Original Article

Characteristics of bacterial colonization after indwelling double-J ureteral stents for different time duration

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Abstract

Background: Indwelling Double-J ureteral stenting is commonly used in urological practice and has various complications. This study aimed to assess the frequency of bacterial stent colonization and stent-associated bacteriuria after indwelling it for different time durations and to evaluate the significance of urinary cultures for identification of colonizing microorganisms.

Materials and Methods: A prospective cross-sectional study was conducted. Midstream urine from 72 patients undergoing J stent insertion was investigated microbiologically before stent insertion and on the day of stent removal. The stents were removed by aseptic manipulation, and 1–3 cm of the tip located in the bladder was collected for microbiological study. The urine and stent samples were cultured, and the bacterial pathogens were identified using standard microbiological methods followed by Phoenix automated system. Antimicrobial susceptibility testing was performed by Kirby-Bauer disc diffusion method.

Results: Bacterial colonies were found in 47.2% (34 of 72) of the stents. Of the multiple pathogens identified, *Escherichia coli* (20%) was the most common, followed by *Streptococcus* sp. (17.5%) and *Pseudomonas* sp. (12.5%). The bacteria did not colonize within the first 2 weeks of stent placement. Results showed that 55% of the isolates were resistant to erythromycin, 52.5% to ampicillin, 42.5% to piperacillin, and least resistant being 17.5% for tetracycline and imipenem. However, 81.3% and 66.7% of the stents were colonized when placed for 90–120 days and 60–90 days, respectively.

Conclusion: High prevalence of bacterial isolates and risk of bacteriuria and colonization was found in the DJ stent tips, with *E. coli* being dominant colonizer. Most of the bacteria were resistant to different classes of antibiotics. Bacteriuria and stent colonization gradually increases with the duration of stent retention in the body.

Keywords: Antimicrobial susceptibility, bacterial colonization, ureteral stents

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INTRODUCTION

Ureteral stents have an important role in the management of upper urinary tract obstruction and the prevention of postoperative complications after open or endoscopic urological procedures. Due to its broad range application, stent insertion has become the routine practice in the urology. DJ stents are one of the most commonly used ureteral stents.[1]

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Although ureteric stents are an integral part of urological practice, routine placement of ureteric stents is usually associated with potentially troublesome urinary symptoms or mild morbidities such as dysuria, loin pain, suprapubic pain, and urinary tract infections. Other related complications such as migration, infection, pyelonephritis, breakage, encrustation, and stone formation are seen rarely. It is often assumed that stent-associated disease is rare and asymptomatic, although it may be related to significant morbidity, fever, acute pyelonephritis, bacteremia, chronic renal failure, and even death. All stents can form biofilm with some degree of bacterial adherence irrespective of the stenting duration. Nearly all stents can encrust if left for a sufficiently long time.[2] In indwelling ureteral stents, bacterial colonization in the ureteral stent plays an essential role in the pathogenesis of stent-associated infection.[3]

We investigated the microorganisms responsible for infection/colonization of double J stents and stents-associated bacteriuria and determined the safest time duration a stent can be placed inside the body causing no or less infection/bacterial colonization.

MATERIALS AND METHODS

Study design, participants, and specimen

A prospective cross-sectional study was conducted from January 2017 to June 2017 in patients admitted to a tertiary care hospital in Mangalore (India) requiring double J stent (material used: polyurethane) insertion. Out of 250 patients reviewed, 72 patients meeting inclusion criteria were included. All the patients underwent a baseline assessment, including a detailed medical history, physical examination, urinalysis, complete blood count and X-ray of kidneys, ureters, and bladder (KUB). Patients with active urinary tract infections before admission, ureteral stents being placed for <7 days, and those not willing to consent were excluded. All patients received prophylactic antibiotics before insertion of double J stents. Stents made of polyurethane were inserted retrograde endoscopically under fluoroscopic guidance. The stents were placed for different time durations. The duration of stenting ranged from 7 to 120 days. Stents were removed in the operating room under aseptic conditions. Written informed consent was obtained from all the participants. All the procedures performed in studies involving human participants were approved by the Institutional Ethics Committee (YUEC. 022/16).

Isolation and identification of bacteria

Midstream urine from patients was collected before the insertion of ureteral stents and on the day of stent removal. After the stent removal, 1–3 cm of the tip located in the bladder was cut aseptically and immediately inoculated into MacConkey Agar and CLED Agar (Hi-media, India). All the samples were incubated aerobically at 37°C for 18–24 h. Following incubation, each separate morphological colony type was counted using a digital colony counter. If no growth was observed, the culture was reported as "no growth." All the similar individual colonies were further processed for Gram staining. Pure cultures were obtained and further used for identification. The bacteria were identified using standard microbiological techniques followed by Phoenix 100 automated system (BACTEC 9120) according to the manufacturer's instructions.[4] All the specimens were handled according to the Clinical Microbiology Laboratory Standard Operating Procedures.

Antibiotic sensitivity tests

Antimicrobial susceptibility testing was performed using Kirby-Bauer disc diffusion method on Muller-Hinton agar following the Clinical and Laboratory Standards Institute guidelines. Antimicrobial susceptibility patterns were determined using commercial antimicrobial disks (Hi-Media, India). Ten antibiotics with a broad range of mechanisms of action, including drugs that target cell wall, nucleic acid, and protein were selected [Table 1]. The antimicrobial efficacy was determined by measuring the diameter of the zones of inhibition. Bacterial strains were classified as susceptible (S), intermediate (I), or resistant (R) according to the diameter of the inhibition zone.[5]

RESULTS

Demographic characteristics

A total of 72 patients undergoing J stent insertion were included in the study. There were 61 males (84.7%) and 11 females (15.3%). The mean age of the patients was 42.5 years (range 19–82) with the standard deviation of 12.6. Peak age group of the patient was 25–50 years followed by above 50 years and below 25 years, respectively [Table 2]. DJ stenting was done in 30 patients with ureteric calculi, 14 patients with renal calculi, 9 patients with ureteric stricture, 6 patients for vesicoureteric junction calculi, 5 patients had severe to mild hydronephrosis, 4 patients for pelviureteric junction (PUJ) obstructions, 2 patients had renal and ureteric calculi and 2 patients had PUJ with ureteric stricture.

Bacterial isolates and microbiologic evaluation

Of the 72 samples assayed via standard culture, only 33 (45.8%) showed bacterial growth, and we found 40 bacterial isolates from these. Of the total 40 isolates, 22 (55%) were Gram-positive and 18 (45%) were

Table 1: List of all the antibiotics used in the study

Antibiotics	Abbreviation	Antibiotic concentration (mcg)	Class	Mechanism of action
Piperacillin	PI 100	100	Ureidopenicillin	Inhibits bacterial cell wall synthesis
Gentamicin	GEN 10	10	Aminoglycoside	Protein synthesis
Imipenem	IPM 10	10	Carbapenem	Inhibits bacterial cell-wall synthesis
Ampicillin	AMP 10	10	Penicillins	Inhibits bacterial cell-wall synthesis
Nitrofurantoin	NIT 300	300	Other	Inactivates the bacterial ribosomal proteins
Ciprofloxacin	CIP 5	5	Quinolone	Inhibiting cell division
Ceftazidime	CAZ 30	30	Cephalosporin	Inhibits cell-wall synthesis
Erythromycin	E15	15	Macrolide	Inhibits 50S ribosomal subunits
Nalidixic acid	NA30	30	Other	Inhibits DNA synthesis
Tetracyclin	TE 30	30	Other	Inhibits protein synthesis

Gram-negative. No bacterial colonization was found for first 2 weeks of stent placement; however, 27.8%, 46.2%, 66.7%, and 87.5% of the stents were colonized when placed for 15–30 days, 30–60 days, 60–90 days, and 90–120 days, respectively [Figure 1]. Stent colonization and urine culture positive was found in 30.5% of the total cases. However, 16.7% of cases showing positive stent colonization were found to be negative for urine culture [Table 3]. Bacterial colonies were observed in 47.2% (34 of 72) of the stents. Of the multiple pathogens identified, *Escherichia coli* (20%) was the most common, followed by *Streptococcus* sp. (17.5%) and *Pseudomona*s sp. (12.5%) [Table 4].

Antimicrobial susceptibility test

Most of the isolates were sensitive to the tested antibiotics. 55.5% of the isolates were resistant to erythromycin, followed 52.5% to ampicillin, 42.5% to piperacillin, and least resistant being 17.5% to tetracycline and imipenem. The highest sensitivity among Gram-positive isolates was seen in gentamicin (77.8%), followed by imipenem and ciprofloxacin (66.7%). On the other hand, the antibiotic susceptibility in the Gram-negative organisms was seen predominantly with imipenem (81.8%) followed by ciprofloxacin and tetracycline (68.2%) [Table 5].

Table 2: Age and gender-wise distribution of patients

Sex	Age group (years)			Total (%)
	<25 (%)	25-50 (%)	>50 (%)	
Female	2 (2.7)	7 (9.7)	2 (2.7)	11 (15.3)
Male	5 (6.9)	41 (56.9)	15 (20.8)	61 (84.7)
Total	7 (9.7)	48 (66.7)	17 (23.6)	72 (100)

Table 3: Relation of stent colonization with positive urine cultures

Urine cultures	Stent colonization	
	Negative (%)	Positive (%)
Negative	36 (50)	12 (16.7)
Positive	2 (2.8)	22 (30.5)

Table 4: Bacterial colonies identified from the stents when placed for different time durations

Bacterial colonies	Number of isolates (%)
Escherichia coli	8 (20)
Streptococcus sps.	7 (17.5)
Pseudomonas sps.	5 (12.5)
Staphylococcus sp.	3 (7.5)
Klebsiella pneumoniae	3 (7.5)
Enterococcus faecalis	3 (7.5)
Burkholderia cepacia	3 (7.5)
Achromobacter sps.	2 (5)
Corynebacterium sps.	2 (5)
Staphylococcus warneri	1 (2.5)
Kocuria kristinae	1 (2.5)
Enterococcus faecium	1 (2.5)
Serratia sps.	1 (2.5)
Total	40 (100)

DISCUSSION

Double J stents have been used for more than two decades and become an integral part of the urological armamentarium. Various complications are associated with short and/or long-term use of indwelling stents. The possible side effects can be mild abdominal pain and suprapubic pain, vesicoureteric reflux, stent migration, encrustation, stent fracture, and urinary infections. As the use of indwelling ureteral stents has increased, the stent-associated infection has also become more frequent. Bacterial colonization in the stent plays an essential role in the pathogenesis of stent-associated infections, but the relationship between these DJ stents and the development of urinary tract infection is not clear. Understanding the microorganisms involved in the stent colonization and their sensitivity profile will help in better treatment regime. With respect to the above reasons, an understanding of the nature of stent colonizating bacteria and their dynamics is crucial in understanding or managing stent associated infection [Figure 2].

In the present study, we investigated the bacteria responsible for infection/colonization of Double J stents and determined the safest time duration, a stent can be placed inside the body causing no or less infection/bacterial colonization. Bacterial stent colonization and stent-associated bacteriuria on indwelling ureteral stents have been reported earlier.[6,7]

Table 5: Antibiotic sensitivity pattern of Gram-positive and Gram-negative isolates

Antibiotic	Gram-positive isolates			Gram-negative isolates		
	Sensitive (%)	Intermediate (%)	Resistant (%)	Sensitive (%)	Intermediate (%)	Resistant (%)
Piperacillin	11 (61.1)	2 (11.1)	5 (27.8)	6 (27.2)	4 (18.1)	12 (54.5)
Gentamicin	14 (77.8)	1 (5.6)	3 (16.7)	13 (59.1)	1 (4.5)	8 (36.4)
Imipenem	12 (66.7)	2 (11.1)	4 (22.2)	18 (81.8)	1 (4.5)	3 (13.6)
Ampicillin	10 (55.6)	3 (16.7)	5 (27.8)	4 (18.1)	2 (9.1)	16 (72.7)
Nitrofurantoin	10 (55.6)	4 (22.2)	4 (22.2)	10 (45.5)	6 (27.2)	6 (27.2)
Ciprofloxacin	12 (66.7)	1 (5.6)	5 (27.8)	15 (68.2)	1 (4.5)	6 (27.2)
Ceftazidime	6 (33.3)	10 (55.6)	2 (11.1)	7 (31.8)	2 (9.1)	13 (59.1)
Erythromycin	5 (27.8)	3 (16.7)	10 (55.6)	5 (22.7)	5 (22.7)	12 (54.5)
Nalidixic acid	11 (61.1)	1 (5.6)	6 (33.3)	13 (59.1)	3 (13.6)	6 (27.2)
Tetracyclin	11 (61.1)	5 (27.8)	2 (11.1)	15 (68.2)	2 (9.1)	5 (22.7)

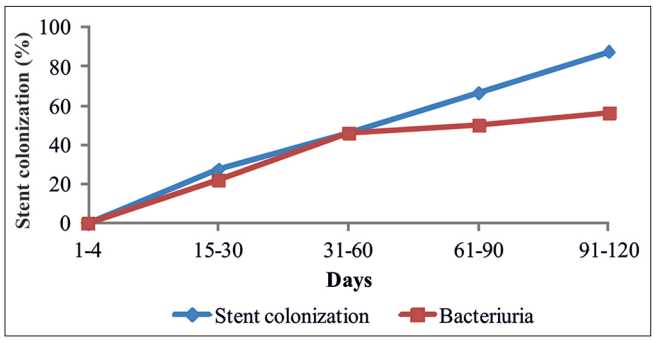

Figure 1: Progression of stent colonization and bacteria through the period of placement of stent

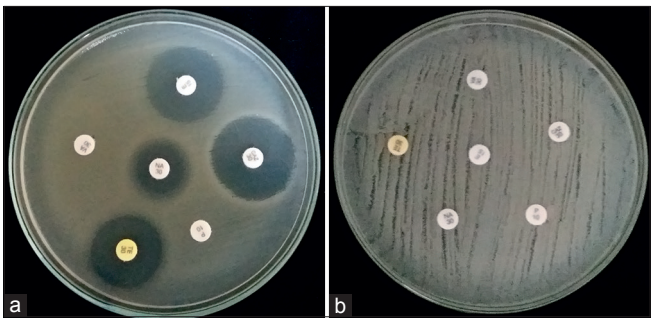

Figure 2: (a and b) Representative images of bacterial susceptibility testing on Muller-Hinton agar

In the present study, we found bacterial colonization in 47.2% of DJ stents which is similar to the previously reported studies.[8] Multiple colonies were identified from the stents and urine. *E. coli, Streptococcus*, and *Pseudomonas* sp. were found to be predominant. Most of the isolates were sensitive to the tested antibiotics. Moreover, multiple colonies were identified in DJ stents that were placed for more than 4 weeks. With the high prevalence of kidney stones[9] and other urological diseases in our population there is an increased need for ureteral stent placement in routine clinical practice. The kind of stent determines the maximum period of time a stent can safely remain in place; however, this is not well defined. Therefore, management of the materials associated with biofilm-based infection remains problematic.

CONCLUSION

High prevalence of bacterial isolates and risk of bacteriuria and colonization was found in the DJ stent tips. Colonization of the J stent tip is increased significantly by longer duration of stent retention. Bacterial resistance to multiple antibiotics is a major concern and therefore precautions should be taken against it. Massive global public awareness campaign, improved global surveillance of drug resistance, and rapid diagnostics to cut unnecessary use of antibiotics will be necessary in this regard.[10,11]

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Kehinde EO, Rotimi VO, Al-Awadi KA, Abdul-Halim H, Boland F, Al-Hunayan A, *et al.* Factors predisposing to urinary tract infection after J ureteral stent insertion. J Urol 2002;167:1334-7.
2. Haleblian G, Kijvikai K, de la Rosette J, Preminger G. Ureteral stenting and urinary stone management: A systematic review. J Urol 2008;179:424-30.
3. Riedl CR, Plas E, Hübner WA, Zimmerl H, Ulrich W, Pflüger H. Bacterial colonization of ureteral stents. Eur Urol 1999;36:53-9.
4. Stefaniuk E, Baraniak A, Gniadkowski M, Hryniewicz W. Evaluation of the BD phoenix automated identification and susceptibility testing system in clinical microbiology laboratory practice. Eur J Clin Microbiol Infect Dis 2003;22:479-85.
5. Wayne PA. Clinical and Laboratory Standards Institute (CLSI) Performance Standards for Antimicrobial Disk Diffusion Susceptibility Tests. Approved Standard. M100-S19. 19th ed. CLSI Document; 2009. p. 29.
6. Keane PF, Bonner MC, Johnston SR, Zafar A, Gorman SP. Characterization of biofilm and encrustation on ureteric stents *in vivo*. Br J Urol 1994;73:687-91.
7. Paick SH, Park HK, Oh SJ, Kim HH. Characteristics of bacterial colonization and urinary tract infection after indwelling of double-J ureteral stent. Urology 2003;62:214-7.
8. Kehinde EO, Rotimi VO, Al-Hunayan A, Abdul-Halim H, Boland F,

Al-Awadi KA. Bacteriology of urinary tract infection associated with indwelling J ureteral stents. J Endourol 2004;18:891-6.
9. Manzoor MA, Mujeeburahiman M, Rekha PD. Association of serum biochemical panel with mineralogical composition of kidney stone in India. Acta Med Int 2017;4:26-30.
10. O'neill J. Tackling drug-Resistant Infections Globally: Final Report and Recommendations; 2016.
11. Chandra HJ, Rao BS, Manzoor AM, Arun AB. Characterization and antibiotic sensitivity profile of bacteria in orofacial abscesses of odontogenic origin. J Maxillofac Oral Surg 2017;16:445-52.