomoya Nakamura [36] evaluated the risk of febrile urinary tract infections after ureterorenoscopic lithotripsy in patients with upper urinary tract stones. In a retrospective analysis, they examined the clinical data of 109 patients who underwent this procedure. The parameters analysed were age, sex, body mass index (BMI), mobility, presence of diabetes, duration of surgery, use of ureteral stent preoperatively, number and size of stones, their characteristics on CT scan, localisation, as well as the presence of urinary tract infection and pyelonephritis preoperatively and urine bacteriological test results. Comparisons were made between groups with different postoperative outcomes.

Postoperative infection developed in three out of 109 patients (2.8%). When comparing the two groups, low BMI was a significant risk factor.

One of the three episodes of febrile UTI was accompanied by anorexia nervosa and BMI was 11 kg/m2. As a result, the authors conclude that low BMI is a significant risk factor for urinary tract infection after ureterorenoscopy [36].

Recently, an increasing number of studies on the use of disposable ureteroscopes have appeared. *Rei Unno, Gregory Hosier, Fadl Hamouche, David B Bayne* state that urinary tract infection is a frequent complication after ureteroscopy [37]. Disposable ureteroscopes have been shown to contain bacteria despite sterilisation. It is unknown whether this characteristic was associated with a higher incidence of UTIs. The authors conducted a study comparing the incidence of postoperative UTIs after ureteroscopy for urolithiasis performed with disposable ureteroscopes versus reusable ureteroscopes. The primary outcome was postoperative urinary tract infection.

Secondary endpoints were intraoperative and postoperative outcomes, as well as the use of additional medical services postoperatively. Of the 991 patients identified, 500 (50.4%) underwent ureteroscopy using a disposable ureteroscope. The incidence of postoperative UTIs was lower in those who underwent ureteroscopic stone removal with a disposable ureteroscope compared to a reusable ureteroscope. Use of a disposable ureteroscope was associated with lower risks of postoperative UTI compared with a reusable ureteroscope. Use of a disposable ureteroscope was associated with a higher rate of stone removal compared with a reusable ureteroscope. There were no differences in operative time, overall complication rates, re-hospitalisation or emergency department visits between the two groups. Thus, the authors concluded that the use of disposable ureteroscopes resulted in a twofold reduction in the risk of UTI and an increased stone removal rate after ureteroscopy for urolithiasis compared with reusable ureteroscopes [37].

In this case report, the authors *Luca Sindolo, Francesco Berardinelli and Pietro Castellan* [38] mention a very important and unusual consequence of retrograde intrarenal surgery. The authors describe a 44-year-old woman with a single left kidney who had a history of extensive multiple sclerosis, epilepsy, bed rest and percutaneous endoscopic gastrostomy. The patient was hospitalised due to recurrent lower urinary tract infections. A follow-up computed tomography (CT) scan revealed an obstructive renal pelvic stone measuring 1.7 cm and multiple bladder stones. After cancellation of percutaneous access, RIFC was planned and performed. No intraoperative problems were found. During the postoperative period, she developed urinary tract septicaemia, which worsened her general health. The patient died of septic shock six days after RIRC despite a positive blood culture for Candida glabrata. As a result, the authors recommend that future research should be conducted in a certain direction and that the patient should be carefully preoperatively prepared [38].

In their study, *James P. Blackmoore, Neil W. Maitra, and Rajendar R. Marri* [39] sought to identify the factors most likely to increase the incidence of postoperative urosepsis within 28 days after ureteroscopy and laser fragmentation of a ureteral or kidney stone. The authors prospectively collected data from a single national health centre.

A total of 462 patients were included in the study. Thirty-four patients (7.4%) developed an episode of urosepsis within 28 days after surgery. A positive preoperative midstream urine culture was significantly associated with postoperative urosepsis in multivariate analysis despite appropriate treatment with a preoperative course of antibiotics. Presence of diabetes mellitus, presence of ischaemic heart disease, American Society of Anaesthesiologists' patient status score, bilateral URS during one session and stone volume were other variables significantly associated with postoperative infection in single factor analysis, but they ceased to be significantly associated in multivariate analysis. analysis. analysis. Subgroup analysis showed that a positive midstream urine culture in both patients with and without a preoperative ureteral stent was significantly associated with postoperative urosepsis. In matched pairs analysis, patients with a positive preoperative bacteriological culture were significantly more likely to have postoperative urosepsis compared to the control group

Based on their results, the authors concluded that a positive preoperative bacteriological culture was significantly associated with postoperative urosepsis. Patients at higher risk should be appropriately counselled preoperatively and should be the focus of vigilant postoperative follow-up. The study suggests special caution in patients with a positive preoperative urine culture [39].

According to *Marcelino Rivera , Boyd Viers , Patrick Cockerill*,[40] who analysed the case histories of 227 patients, the presence of a coral stone increases the risk of postoperative infection by more than 3 times.

Jun Sheng, Fa Sin, Fang-Ming Chen and Zhi-Ping Wu [40] aimed to identify risk factors that contribute to the development of urosepsis after endoscopic ureterolithotripsy in patients without preoperative infection. Their aim was to create a more efficient and safer approach to the prevention and treatment of such complications. The authors analysed the histories of 5 patients with ureteral calculi who underwent endoscopic lithotripsy of ureteral stones with Holmium laser and developed urosepsis in the postoperative period, confirmed by clinical and laboratory findings, while they had no preoperative blood or urine infection. All 5 patients were eventually cured. The authors state that stones and surgery

alone are potential factors causing urosepsis after endoscopic ureteral lithotripsy, even in the absence of infection preoperatively. Careful preoperative preparation, corrective manipulation, low-pressure irrigation, drainage and time control during surgery, as well as early diagnosis and appropriate postoperative management, are key to cure and prevention of urosepsis, especially for patients who have not had infection before surgery [41].

Discussion of results

Urolithiasis (urolithiasis) continues to be an important medical problem with a high prevalence, especially in countries with a high standard of living where high-protein diets are common. The increased incidence is associated with metabolic disorders such as obesity and diabetes, requiring a comprehensive treatment approach including nutritional intervention and management of comorbidities. The economically rising costs of treating urolithiasis, which are projected to be up to $4.5 billion in the US by 2030, highlight the need to optimise diagnostic and treatment methods.

One of the most serious complications of urolithiasis remains infections, especially after surgery. This requires the development of effective preventive strategies, including the fight against antibiotic resistance. Despite advanced therapies, urinary tract infections, especially pyelonephritis, remain frequent complications after surgical interventions such as ureterorenoscopy or endoscopic lithotripsy. For example, studies have shown that the risk of infections after endoscopic upper urinary tract stone removal surgery can be as high as 11.2% for complicated pyelonephritis. These data emphasise the need for early detection and effective treatment of urinary tract infections prior to surgery.

Special attention is paid to preoperative preparation. The presence of a primary urinary tract infection, even despite the preparation, may contribute to complications. The risk of infectious complications also depends on the complexity of the operation and the patient's condition. Patients with primary urinary tract infections or those who encounter difficulties during the intervention have an increased risk of developing infections.

In addition, it is important to note the impact of catheterisation on the incidence of infectious complications. The use of catheters, especially in prolonged catheterisation, significantly increases the risk of infection, which requires adherence to strict protocols for catheter insertion and use, as well as antibiotic prophylaxis. Open catheterisation increases the risk of infection in the first days after surgery, whereas a closed system causes infectious manifestations later, but with a longer period of spread.

To minimise infectious complications associated with urinary tract surgery, appropriate choice of equipment (e.g. disposable ureteroscopes, which reduce infection rates compared with reusable ones), careful preoperative diagnosis, antibiotic prophylaxis and strict postoperative monitoring are important measures. Urinary tract stones, especially coral stones, significantly increase the likelihood of urosepsis, even in the absence of infection preoperatively, which also emphasises the importance of a comprehensive approach to treatment and infection prevention.

Thus, successful treatment of urolithiasis requires a comprehensive approach that includes dietary recommendations, correction of metabolic disorders, improved medical care, and effective prevention and treatment of infectious complications.

Conclusions

Urolithiasis remains an important medical problem characterised by high morbidity, especially in countries with a high standard of living where high-protein diets are common. In recent decades, there has been an increase in the incidence of urolithiasis, which is associated with metabolic disorders such as obesity and diabetes. These changes require a comprehensive approach to treatment, including nutritional correction, treatment of comorbidities and the use of modern diagnostic and therapeutic methods.

Special attention should be paid to infectious complications, which are a serious problem in the surgical treatment of urolithiasis. Urinary tract infections such as pyelonephritis and urosepsis remain frequent complications after urinary tract surgery. This emphasises the need to develop effective preventive strategies such as antibiotic prophylaxis and antibiotic resistance, as well as close monitoring of patients in the postoperative period. Preoperative preparation is an important step in preventing infections, as the presence of urinary tract infection before surgery significantly increases the risk of postoperative complications. A positive preoperative bacteriological urine culture is also a risk factor for the development of infections, which requires preoperative treatment and monitoring.

In addition, the choice of medical equipment has a significant impact on the incidence of infectious complications. For example, the use of disposable ureteroscopes is associated with a lower incidence of infection compared with reusable ones, which confirms the importance of choosing quality equipment. However, even in the absence of preoperative infection, the presence of stones, especially coral stones, increases the likelihood of urosepsis, which requires special attention during preparation and surgical intervention.

An equally important problem is catheter-associated infections, which significantly increase the risk of infections in the postoperative period, especially with prolonged catheter use. In such cases, the use of antibiotic prophylaxis, preference for intermittent catheterisation and the use of antimicrobial catheters can significantly reduce the incidence of infectious complications.

Thus, successful treatment of urolithiasis and prevention of infectious complications require a comprehensive approach, including the correct choice of equipment, preoperative diagnosis, antibiotic prophylaxis and careful monitoring of the postoperative condition of patients. It is important to consider the individual risks of each patient to minimise the likelihood of complications and improve treatment outcomes.

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