Journal of Paediatric Surgeons of Bangladesh

Original Article

Perspective Determination of the relationship between Bacteriuria and D-J Stent Colonization due to the indwelling of D-J Stent following A-H Pyeloplasty

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Abstract

Background: The Double J (D-J) stent is commonly used following A-H pyeloplasty to facilitate the drainage of urine from the kidney to the bladder. One of the most frequent complications associated with the D-J stent is bacterial colonization, which can occur both on the stent itself and in the urine. However, bacterial colonization of an indwelling D-J stent may serve as a nidus for bacteriuria. The aim of this study was to identify the microbiological characteristics associated with stent colonization and urinary tract infection (UTI) in these patients, as well as to determine the drug susceptibility of the microorganisms involved.

Methods: This study was conducted in the Department of Pediatric Surgery at Chittagong Medical College and Hospital over a period of twenty-four months, from January 2018 to December 2019. A total of 31 patients with unilateral PUJ obstruction who underwent A-H pyeloplasty were included in this study. D-J stents were placed and left in situ for four weeks. The main outcome variables were UTI, stent colonization, microorganisms cultured from both the D-J stent and urine, and their antibiotic sensitivities. Post-operative follow-ups were conducted at 2 weeks, 1 month, 3 months, 6 months, and 12 months following A-H pyeloplasty, utilizing urine routine microbiological examination (R/M/E) and culture and sensitivity (C/S) tests.

Results: There was a total of 31 patients included in this study. The median age was 5 years (IQR: 1.7 years to 7 years), and the male-to-female ratio was 2.44:1. The affected side was right in 14 cases (45.2%) and left in 17 cases (54.8%). One month after the pyeloplasty, 41.9% of cases had positive urinary culture, and the proximal and distal segments of the D-J stent were colonized in 32% and 61.3% of patients, respectively. However, no statistically significant association was found between stent colonization and urine culture. The most commonly identified organisms colonized in both the stent and urine wereEscherichia coli. These cultured organisms were mostly sensitive to nitrofurantoin and meropenem.

Conclusion: Bacterial colonization in the D-J stent does not always induce UTI. Escherichia coli was the most frequently identified organism found in both the stent and urine, while nitrofurantoin and meropenem demonstrated high sensitivity against this pathogen.

Keywords: Double-J stent,urinary tract infection, stent colonization, microorganism, antibiotic sensitivity.

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Introduction:

Pelviureteric junction (PUJ) obstruction is the most common congenital anomaly causing hydronephrosis in neonates, infants, and children[1]. Anderson-Hynes (A-H) pyeloplasty is a well-established technique for PUJ obstruction with a 90–95% success rate [2]. The double J (D-J) stent is an important adjunct in pyeloplasty. Many pediatric urologists advocate the use of transanastomotic D-J stent for pyeloplasty to facilitate urinary drainage[3]. The main component of the D-J stent is polyethylene, which provides stiffness as an aid for insertion[4]. The most common reasons to leave a stent in place after A-H pyeloplasty are to ensure proper urinary diversion, maintain ureteral caliber, ensure anastomotic alignment,and prevent adhesion of the suture line[5].

Usually, an indwelling ureteral stent is left for 4-6 weeks [5]. It has been thought that a minimum of 4 weeks is needed for ureteral healing to protect the newly formed anastomosis and prevent anastomotic leakage [6]. D-J stent is usually removed by cystoscope under general anesthesia [4].

Any material exposed to the urinary system becomes coated with a biofilm composed of glycoproteins, matrix, and exopolymers[7]. Bacterial adherence to the biofilm by their fimbriae is followed by exopolysaccharide synthesis, which in turn strengthens the bacterial attachment to the stent and initiates the infection process [7,8]. Bacterial adhesion to the D-J stent surface may occur within the first 24 hours after stent insertion [9].

Bacterial colonization is very common in D-J stents that are retained for several weeks after pyeloplasty [8]. Bacterial stent colonization and stent-associated bacteriuria on indwelling ureteral stents were described by Riedl et al. (1999) [10]. Bacterial colonization of an indwelling ureteral stent begins approximately 2 weeks after its placement [3, 7]. The stent colonization rates in female patients were higher than in male patients, but the urinary tract infection rates were approximately equal [11]. They also reported in their study that the proximal and distal segments of the stent were colonized in 24% and 34% of patients, respectively [11]. The main organisms colonized from the stents were Escherichia coli, Enterococcus, and Pseudomonas [3, 9]. Staphylococcus aureus and Staphylococcus epidermidis were also common and considered to derive from the urethra [7].

Even with short courses of antibiotics, colonization of the urine eventually follows stent colonization, and infection often results [3]. Ben-Meir et al. (2009) reported that 70% of patients treated with an indwelling D-J stent following pyeloplasty had a positive urine culture, and 10% had symptomatic infections requiring treatment [7].

Materials and methods:

This study represents a prospective observational research conducted over a significant period of twenty-four months, from January 2018 to December 2019. The research was carried out in the Department of Pediatric Surgery at Chittagong Medical College Hospital (CMCH). The study population included all patients under the age of 12, irrespective of gender, who were admitted to the Pediatric Surgery Department for pyeloplasty due to PUJ obstruction at CMCH.

Selection criteria:

A. Inclusion criteria:

1. Age: Under 12 years.
2. Sex: Both (Male and Female).
3. Unilateral hydronephrosis due to PUJ obstruction.
4. Normal functioning of the contralateral kidney.

B. Exclusion criteria:

1. Patient with other congenital urological anomaly.
2. Bilateral PUJ obstruction.
3. Solitary kidney with PUJ obstruction.
4. Pyonephrosis.
5. History of previous nephrostomy.
6. Redopyeloplasty.
7. The patient's guardian who was refused to participate in this study.
8. Patient who did not complete at least 12 months of follow-up.

Variables of this study:

1. Urinary tract infection (UTI).
2. Stent colonization.
3. Microorganism cultured from D-J stent and urine.
4. The pattern of antibiotic sensitivity of cultured bacteria.

Pre-operative preparation:

During pre-operative preparation, correction of UTI was done as per culture and sensitivity (C/S) report, and again confirmed with negative urine culture according to the C/S report.

Antibiotics:

All patients were given a single dosage of broad-spectrum IV antibiotic just prior to induction of anesthesia, and the antibiotic was continued up to the 5thpostoperative day (POD). On 7th POD, a mid-stream urine sample was collected and sent for urine R/M/E and C/S.

Plain X-ray of the KUB region:

The position of the D-J stent was confirmed by plain X-ray of the KUB region just before the discharge of patients and before cystoscopic removal of the D-J stent.

Removal of D-J stent:

Cystoscopic removal of the D-J stent was done under general anesthesia between the 28th and 30th POD. 1 cm of the proximal end and distal end of the D-J stent were sent for quantitative bacteriological cultures and were given special instructions for both intraluminal

and extraluminal stent washout to exclude stent colonization.

Follow-up schedule:
a) First follow-up: On 14th POD.
b) Second follow-up: After around 1 month of operation.
c) Third follow-up: After around three months of operation.
d) Fourth follow-up: After around six months of operation.
e) Fifth follow-up: After around twelve months of operation.

Investigations: Urine for R/M/E and C/S were routinely done in every follow-up.

Operational definitions:
Bacteriuria: >105 colony-forming units (CFU) per milliliter of mid-stream urine with the cultureyielding only one or more bacteria[12,13].
Pyuria: Presence of >10 leucocytes per microlitre of mid-stream urine [12].
UTI: Presence of significant bacteriuria and pyuria with or without symptoms (fever, malaise, lethargy, irritability, poor feeding or reluctance to feed, vomiting, abdominal pain, failure to thrive, dysuria, passing frequent and small amounts of urine, foul-smelling and cloudy urine)[12].
Stent colonization: A colony count of >10 per high power field (HPF) in each segment of D-J stent [13].

Results:

Our study, which included a total of 31 patients, had a median age of 5 years (IQR: 1.7 years to 7 years) with male predominance (male to female ratio 2.44:1). The affected side was right in 14 (45.2%) cases and was left in 17 (54.8%) cases. Only 6 (19.4%) patients were diagnosed antenatally, as detailed in Table I.

Table I: The demographic characteristics of the patients

Variables		Patients of the study group (n=31)
Age, in months	Median (IQR)	63 (20-84)
	Range	1-132
Sex	Male	22 (71.0%)
	Female	9 (29.0%)
Affected side	Right	14 (45.2%)
	Left	17 (54.8%)
Antenatal diagnosis	Yes	6 (19.4%)
	No	25 (80.6%)

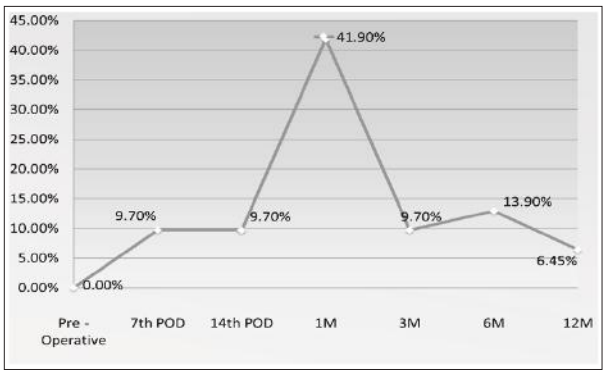

Figure 1: Trends of positive growth in urine culture at different time interval in the study group.

As shown in Figure 1, pre-operatively, both groups had confirmed negative urine culture, and features of UTI were also absent. On the 7thpostoperative day following pyeloplasty, 9.7 % of cases had a positive urinary culture, which remained consistent at 14thdays postoperatively. By one month after the pyeloplasty, 41.9% of cases had positive urinary culture.Followingthe removal of the D-J stent, urine culture became negative; at three months following pyeloplasty, only 9.7 % of cases had positive urinary culture. At six months following the operation, this figure was 13.9%, and by one year after the operation, only two patients (6.45%) had positive urinary culture.

In our study, the proximal and distal segments of the D-J stent were colonized in 32% and 61.3% of patients, respectively (Table II).

Table II: The site of D-J stent colonization

Site of stent colonization	Patients of the study group (n=31)
Stent colonization (Total)	19 (61.3%)
Proximal end	10 (32%)
Distal end	19 (61.3%)

Out of the 31 patients, 19 had positive stent cultures; among these, nine patients (47.4%) had negative urine cultures. Conversely, among the 12 patients who had negative stent culture, three patients (25%) had a positive urine culture (Table III).There was no statistically significant association observed between stent colonization and urine culture ($P > 0.05$). This finding indicates that stent colonization does not demonstrate a significant correlation with concurrent urinary infections at the time of stent removal.

Table III: Relationship of stent colonization with urine culture status

		Urine culture		Total	P value
		Positive	Negative		
Stent colonization	Positive	10 (52.6%)	9 (47.4%)	19 (100.0%)	0.252^{NS}
	Negative	3 (25%)	9 (75%)	12 (100.0%)	

Table IV: Pathogens cultured from D-J stent and urine on the day of stent removal

Microorganism	D-J stent culture: no. of patients (%)	Urine culture: no. of patients (%)	P value
Escherichia coli	7 (36.8%)	5 (38.4%)	
Enterococcus faecalis	3 (15.8%)	1 (7.7%)	
Staphylococcus aureus	2 (10.5%)	2 (15.4%)	0.832^{NS}
Staphylococcus epidermidis	1 (5.3%)	1 (7.7%)	
Proteus mirabilis	3 (15.8%)	2 (15.4%)	
Klebsiella pneumonia	2 (10.5%)	0	
Pseudomonas aeruginosa	1 (5.3%)	1 (7.7%)	
Serratia species	0	1 (7.7%)	
Total	19	13	

P values are derived from the Chi-square test. NS: Statistically not significant.

Bacterial colonization of the D-J stent was detected in 19 out of 31 patients (61.3%).The most commonly identified organisms colonized in the stent were Escherichia coli(36.8%), followed by Enterococcus faecalis (15.8%), Proteus mirabilis (15.8%), Staphylococcus aureus (10.5%), Klebsiella pneumonia (10.5%), Pseudomonas aeruginosa(5.3%) and Staphylococcus epidermidis (5.3%) (Table IV). The most frequently isolated pathogen in urine was Escherichia coli, found in 5 out of 13 patients (38.4%). Additional isolated pathogens are listed in Table IV. There is no statistically significant difference in the types of organisms found between D-J stents and urine samples ($P > 0.05$). This high p-value suggests a strong lack of evidence against the null hypothesis, which states that the distribution of organisms is the same in both stent and urine cultures.

The cultured organisms from both the D-J stent and urine were most sensitive to nitrofurantoin and meropenem.In contrast, they exhibited poor sensitivity to tetracycline, a combination of amoxicillin and clavulanic acid, as well as erythromycin, as shown in Table V. There is no statistically significant difference in the sensitivity patterns between D-J stents and urine cultures ($P > 0.05$). This elevated p-value indicates that there is no statistically significant difference in the antibiotic sensitivity profiles of bacteria isolated from D-J stents compared to those obtained from urine cultures.

Table V: The Antibiotic sensitivity pattern of the bacteria cultured in D-J stent and urine

Antibiotic	D-J stent: no. of patients (%)	Urine: no. of patients (%)	P value
Nitrofurantoin	16 (84.2%)	11 (84.6%)	
Vancomycin	13 (68.4%)	10 (76.9%)	
Linezolid	12 (63.2%)	9 (69.2%)	
Amikacin	14 (73.7%)	10 (76.9%)	
Meropenem	15 (78.9%)	11 (84.6%)	0.999^{NS}
Gentamicin	14 (73.7%)	10 (76.9%)	
Levofloxacin	10 (52.6%)	7 (53.8%)	
Ceftriaxone	8 (42.1%)	6 (46.2%)	
Ceftazidime	8 (42.1%)	6 (46.2%)	
Ciprofloxacin	9 (47.4%)	7 (53.8%)	
Trimethoprim and sulphamethaxole	9 (47.4%)	5 (38.5%)	
Tetracycline	4 (21.1%)	3 (23.1%)	
Imipenem	8 (42.1%)	5 (38.5%)	
Amoxicillin and clavulanic acid	3 (15.8%)	2 (15.4%)	
Erythromycin	3 (15.8%)	2 (15.4%)	

P values are derived from the Chi-square test. NS: Statistically not significant.

Discussions

The placement of a D-J stent following A-H pyeloplasty can lead to several complications, which have been extensively documented in the literature [14]. This study aimed to investigate one of the primary complications associated with D-J stents: the incidence of post-operative urinary tract infections (UTIs) and stent colonization over time. The findings of this study indicated that stent colonization after A-H pyeloplasty does not exhibit a significant correlation with concur

rent urinary infections. Furthermore, the distribution of microorganisms and the antibiotic sensitivity profiles of the bacteria were nearly identical in both the D-J stent cultures and the urine cultures.

This study was conducted on 31 patients, and all of the patients were followed up for 12 months according to the case record form. In this study, the median age of the patients was 5 years. Senguttuvan and Jigy (2014) stated that the median age at presentation of PUJ obstruction was 11 months (3 months to 11 years) [15]. Luis et al. (2003) showed that median age at the time of surgery was 6.3 years, with ages ranging from 4 months to 16 years [16]. Our study showed a male predominance, with a male-to-female ratio of 2.44:1. Out of the total patients, 14 (45.2%) patients had left PUJ obstruction, and 17 (54.8%) patients had right PUJ obstruction. Similarly, Senguttuvan and Jigy (2014) noted that boys (57%) were affected more commonly with PUJ obstruction than girls (43%), and the left side (52.3%) was more frequently involved than the right side [15]. In our study, six patients (19.4%) were diagnosed during antenatal check-ups using ultrasound. Similarly, an Indian study conducted by Laddha et al. (2018) reported a low rate of antenatal diagnosis at 21.3% [17]. In contrast, other studies indicated higher rates, with 53.9% in England and 52% in the USA [3, 18]. It appears that developed countries have better antenatal check-up facilities compared to our own [3, 18]. This discrepancy calls for increased attention and awareness in our country. However, it is encouraging to note that more people are now seeking antenatal consultations for fetuses diagnosed with hydronephrosis.

The colonization of bacteria on the ureteral stent is an important problem.In this study, we found that the occurrence of post-operative UTI was 41.9% on the day of stent removal, while the rate of stent colonization was 61.3%. After removal of the D-J stent, urine culture returned negative, and only two patients (6.45%) had positive urinary culture one year after the operation. However, there was a notable discrepancy between the urine culture and the stent culture. D-J stents act as a nidus for bacteria, and long-term stent retention in the urinary tract was associated with a high risk of bacterial colonization, whereas the risk of urine infection was much lower [12,13]. In our findings, stent colonization was often followed by colonization of the urine. Interestingly, 19 had positive stent cultures; among these, nine patients (47.4%) had negative urine cultures. Islam et al. (2022) reported that out of 14 stent-positive cases, 10 (71%) had negative urine cultures [19]. All of these results demonstrated inconsistencies between urine and stent colonization. However, our study did not find a statistically significant association between stent colonization and urine culture results. This observation was also supported by some other studies, where Farsi et al. (1995) reported a 68% stent colonization rate and a 30% prevalence of bacteriuria, and Paick et al. (2003) reported that the incidence of stent colonization was 44% and bacteriuria was 21% in the 4-week stenting group [20, 21]. Additionally, Ozgur et al. (2013) found that the rate of colonization was 2.2% and 25% when the indwelling time was less than 4 weeks and more than 4 weeks, respectively [22]. These data suggest that colonization in the stent is an essential step of UTI and precedes colonization in the urine. However, bacterial colonization in ureteral stents does not always induce urinary tract infection.

The colonization rate of D-J stents was found to be higher in the distal segment (61.3%). Akay et al. (2006) also reported in their study that the proximal and distal segments of the D-J stent were colonized in 24% and 34% of patients, respectively [11]. Factors such as frequent contact with urothelium, the curling properties of the stent, and the presence of multiple holes at both ends of the D-J stent could play an important role in bacterial colonization [14, 20]. Various pathogens were identified in our study, with the most commonly isolated organisms being Escherichia coli (36.8%), followed by Enterococcus faecalis and Proteus mirabilis (both at 15.8%), Staphylococcus aureus and Klebsiella pneumonia (both at 10.5%), Pseudomonas aeruginosa (5.3%), and Staphylococcus epidermidis (5.3%). In urine samples, Escherichia coli was the most frequently isolated pathogen, detected in 5 out of 13 patients (38.4%). Additionally, Ben-Meir et al. (2009) found Escherichia coli, Enterococcus and Pseudomonas were the main organisms colonized in the stents [7]. While most pathogens detected were not clinically significant, UTI caused by Pseudomonas were noted to be highly virulent [7].

In this study, we found that the cultured organisms from both the D-J stent and urine exhibited the highest sensitivity to nitrofurantoin and meropenem. This aligns with findings from Abu et al. (2022), which reported that the organisms cultured from the D-J stent and urine were most sensitive to nitrofurantoin [23].They noted poor sensitivity to cephalosporins and quinolones, along with resistance to tetracycline and ceftriaxone [23]. Bouassida et al. (2023) observed that organisms isolated from urine were slightly more susceptible to the antibiotics tested compared to those cultured from stents, particu

larly regarding Escherichia coliand Pseudomonas spp [24]. In their study, both norfloxacin and ciprofloxacin were effective against various Gram-negative and Gram-positive urinary pathogens [24]. Shabeena et al. (2018) reported that most of the isolated organisms were sensitive to the tested antibiotics, with multiple coloniesdetected in D-J stents that were placed for more than 4 weeks [25]. Conversely, Yuehua Li et al. (2022) noted significant drug resistance among bacteria causing UTI associated with D-J stents [26]. They recommended using empirical antibiotics with relatively low drug resistance rates, such as piperacillin /tazobactam, meropenem, tigecycline, cefoperazone/sulbactam, teicoplanin, imipenem, and vancomycin, prior to conducting drug sensitivity tests [26]. Additionally, Lifshitz et al. (1999) found that prophylactic antibiotic treatment does not prevent bacterial adherence to ureteral stents [27]. Their data implied that bacterial adherence is an early event; thus, while antibiotic treatment may not prevent stent colonization, it can alter the bacterial flora.

Conclusion:

An indwelling D-J stent poses a considerable risk of stent colonization and UTI. However, bacterial colonization in D-J stents does not always induce UTI, and stent colonization does not demonstrate a significant correlation with concurrent urinary infections. Escherichia coli is the most commonly identified organism found in both the stent and urine. The bacteria cultured from both the D-J stent and urine are highly sensitive to nitrofurantoin and meropenem, which indicates effective treatment options are available.

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