ORIGINAL ARTICLE
UDC: 616.6
https://doi.org/10.2298/VSP181014199J

Possible risk factors for postoperative urinary tract infection following ureteroscopic lithotripsy

Mogući faktori rizika od nastanka postoperativne urinarne infekcije nakon ureteroskopske litotripsije

Mirko Jovanović*, Vladimir Bančević*†, Branko Košević*†, Predrag Aleksić*†, Vesna Šuljagić†‡

Military Medical Academy, *Urology Clinic, ‡Department for Prevention and Control of Nosocomial Infection, Belgrade, Serbia; University of Defence, †Faculty of Medicine of the Military Medical Academy, Belgrade, Serbia

Abstract

Background/Aim. Ureteroscopic lithotripsy is today a safe method of endoscopic destruction of stone in the kidney and ureter with a small number of complications of which the most common is postoperative urinary tract infection. Risk factors for the occurrence of urinary tract infection after the ureteroscopic destruction of stones in the ureter and kidney are not clearly defined in the previous studies. **Methods**. The study included 389 patients with ureteroscopic lithotripsy and possible risk factors were analyzed: age of the patients, sex, diabetes presence, degree of hydronephrosis, stone size, stone localization, wear of ureteral JJ stent and percutaneous nephrostomy catheter, type of surgical procedure and duration of the operation. The frequency of postoperative urinary tract infection was statistically analyzed in relation to the possible risk factors. **Results.** Ten percent of the patients had postoperative urinary tract infection. The higher incidence of postoperative urinary tract infection was found in patients with diabetes ($\chi^2 = 22.918$; $p < 0.001$), those who before surgery carried a ureteral JJ stent ($\chi^2 = 4.620$; $p = 0.040$) and percutaneous nephrostomy catheter ($\chi^2 = 8.240$; $p = 0.004$), who had a larger stone ($\chi^2 = -3.301$; $p = 0.001$), and whose surgery lasted longer ($t = 4.261$; $p < 0.001$). **Conclusion.** The frequency of postoperative urinary infection and risk factors for its emergence in our study are in line with the results of studies by other authors. Patients with diabetes, who preoperatively carried JJ stent or a percutaneous nephrostomy catheter, who had large stones and in which the operating time is longer have a greater risk of developing postoperative urinary tract infection. Accordingly, the importance of identifying these patients in the preparation for ureteroscopic lithotripsy contributes to the appropriate preoperative preparation and decreases the frequency of postoperative urinary tract infection to a minimum.

Key words:
ureteroscopy; lithotripsy; risk factors; infection postoperative complications.

Apstrakt

Uvod/Cilj. Ureteroskopska litotripsija je u današnje vreme sigurna metoda endoskopskog razbijanja kamena u bubregu i ureteru, sa malim brojem komplikacija, od kojih je najčešća postoperativna urinarna infekcija. Faktori rizika od pojave urinarne infekcije nakon ureteroskopskog razbijanja kamena u ureteru i bubregu nisu jasno definisani u dosadašnjim radovima. **Metode**. Istraživanjem je bilo obuhvaćeno 389 bolesnika kod kojih je urađena ureteroskopska litotripsija, a od mogućih faktora rizika analizirani su: starost bolesnika, pol, dijabetes, prisustvo i stepen hidronefroze, veličina kamena, lokalizacija kamena, nošenje ureteralne JJ sonde i perkutanog nefrostomskog katetera, vrsta operativne metode i dužina trajanja operacije. Statistički je bila analizirana učestalost postoperativne urinarne infekcije u odnosu na pomenute moguće faktore rizika. **Rezultati**. Postoperativnu urinarnu infekciju je imalo 10% bolesnika Veća učestalost postoperativne urinarne infekcije nađena je kod bolesnika koji su imali dijabetes ($\chi^2 = 22,918$; $p < 0,001$), koji su preoperativno nosili ureteralnu JJ sondu ($\chi^2 = 4,620$; $p = 0,040$) i perkutani nefrostomski kateter ($\chi^2 = 8,240$; $p = 0,004$), koji su imali veći kamen ($Z = -3,301$; $p = 0,001$) i kod kojih je operacija trajala duže ($t = 4,261$; $p < 0,001$). **Zaključak**. Učestalost postoperativne urinarne infekcije i faktori dijabetesa, koji preoperativno imaju postavljenu JJ sondu ili perkutani nefrostomski kateter, koji imaju veliki kamen i

Correspondence to: Mirko Jovanović, Military Medical Academy, Urology Clinic, Crnotravska 17, 11 000 Belgrade, Serbia.
E-mail: mirkojov70@gmail.com

kod kojih je operativno vreme duže, imaju veći rizik od razvoja postoperativne urinarne infekcije. U skladu sa tim, značaj identifikacije ovih bolesnika u pripremi za ureteroskopsku litotripsiju doprinosi da se preduzme adekvatna preoperativna priprema i učestalost postoperativne urinarne infekcije smanji na najmanju meru.

Ključne reči:
ureteroskopija; litotripsija; faktori rizika; infekcija; postoperativne komplikacije.

Introduction

The endoscopic destruction of ureter and kidney stone or ureteroscopic lithotripsy (URSL) is a standard procedure in surgical treatment of urinary stones [1]. Previous studies have shown that ureteroscopic lithotripsy is a safe method with few complications and with a success rate of up to 85.6% [2]. The most common postoperative complications are infectious complications including transient febrile condition and urinary tract infection with a frequency of 1.7–18.8% [3–5]. Urosepsis is one of the most severe complications after ureteroscopic lithotripsy [6].

In previous studies that have been published, factors that are directly related and lead to infectious complications and sepsis are not clearly defined [7–10].

The importance of identifying possible risk factors for the occurrence of urinary tract infection after ureteroscopy because of ureter and kidney stones, either pneumatic or laser lithotripsy, would be crucial in order to take specific measures for the prevention of severe forms of postoperative urinary tract infection and sepsis [11, 12].

As individual risk factors for the development of urinary tract infections after ureteroscopic lithotripsy investigated so far were: age, sex, diabetes, bacteriuria and pyuria, acute pyelonephritis, the presence of percutaneous nephrostomy catheter and ureteral JJ stent, the presence of hydronephrosis, the use of antibiotic therapy before ureteroscopic lithotripsy, duration of surgery, the presence of kidney and heart diseases, the use of anticoagulant therapy, as well as the number, size and localization of the stone [13–15].

Methods

The study included 389 patients, 200 males and 189 females who underwent ureteroscopic lithotripsy with semi-rigid and/or flexible ureteroscope in a five-year period, from January 2010 to December 2014. The stone was fragmented using a laser with a power of 10 watts or pneumatic stone breaking device.

Preoperative clinical data included patient-related characteristics, stone characteristics, and type of procedures prior to surgery. Thus, preoperative clinical information regarding the patients included: age, sex, presence of diabetes, and degree of hydronephrosis.

Preoperative clinical data that were related to the stone were: stone size, stone localization, and presence of ureteral JJ stent and/or percutaneous nephrostomy catheter prior to surgery.

Surgery information included: the type of surgical procedure (pneumatic or laser lithotripsy with semi-rigid and/or flexible ureteroscope) and duration of the operation.

In all of the patients, the characteristics and degree of postoperative urinary tract infection were analyzed according to the modified Klavien-Dindo classification (MCCS) [16], and for the definition of urinary tract infection, we used provisions of the European Association of Urology (EAU) Section of Infection in Urology (ESIU) [17].

For the definition of sepsis, in addition to the criteria of ESIU, we used the provisions of the International Conference on the definition of sepsis and organ failure and guidelines for the use of innovative therapies in sepsis of American pediatricians and critical care organizations (Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis, The American College of Chest Physicians (ACCP)/Society of Critical Care Medicine (SCCM) Consensus Conference Committee, established in 1992 and supplemented 2001/2003 [18]. According to these criteria, sepsis is defined as the presence of the source of infection and Systemic Inflammatory Response Syndrome (SIRS). For SIRS, it is characteristic that two or more of the following criteria are present: body temperature > 38 ºC or < 36 ºC; heart rate > 90/min; respiration rate of 12/min or CO_2 partial pressure < 32 mmHg; leukocytosis: 12,000 or 4,000/mm^3. Severe sepsis is characterized by organ dysfunction and septic shock by acute circulatory collapse with persistent arterial hypotension [19].

All data in this study were processed in the SPSS 20.0 (IBM Corporation) software package. The selected level of significance or the probability of the first type error was 0.05. The examinees were classified into two groups. In the first group were patients who had ureteroscopic lithotripsy and did not have postoperative urinary tract infection. In the second group were patients with ureteroscopic lithotripsy who had postoperative urinary tract infection.

Results

Of the 389 patients who had ureteroscopic lithotripsy, 350 (90%) were without postoperative urinary tract infection and 39 (10%) were with postoperative urinary tract infection.

The average age of patients in the study was 55 (13–92) years. The average size of the stone was 13 (4–50) mm. In 94 (24.2%) patients lithotripsy was performed in the kidney, and in 295 (75.8%) in the ureter. According to kidney localisation, in the lower calyx lithotripsy was performed in 19 (4.9%) patients, in the middle calyx in 7 (1.8%), in the upper calyx in 2 (0.5%), and in the renal pelvis in 66 (17.0%) patients. According to ureter localization, lithotripsy in the lower ureter was performed in 68 (17.4%) patients, in the middle ureter in 94 (24.2%), and in the upper ureter in 133 (34.2%) patients. Laser lithotripsy was performed in 237 (60.9%) patients and lithotripsy with pneumatic probe in 152

Table 1

Incidence of infective complications and postoperative urinary infections and the treatment method

Complication	Patients n (%)	Treatment
Gradus I		
temporary febrile condition	34 (8.7)	Antipyretics
Gradus II		
SIRS	32 (8.3)	Antibiotic therapy
sepsis	3 (0.9)	Antibiotic therapy Parenteral infusion solution Inotropic drugs
Gradus III		
obstructive sepsis- pyelonephritis	2 (0.4)	Endoscopic intervention Placement of JJ stent or PNC
Gradus IVa		
severe sepsis	1 (0.2)	Intesive care unit management
Gradus IVb		
septic shock	1 (0.2)	Intesive care unit management

SIRS – Systemic Inflammatory Response Syndrome; PNC – percutaneous nephrostomy catheter.

(39.0%) ones. The laser was used for lithotripsy in the lower ureter in 15 (3.9%) patients, in the middle ureter in 44 (11.3%), in the upper ureter in 95 (24.4%), in the lower calyx in 19 (4.9%), in the middle calyx in 7 (1.8%), in the upper calyx in 1 (0.2%) and in the renal pelvis in 56 (14.4%) patients. Pneumatic probe was used in the lower ureter in 53 (13.6%) patients, in the middle ureter in 50 (12.9%), in the upper ureter in 38 (9.8%), in the upper calyx in 1 (0.2%) and in the renal pelvis in 10 (2.6%) patients. The average duration of the operation was 40 minutes. The shortest duration of the operation was 5 minutes, and the longest one 185 minutes. Semi-rigid ureteroscope was used in 357 (91.8%) patients, flexible in 28 (7.2%), and in 4 (1.0%) patients both types of ureteroscope were used. In all patients for the localization of stones in the ureter, only the semi-rigid instrument was used: in the lower ureter in 68 (17.4%), in the middle ureter in 94 (24.4%) and in the upper ureter in 133 (34.2%) patients. Semi-rigid instrument was used for lithotripsy in the renal pelvis in 61 (15.7%) patients and in the upper calyx in 1 (0.2%) patient. Flexible urethroscope was not used for lithotripsy in the ureter, but only in the kidney: in the lower calyx in 19 (4.9%) patients, in the middle calyx in 7 (1.8%), in the upper calyx in 1 (0.2%) and renal pelvis in 1 (0.2%) patient.

Infectious complications in our study were reported in 73 (18.7%) patients (Table 1). In 34 (8.7%) patients, a transient febrile state lasting up to 48 hours occured, and these patients, apart from the use of antipyretics, were not further treated. Postoperative urinary tract infection, according to the definitions of EAU/ESIU and Definitions for sepsis and organ failure and Guidelines for the use of innovative therapies in sepsis, the ACCP/SCCM from the International Sepsis Definitions Conference, had 39 (10%) patients [17–19]. In these patients, the treatment included the use of antipyretics, an additional antibiotic, infusion, inotropic and supportive therapy, and in 2 (0.4%) patients additional procedures were performed for placing an ureteral JJ stent and a percutaneous nephrostomy catheter.

A higher incidence of postoperative urinary tract infection was found in 32 (8.2%) patients who had diabetes ($\chi^2 = 22.918$; $p < 0.001$), in 48 (12.3%) patients who had an inserted ureteral JJ stent prior to surgery ($\chi^2 = 4.620$; $p = 0.040$) and in 52 (13.3%) patients who had a percutaneous nephrostomy catheter ($\chi^2 = 8.240$; $p = 0.004$) (Table 2). It was also reported in patients with larger stones ($Z = -3.301$; $p = 0.001$) and in patients in whom the operation lasted longer ($t = 4.261$; $p < 0.001$) (Table 3).

In our study no statistically significant difference was found between groups with and without postoperative urinary infection in relation to age, sex, hydronephrosis, the side where lithotripsy was performed, stone localization, type of ureteroscope, and type of stone fragmenting.

In all of the patients with postoperative urinary tract infections, an infective agent in the urinary culture was isolated. The most common bacterium was *Escherichia coli* (43.6%), followed by *Pseudomonas aeruginosa* (25.6%), *Klebsiella species* (12.8%), *Enterococcus faecalis* (5.1%), *Proteus mirabilis* (5.1 %), *Pseudomonas aeruginosa* + *Escherichia coli* (5.1%) and *Proteus mirabilis* + *Pseudomonas aeruginosa* + *Enterococcus faecalis* (2.7%).

Table 2

Diabetes, preoperatively inserted JJ stent and percutaneous nephrostomy catheter (PNC) as possible risk factors for predicting postoperative urinary tract infection following ureteroscopic lithotripsy

Parameter	Total n (%)	Postoperative urinary tract infection, n (%)		*p*-value
		No	Yes	
Number of patients	389 (100)	350 (90.0)	39 (10.0)	
Diabetes	32 (8.2)	21 (65.6)	11 (34.4)	< 0.001
Preoperatively inserted JJ stent	48 (12.3)	39 (81.2)	9 (18.8)	0.040
PNC	52 (13.3)	41 (78.8)	11 (21.2)	0.004

Table 3
Stone size and operative time duration as possible risk factors for predicting postoperative urinary tract infection following ureteroscopic lithotripsy

Postoperative urinary tract infection	Number of patients	Stone size* (mm) mean (range)	Operative time duration (min) mean (range)
No	350	12.7 (4–50)	42.6 (5–185)
Yes	39	16.1 (5–35) †	60.0 (20–130)†
Total	389	13.2 (4–50)	44.4 (5–185)

***Stone size was calculated as the sum of the diameter of each stone in case of multiple stones.**
† $p < 0.001$.

Discussion

This study examined some of the possible risk factors for the occurrence of postoperative urinary tract infection in patients following ureteroscopic lithotripsy.

Although ureteroscopic lithotripsy is a safe procedure today, the risks of occurring postoperative infectious complications are not negligible [14] and are not clearly defined in the existing literature [1].

Diabetes mellitus is associated with older age and other chronic diseases. Daels et al. [20] analyzed the data from the Clinical Research Office of the Endourological Society (CROES) database of a multicentre study of Endourological Society, which included 114 hospitals from 32 countries and 11,885 patients with ureteroscopic lithotripsy, and concluded that the risk of complications was greater in elderly patients suffering from associated diseases. It was found that there was a significant risk of complications in patients suffering from cardiovascular disease, diabetes, obesity and patients using anticoagulant therapy. In many studies, diabetes was analyzed as a risk factor for the occurrence of infectious complications following ureteroscopic lithotripsy. Uchida et al. [10] analyzed diabetes and frequency of SIRS following ureteroscopic laser lithotripsy but did not find statistically significant difference between groups without and with postoperative signs of SIRS ($p = 0.71$) [10]. Similar results were published by Berardinelli et al. [16], Moses et al. [7], and Sohn et al. [14] in their papers. However, in our study of 32 patients with diabetes, who had ureteroscopic lithotripsy, 11 (34.4%) patients had a postoperative urinary tract infection. By univariate analysis, it was concluded that there was a statistically significant difference between groups without and with postoperative urinary tract infection ($p < 0.001$). Diabetes as a risk factor for postoperative urinary tract infection was examined by Martov et al. [21] in 2015. They analyzed data from the CROES database and concluded that in patients with diabetes the incidence of postoperative infections was higher ($p < 0.05$).

By multivariate analysis in our study, preoperatively placed ureteral JJ stent represented a significant risk factor for the occurrence of postoperative urinary tract infection ($p = 0.024$). A JJ stent was preoperatively placed due to verified obstructive pyelonephritis in 48 (12.3%) patients. It was left in place during an average 4 weeks, and in the group with postoperative urinary infection for 8 weeks. Also, by univariate analysis, statistically significant difference existed between groups without and with postoperative urinary infection in relation to preoperatively placed JJ stent ($p = 0.040$). In a study by Japanese authors, Mitsuzuka et al. [22], preoperatively placed JJ stent was associated with a higher incidence of postoperative febrile urinary tract infection in the univariant ($p = 0.013$), but not in multivariate analysis ($p = 0.529$). In this study, the univariate ($p < 0.001$) and multivariate ($p = 0.044$) analyses showed that acute pyelonephritis was a significant risk factor for the occurrence of postoperative urinary infection. Half of the patients with JJ stent had preoperatively acute pyelonephritis, so it was not entirely clear in what degree the preoperatively placed JJ stent independently influenced the occurrence of postoperative urinary infection. The presence of preoperative JJ stent was associated with the appearance of SIRS in a study by Uchida et al. [10], which was proven by the univariate analysis ($p < 0.001$), but not by multivariate analysis. There is possible bacterial colonization on the surface of the stent (bacterial "biofilm"), and due to the reflux of urine from the urinary bladder, the risk of pyelonephritis and sepsis increases [11]. In a study published by Moses et al. [7] in 2016, 550 patients underwent ureteroscopic laser lithotripsy and in 327 (60%) patients, a JJ probe was placed for passive dilatation of the ureter. Postoperative urinary tract infection was more frequent in the group with JJ stent ($p = 0.025$). However, these results are in contrast to those from a study published by Blackmur et al. [12] and show that preoperatively placed JJ stent reduces the risk of postoperative SIRS in patients with preoperative positive urine culture.

Percutaneous nephrostomy catheter, as well as ureteral JJ stent, is most often preoperatively placed in patients with obstructive pyelonephritis. In our study, 52 (13.4%) patients had percutaneous nephrostomy (PNS) catheter prior to ureteroscopic lithotripsy. PNS catheter was necessarily placed in a patient who had a preoperatively verified hydronephrosis of 3rd or 4th grade according to the 2007 classification by Onen [23]. In case of suspicion of obstructive pyelonephritis, renal failure, and renal impairment, PNS catheter is installed regardless of the degree of hydronephrosis. The univariate analysis showed that patients with preoperatively established PNS catheter recorded a higher incidence of postoperative urinary tract infection ($p = 0.004$), which is in line with a study published by Sohn et al. [14], in which patients who had preoperatively PNS catheter had a greater incidence of infectious complications. However, in a study by Japanese authors, Uchida et al. [10], in

patients with preoperatively introduced PNS catheter, no higher incidence of postoperative infectious complications was found ($p = 0.42$). These authors state that PNS catheter plays an important role during ureteroscopic lithotripsy improving intraoperative irrigation and reducing intrarenal pressure. This discrepancy between studies, and higher incidence of postoperative urinary tract infection in our study and in that by Sohn et al. [14], can also be explained by the fact that patients who had PNS catheter prior to surgery were mainly patients with multiple stones, big stone and preoperative bacteriuria (due to colonization of PNS catheter surface with bacterial biofilm), which also had an effect on the occurrence of postoperative urinary tract infection.

The size of the stone in our study was from 4 to 50 millimeters. In patients who had multiple stones, but at one localization, the total size of the stone was taken as the sum of diameters of all the stones. Uchida et al. [10] analyzed the cumulative volume of the stone as the volume of the each stone [cumulative diameter of the stone in their study amounted to 10 millimeters (3–47 millimeters)] and did not find that the volume and size of the stone were significant factors for the occurrence of postoperative urinary tract infection. In our study, in the group of patients with postoperative urinary tract infection, the mean stone size was 16.1 millimeters, and in the group of patients who did not have a postoperative urinary infection, the mean stone size was 12.7 millimeters. These results might be an explanation for the statistical significance of the occurrence of postoperative urinary tract infections after ureteroscopic lithotripsy ($p = 0.001$) in our study in relation to results published by Uchida et al. [10] since the cumulative stone diameter in our study was higher. In a study from 2015, Mitsuzuka et al. [22] analyzed the stone size as a risk factor for the occurrence of postoperative urinary tract infection, and no statistical significance of this parameter was found ($p = 0.139$). In their study, the stones were divided by sizes into stones smaller than 20 millimeters and those of 20 or more millimeters. In a group of patients with a stone size below 20 millimeters, 15.2% of patients had postoperative urinary infection, and 25% of patients had postoperative urinary infection when the stone sizes were 20 or more than 20 millimeters.

The average length of surgery in our study was 44.4 (5/185) minutes, and in the group of patients with postoperative urinary infection 60 (20/130) minutes. Multivariate analysis showed that there was a statistically significant difference between groups without and with postoperative urinary tract infection in relation to the length of the operation ($p < 0.001$). It is understandable that the length of ureteroscopic lithotripsy may also depend on the severity of the case, the technical deficiencies of the existing equipment, the stone size, as well as the stone type and location. The length of the operation increases the intraoperative exposure to the bacteria that are located on the surface of the stone or are released from the stone breaking. Knipper et al. [24] found in their study that longer operating time was associated with complications. Moses et al. [7] state that if the operative time lasts over 120 minutes, it is associated with postoperative urinary tract infection ($p < 0.001$). The identical results are found by Fan et al. [25] ($p = 0.026$) and Martov et al. [21] ($p < 0.001$), who in their studies suggest that the length of the operation has an effect on the higher incidence of postoperative urinary tract infection. However, Berardinelli et al. [16], Mitsuzuka et al. [22], and Sohn et al. [14] state that the length of the operation did not cause the higher incidence of postoperative urinary infection. The explanations for the difference of our results with the results of Berardinelli et al. [16], Mitsuzuka et al. [22], and Sohn et al. [14] studies are that in those studies the total diameter of the stone was smaller. Also, there was a higher number of patients in our study who had a preoperatively and postoperatively placed ureteral JJ stent, which prolonged the duration of the operation and exposure to bacteria.

Infectious complications in our study were reported in 73 (18.7%) patients. Postoperative urinary infection, as defined by the EAU/ESIU and Definitions for sepsis and organ failure and Guidelines for the use of innovative therapies in sepsis, the ACCP/SCCM, from the International Sepsis Definitions Conference, had 39 (10%) patients. According to these criteria, all 39 patients had complicated postoperative urinary tract infection [all had an elevated body temperature ($\geq$ 38 ºC) and leukocytosis (12,000/mm^3] and their treatment required the use of antipyretics, an additional antibiotic therapy, infusion, inotropic and supportive therapy. In 2 (0.5%) patients, additional procedures for placing JJ stent and percutaneous nephrostomy catheter were made.

In our study, 34 (8.7%) patients had a transient febrile state lasting up to 48 hours and defined according to the MCCS as grade I complications. Infectious of grade I complications in our study were not classified as postoperative urinary tract infection because patients did not require additional pharmacological treatment or the use of antibiotic therapy, except for the use of antipyretics. Mitsuzuka et al. [22] stated that febrile status following ureteroscopic lithotripsy occurred in 15% of patients, and the total number of infectious complications after ureteroscopic lithotripsy in their study was 18.3%. As in our study, Mitsuzuka et al. [22] classified febrile condition with a body temperature up to 38 ºC, without the need for additional treatment or administration of antibiotics as an infectious complication of grade I.

Out of 39 patients with postoperative urinary tract infections in our study, 35 (8.9%) patients had grade II infectious complications, of which 32 (8.3%) had characteristic signs for SIRS (with a measured body temperature of 38ºC and leukocytosis over 12,000). Uchida et al. [10] reported 5.7% of patients with SIRS following ureteroscopic laser lithotripsy. Out of 27 patients who had SIRS in our study, the condition of one patient required admission to the intensive care unit, but no fatal outcome was registered. This indicates that SIRS does not necessarily lead to a fatal outcome, but requires a long treatment that has an impact on the physical and economic status of a patient. Of 35 patients in our study with grade II infectious complications, 3 (0.9%) patients developed sepsis, which

was confirmed by a positive, hemoculture. These 3 patients, besides signs for SIRS had hypotension and cardiovascular collapse and required treatment with an additional antibiotic therapy and use of infusion solutions and inotropic drugs, but their condition did not require staying in the intensive care unit, although the finding of hemoculture was positive. In all 3 patients, *Staphylococcus coagulase* (-) was isolated. In 2 (0.5%) patients with grade III complications, obstructive pyelonephritis and sepsis were postoperatively verified, and apart from the application of antibiotic therapy, it was necessary to place JJ stent in one patient, and percutaneous nephrostomy catheter in the second one. In one patient, *Escherichia coli* was isolated from the hemoculture, and in the second one *Staphylococcus coagulase* (-). Two patients in our study had grade IV complications and were treated in the intensive care unit due to circulatory collapse and cardiorespiratory dysfunction, under the diagnosis of severe sepsis and septic shock. They were intubated and ventilated, with simultaneous administration of several antibiotics, inotropic drugs, and colloidal and nutritional solution infusions. *Escherichia coli* was isolated from hemoculture in both patients.

Sepsis after ureteroscopic lithotripsy is one of the most severe complications. In our study, 7 (1.8%) patients developed clinical signs of the sepsis. Out of this number, 5 (1.4%) patients were treated in the department, and 2 (0.4%) required monitoring and treatment in the intensive care unit. In other studies that dealt with risk factors for the occurrence of postoperative urinary tract infection, the frequency of sepsis was between 1–3%. Mitsuzuka et al. [22] reported 1.3% of patients with sepsis following ureteroscopic lithotripsy. In the existing literature, only a few studies analyzed the frequency of sepsis following ureteroscopic lithotripsy. Geavlete et al. [26] reported that 1.13% of 2,735 patients had sepsis after ureteroscopic lithotripsy with a semi-rigid ureteroscope. Eswara et al. [15] analyzed 328 patients who had endourological procedures, of which 11 (3%) had sepsis. However, Blackmur et al. [12], in their analysis of the risk factors for the occurrence of sepsis after ureteroscopic lithotripsy in 462 patients, reported that 34 (7.4%) patients had sepsis. This somewhat larger number of patients who had sepsis after ureteroscopic lithotripsy can be explained by the fact the study included both patients with bilateral ureteroscopic lithotripsy and a large number of patients who had associated cardiovascular disease and diabetes, a high American Society of Anestesiology (ASA) score and a larger volume of stones.

Our study had several shortcomings and limitations. All of 389 patients were referred for treatment from smaller hospitals and they already had a complicated state with large or infected stone since our institution is a tertiary reference center for the treatment of urolithiasis. Most of these patients had associated comorbidities, and previously failed procedures in other hospitals. These were the possible reasons for a greater incidence of postoperative urinary tract infections following ureteroscopic lithotripsy in our study than in reference ones. Additional intraoperative urinalysis for bacterial examination and bacteriological examination of stones and fragments obtained during the procedure, that could provide additional information in the selection of antibiotics for the prevention of severe infectious complications, were not done in this study.

However, despite some shortcomings, the benefits of the study are: the broad age group of patients who were analyzed, the evaluation of a large number of variables and the use of standardized criteria in the identification of risk factors for the emergence of postoperative urinary tract infection after ureteroscopic lithotripsy. Also, the use of a standardized classification system for infectious complications (MCCS) made it easier and more accurate for comparison with reference studies.

Conclusion

Patients with diabetes, preoperatively placed JJ stent or percutaneous nephrostomy catheter, large stones and with prolonged operating time, have a higher risk of developing postoperative urinary infection. Accordingly, adequate preoperative preparation and antibiotic prophylaxis can contribute to preventing infectious complications and postoperative urinary tract infection in these patients.

REFERENCES

1. European Association of Urology (Updated 2017). Guidelines on urolithiasis. Available from: http://uroweb.org/guideline/urolithiasis/.
2. *de la Rosette J, Denstedt J, Geavlete P, Keeley F, Matsuda T, Pearle M*, et al. CROES URS Study Group. The clinical research office of the endourological society ureteroscopy global study: indications, complications, and outcomes in 11,885 patients. J Endourol 2014; 28(2): 131–9.
3. *Sofer M, Watterson JD, Wollin TA, Nott L, Razvi H, Denstedt JD.* Holmium: YAG laser lithotripsy for upper urinary tract calculi in 598 patients. J Urol 2002; 167(1): 31–4.
4. *Jiang H, Wu Z, Ding Q, Zhang Y.* Ureteroscopic treatment of ureteral calculi with holmium: YAG laser lithotripsy. J Endourol 2007; 21(2): 151–4.
5. *Biester R, Gillenwater JY.* Complications following ureteroscopy. J Urol 1986; 136(2): 380–2.
6. *Bloom J, Fox C, Fullerton S, Matthews G, Phillips J.* Sepsis after elective ureteroscopy. Can J Urol 2017; 24(5): 9017–23.
7. *Moses RA, Ghali FM, Pais VM Jr, Hyams ES.* Unplanned Hospital Return for Infection following Ureteroscopy-Can We Identify Modifiable Risk Factors? J Urol.2016; 195(4 Pt 1): 931–6.
8. *Matsumoto M, Shigemura K, Yamamichi F, Tanaka K, Nakano Y, Arakawa S,* et al. Prevention of infectious complication and its risk factors after urological procedures of the upper urinary tract. Urol Int 2012; 88: 43–7.

9. *Özsoy M, Acar Ö, Sarica K, Saratlija-Novakovic Z, Fajkovic H, Librenjak D,* et al. Impact of gender on success and complication rates after ureteroscopy. World J Urol 2015; 33(9): 1297–302.
10. *Uchida Y, Takazawa R, Kitayama S, Tsujii T*. Predictive risk factors for systemic inflammatory response syndrome following ureteroscopic laser lithotripsy. Urolithiasis 2018; 46(4): 375–81.
11. *Nevo A, Mano R, Baniel J, Lifshitz DA*. Ureteric stent dwelling time: a risk factor for post-ureteroscopy sepsis. BJU Int 2017; 120(1): 117–22.
12. *Blackmur JP, Maitra NU, Marri RR, Housami F, Malki M, McIlhenny C*. Analysis of Factors' Association with Risk of Postoperative Urosepsis in Patients Undergoing Ureteroscopy for Treatment of Stone Disease. J Endourol 2016; 30(9): 963–9.
13. *Akbas A, Kurt O*. How to manage sepsis associated with ureteral calculi? Urolithiasis 2016; 44(3): 285–6.
14. *Sohn DW, Kim SW, Hong CG, Yoon BI, Ha US, Cho YH*. Risk factors of infectious complication after ureteroscopic procedures of the upper urinary tract. J Infect Chemother 2013; 19(6): 1102–8.
15. *Eswara JR, Shariftabrizi A, Sacco D*. Positive stone culture is associated with a higher rate of sepsis after endourological procedures. Urolithiasis 2013; 41(5): 411–4.
16. *Berardinelli F, De Francesco P, Marchioni M, Cera N, Proietti S, Hennessey D,* et al. Infective complications after retrograde intrarenal surgery: a new standardized classification system. Int Urol Nephrol 2016; 48(11): 1757–62.
17. *Johansen TE, Botto H, Cek M, Grabe M, Tenke P, Wagenlehner FM*, et al. Critical review of current definitions of urinary tract infections and proposal of an EAU/ESIU classification system. Int J Antimicrob Agents 2011; 38 Suppl: 64–70.
18. *Bone RC, Balk RA, Cerra FB, Dellinger RP, Ferin AM, Knaus WA*, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Cosensus Conference Commitee. American College of Chest Physicians/Society of Critical Care Medicine. Chest 1992; 101(6): 1644–55.
19. *Levy MM, Fink MP, Marshall JC, Abraham E, Angus D, Cook D,* et al. 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. Crit Care Med 2003; 31(4): 1250–6.
20. *Daels FP, Gaizauskas A, Rioja J, Varshney AK, Erkan E, Ozgok Y,* et al. Age-related prevalence of diabetes mellitus, cardiovascular disease and anticoagulation therapy use in a urolithiasis population and their effect on outcomes: the Clinical Research Office of the Endourological Society Ureteroscopy Global Study. World J Urol 2015; 33(6): 859–64.
21. *Martov A, Gravas S, Etemadian M, Unsal A, Barusso G, D'Addessi A*, et al. Postoperative infection rates in patients with a negative baseline urine culture undergoing ureteroscopic stone removal: a matched case-control analysis on antibiotic prophylaxis from the CROES URS global study. J Endourol 2015; 29(2): 171–80.
22. *Mitsuzuka K, Nakano O, Takahashi N, Satoh M*. Identification of factors associated with postoperative febrile urinary tract infection after ureteroscopy for urinary stones. Urolithiasis 2016; 44(3): 257–62.
23. *Kim SY, Kim MJ, Yoon CS, Lee MS, Han KH, Lee MJ*. Comparison of the reliability of two hydronephrosis grading systems: the Society for Foetal Urology grading system vs. the Onen grading system. Clin Radiol 2013; 68(9): e484–90.
24. *Knipper S, Tiburtius C, Gross AJ, Netsch C.* Is prolonged operation time a predictor for the occurence of complications in ureteroscopy? Urol Int 2015; 95(1): 33–7.
25. *Fan S, Gong B, Hao Z, Zhang L, Zhou J, Zhang Y*, et al. Risk factors of infection complications following flexible ureteroscope with a holmium laser: a retrospective study. Int J Clin Exp Med 2015; 8(7): 11252–9.
26. *Geavlete P, Georgescu D, Nita G, Mirciulescu V, Cauni V*. Complications of 2735 retrograde semirigid ureteroscopy procedures: a single-center experience. J Endourol 2006; 20(3): 179–85.

Received on October 14, 2018.
Revised on December 2, 2018.
Accepted on December 14, 2018.
Online First December, 2018