Characteristics and Drug Resistance of Pathogens in Urinary Tract Infection Patients Complicated with Urinary Calculi

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Luo *et al.*: Drug resistance pathogens in patients with urinary calculi

Main objective is to explore the characteristics, drug resistance, and risk factors of pathogens in urinary tract infection patients complicated with urinary calculi. A total of 417 patients with urinary calculi who were treated in our hospital from January 2017 to December 2019 were enrolled in this study, including 234 patients with urinary tract infection and 183 patients without urinary tract infection. The midstream urine of 234 patients with urinary tract infection were cultured and used in the drug sensitivity test. Univariate and multivariate logistic regression analysis was used to analyze the risk factors of postoperative urinary tract infection in patients with urinary calculi. A total of 624 strains of pathogens were isolated from the urine samples of 234 patients with postoperative urinary tract infection, of which 386 strains were gram-negative bacteria (61.86 %), 169 strains were gram-positive bacteria (27.08 %), and 69 strains were fungus (11.06 %). In the drug resistance test, the resistance rates of *Staphylococcus aureus* to tetracycline, rifampicin, and levofloxacin, and the resistance rate of *Enterococcus faecium* to levofloxacin was low. *Enterococcus faecalis* had the lowest resistance rate to levofloxacin, followed by azithromycin and gentamicin. The resistance rates of *Staphylococcus epidermidis* to levofloxacin and vancomycin were low and the resistance rate to erythromycin was 100.00 %. The resistance rate of *Acinetobacter baumannii*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Proteus mirabilis* to meropenem and amikacin, and the resistance rate of *Klebsiella pneumoniae* and *Proteus mirabilis* to etilmicin and ceftriaxone were low.

Univariate analysis showed that the postoperative urinary tract infection in patients with urinary calculi was related to the age, operation time, postoperative indwelling catheter time, stone size, and preoperative prophylactic use of antibiotics. Multivariate logistic regression analysis showed that the age (≥65 y old), operation time (≥60 min), postoperative indwelling catheter time (≥7 d), and no preoperative prophylactic use of antibiotics were the risk factors of postoperative urinary tract infection in patients with urinary calculi. Patients with urinary calculi were prone to urinary tract infection after the operation. The main pathogens of infection were gram-negative bacteria and gram-positive bacteria, and they were resistant to some antibiotics. Antibiotics should be treated reasonably according to the risk factors of urinary tract infection and the results of the drug sensitivity tests to avoid further aggravation of bacterial drug resistances

Key words: Urinary calculi, urinary tract infection, pathogenic bacteria, drug resistance, risk factors

Urinary infection was an inflammation caused by the bacteria directly invading the urinary tract. Both urinary tract obstruction and reflux can cause abnormal changes in urodynamics, resulting in the poor urinary drainage and retention in the urinary tract, which was easy to cause infection. Urinary infection was a common infectious disease in the clinic, which was the second largest infectious disease in the world, and its incidence was second only to the respiratory tract infection[1,2]. There were many factors causing the urinary infection, including the decrease of immune function, postoperative catheter indwelling, and complicated with diabetes, urinary calculi[3-5]. With the progress of modern technology, minimally invasive surgery was widely used in the treatment of urinary calculi. However, the postoperative catheter indwelling often caused the urinary tract infection[6]. Due to the urinary tract infection seriously affects the recovery of postoperative prognosis and perioperative infection, and the unreasonable use or abuse of antibiotics in many hospitals, the drug resistance pathogens had been seriously threatened the patients[7,8]. Therefore, it is of great significance for clinical diagnosis and treatment to further understand the characteristics and drug resistance of pathogens in urinary tract infection patients complicated with urinary calculi. This study aims to explore the characteristics and drug resistance of pathogens in urinary tract infection patients complicated with urinary calculi, thus to providing a reliable basis for the diagnosis and treatment of urinary tract infection[9].

A total of 417 patients with urinary calculi who were treated in our hospital from January 2017 to December 2019 were analyzed retrospectively, including 234 patients with urinary tract infection and 183 patients without urinary tract infection. The midstream urine of 234 patients with urinary tract infection was cultured and used in the drug sensitivity test. A total of 624 strains of pathogens were successfully isolated from urine.

The isolation, culture, and identification of the pathogens follow the "The National Clinical Test Regulation of Operation".

Biomerieux VITEK 2 Compact was used in the isolation and identification of the pathogens. The quantitative culture standard: gram-positive bacteria (10^4 colony-forming units per milliliter-(CFU/ml)), gram-negative bacteria (10^5 CFU/ml), and fungus (10^4 CFU/ml).

Biomerieux VITEK 2 Compact automatic microbial identification and drug sensitivity system was used in bacterial identification, drug sensitivity test, and fungus identification, and Biomerieux ATB Expression was used in fungus drug sensitivity test. All the experiments were in accordance with the rules and standards in the Clinical and Laboratory Standards Institute (CLSI), and the results of the drug sensitivity were further judged.

All the data were analyzed by WHONET 5.6 software, and the rates were compared by Statistical Package for Social Sciences (SPSS) 21.0 analysis, $p < 0.05$ means the difference was statistically significant.

Among the isolated 624 strains of pathogens, gram-negative bacteria accounted for 61.86 % (386), gram-positive bacteria accounted for 27.08 % (169), and

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fungus accounted for 11.06 % (69). The composition of the flora was shown in Table 1.

In the drug resistance test, the resistance rates of *Staphylococcus aureus* to tetracycline, rifampicin, and levofloxacin were low, and the resistance rate of *Enterococcus faecium* to levofloxacin was low. *Enterococcus faecalis* had the lowest resistance rate to levofloxacin, followed by azithromycin and gentamicin. The resistance rates of *Staphylococcus epidermidis* to levofloxacin and vancomycin were low and the resistance rate to erythromycin was 100.00 % (Table 2).

The resistance rate of *Acinetobacter baumannii*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Proteus mirabilis* to meropenem and amikacin were low. The resistance rate of *Klebsiella pneumoniae* and *Proteus mirabilis* to etilmicin and ceftriaxone were low (Table 3).

Univariate analysis was used to explore the risk factors of postoperative urinary tract infection in patients with urinary calculi. Univariate analysis showed that the postoperative urinary tract infection in patients with urinary calculi was not related the sex, intraoperative

blood loss, and baric index (p>0.05), and related to the age, operation time, postoperative indwelling catheter time, stone size, and preoperative prophylactic use of antibiotics (p<0.05) (Table 4).

To explore the independent risk factors of urinary tract infection, multivariate logistic regression analysis was used to analyze the related factors obtained by univariate analysis. Multivariate logistic regression analysis showed that the age (≥65 y old), operation time (≥60 min), postoperative indwelling catheter time (≥7 d), and no preoperative prophylactic use of antibiotics were the risk factors of postoperative urinary tract infection in patients with urinary calculi (p<0.05) (Table 5).

Urinary tract infection was an inflammatory reaction caused by the invasion of bacteria and fungus in urine, which was easily induced by external factors, such as long-term indwelling catheter after operation, poor wound care[10]. Perioperative urinary tract infection must be controlled when the urinary calculi patients were treated with surgical treatment, otherwise, it was easy to affect the postoperative recovery of patients,

TABLE 1: THE COMPOSITION OF THE FLORA

Classification	Pathogens	Number	Percentage (%)
Gram-positive bacteria (n=34)	*Staphylococcus aureus*	79	12.60
	Enterococcus faecium	35	5.61
	Enterococcus faecalis	34	5.45
	Staphylococcus epidermidis	21	3.37
Gram-negative bacteria (n=78)	*Acinetobacter baumannii*	45	7.21
	Escherichia coli	148	23.72
	Klebsiella pneumonia	74	11.86
	Pseudomonas aeruginosa	64	10.26
	Proteus mirabilis	55	8.81
Fungus (n=14)	*Candida tropicalis*	50	8.00
	Candida albicans	19	3.01

TABLE 2: ANTIMICROBIAL RESISTANCE SPECTRUM OF GRAM-POSITIVE BACTERIA

Antibacterials	*Staphylococcus aureus* (n=79)		*Enterococcus faecium* (n=35)		*Enterococcus faecalis* (n=34)		*Staphylococcus epidermidis* (n=21)	
	Number	Resistance rate (%)	Number	Resistance rate (%)	Number	Resistance rate (%)	Number	Resistance rate (%)
Rifampicin	7	8.86	21	60.00	14	41.18	6	28.57
Gentamicin	43	54.43	25	71.43	8	23.53	11	52.38
Ciprofloxacin	21	26.58	27	77.14	18	52.94	3	14.29
Erythromycin	67	84.81	34	97.14	33	97.06	21	100.00
Azithromycin	25	31.65	14	40.00	5	14.71	14	66.67
Penicillin sodium	55	69.62	16	45.71	21	61.76	12	57.14
Levofloxacin	6	7.59	6	17.14	2	5.88	1	4.76
Tetracycline	8	10.13	14	40.00	11	32.35	11	52.38
Clindamycin	65	82.28	32	91.43	32	94.12	16	76.19
Vancomycin	59	74.68	23	65.71	22	64.71	6	28.57

TABLE 3: ANTIMICROBIAL RESISTANCE SPECTRUM OF GRAM-NEGATIVE BACTERIA

Antibacterials	*Acinetobacter baumannii* (n=45)		*Escherichia coli* (n=148)		*Klebsiella pneumonia* (n=74)		*Pseudomonas aeruginosa* (n=64)		*Proteus mirabilis* (n=55)	
	Number	Resistance rate (%)	Number	Resistance rate (%)	Number	Resistance rate (%)	Number	Resistance rate (%)	Number	Resistance rate (%)
Cefuroxime	35	77.78	106	71.62	62	83.78	62	96.88	51	92.73
Cefoxitin	29	64.44	74	50.00	37	50.00	23	35.94	32	58.18
Ceftazidime	27	60.00	81	54.73	27	36.49	52	81.25	31	56.36
Cefotaxime	20	44.44	85	57.43	28	37.84	30	46.88	21	38.18
Amoxicillin	43	95.56	142	95.95	73	98.65	63	98.44	43	78.18
Ciprofloxacin	37	82.22	112	75.68	60	81.08	37	57.81	41	74.55
Etimicin	-	0.00	88	59.46	20	27.03	-	-	10	18.18
Amikacin	7	15.56	4	2.70	17	22.97	5	7.81	1	1.82
Gentamicin	21	46.67	82	55.41	50	67.57	46	71.88	25	45.45
Meropenem	8	17.78	4	2.70	3	4.05	2	3.13	6	10.91
Levofloxacin	31	68.89	102	68.92	56	75.68	49	76.56	37	67.27

TABLE 4: UNIVARIATE ANALYSIS OF POSTOPERATIVE URINARY TRACT INFECTION IN PATIENTS WITH URINARY CALCULI

Factors		Cases	Urinary tract infection	Without urinary tract infection	X^2	p
Age	≥65	203	153	50	16.345	0.001
	<65	214	81	133		
Sex	Male	189	106	73	0.937	0.538
	Female	228	128	110		
Intraoperative blood loss	≥100 ml	157	88	75	0.855	0.641
	<100 ml	260	124	136		
Stone size	≥3 cm	192	147	45	4.102	0.042
	<3 cm	215	86	129		
Operation time	≥60 min	145	97	48	6.391	0.012
	<60 min	272	137	135		
Postoperative indwelling catheter time	≥7 d	152	118	34	10.237	0.001
	<7 d	265	116	149		
Preoperative prophylactic use of antibiotics	Yes	268	108	160	7.787	0.007
	No	149	126	23		
Baric index	≥20 kg/m²	253	140	113	0.751	0.793
	<20 kg/m²	164	94	70		

and even cause life-threatening inflammatory reactions such as urinary tract obstruction[11,12].

In this study, through the isolation, culture, and identification of pathogens in the midstream urine of urinary calculi patients complicated with urinary tract infection, it was found that the main pathogens causing urinary tract infection were gram-negative bacteria, gram-positive bacteria, and fungus. *Escherichia coli* were the most common bacteria in gram-negative bacteria, which may be related to the fact that the cilium on the cell wall of *Escherichia coli* can specifically recognize the specific receptors on urothelial cells. *Escherichia coli* can adhere to the surface of urinary transitional epithelium for retention and reproduction, thus inducing infection. Through the drug sensitivity test, it was found that the resistance rate of gram-negative bacteria to cefuroxime, amoxicillin, ciprofloxacin, and levofloxacin was high, which was consistent with the existing research[13,14]. It may be related to the frequent use of these drugs in the clinic.

Staphylococcus aureus (belongs to *staphylococcus*) was the most common bacteria in gram-positive bacteria, and the most common bacteria causing inflammation, which distributes widely and has strong infectivity. In some studies, it was found that the most infectious pathogens in gram-positive bacteria were *Enterococcus faecium* and *Enterococcus faecalis*, which was not consistent with the results of this study, it may be caused by the regional reasons[15,16]. The results of the drug sensitivity tests showed that the resistance rate of gram-

TABLE 5: MULTIVARIATE LOGISTIC REGRESSION ANALYSIS OF POSTOPERATIVE URINARY TRACT INFECTION IN PATIENTS WITH URINARY CALCULI

Factors	Regression coefficient	SD	X^2	p	Odds ratio (OR)	95 % Confidence intervals (CI)
Operation time	1.104	0.512	6.341	0.017	3.956	1.236-10.536
Postoperative indwelling catheter time	1.053	0.526	5.732	0.028	2.931	1.185-9.321
Preoperative prophylactic use of antibiotics	1.027	0.439	8.255	0.004	5.762	1.978-14.373
Age	1.464	0.616	7.395	0.009	4.389	1.783-11.552
Stone size	1.537	0.507	2.181	0.093	2.105	0.897-10.255

positive bacteria to clindamycin and erythromycin was the highest, and the resistance rate of *Staphylococcus epidermidis* to erythromycin was 100.00 %. The reason may be closely related to the hospital drug management and clinical antibiotic abuse, thus we should pay more attention to the clinical drug management.

Univariate analysis showed that the postoperative urinary tract infection in patients with urinary calculi was related to the age, operation time, postoperative indwelling catheter time, stone size, and preoperative prophylactic use of antibiotics. Multivariate logistic regression analysis showed that the age ($\geq$65 y old), operation time ($\geq$60 min), postoperative indwelling catheter time ($\geq$7 d), and no preoperative prophylactic use of antibiotics were the risk factors of postoperative urinary tract infection in patients with urinary calculi ($p<0.05$). With the increase of age, the immune function and the ability of tissues/organs of patients decreased rapidly, thus they were more likely to have urinary tract infection after the operation. The long operation time was very harmful to the human body, which significantly increased the recovery time of the human body. At the same time, surgical trauma also brings the risk of infection, which greatly increases the risk of urinary tract infection. The postoperative indwelling drainage tube may damage the mucous membrane of the urethra and reduce the defense ability[17], and the long indwelling time was easy to increase the risk of external pathogens entering the urethra, which was more likely to induce urinary tract infection. It has been reported that the asymptomatic bacteriuria was a major cause of urethral infection[18], thus the prophylactic use of antibiotics before the operation can kill bacteria effectively and reduce the risk of urinary tract infection.

In a word, urinary calculi patients were prone to urinary tract infection after the operation, and the main pathogens were gram-negative bacteria and gram-positive bacteria, and they were seriously resistant to some drugs. Antibiotics should be reasonably selected according to the risk factors of urinary tract infection and the results of the drug sensitivity tests to avoid further aggravation of bacterial drug resistance.

Conflict of Interests:

The authors declared no conflict of interest.

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