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Ureteral Double J Stent Encrustation: Prevalence and Associated Factors

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ORIGINAL ARTICLE

Ureteral Double J Stent Encrustation: Prevalence and Associated Factors

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Abstract

Background: ***The encrustation of ureteral double-J stents (DJS) is a troublesome complication that may impede their removal.***
Aims: ***To identify the prevalence and possible risk factors involved in the encrustation process, as well as related morbidity.***
Patients and Methods: ***Patients undergoing DJS removal at two university hospitals between July 2017 and November 2023 were included in a cross-sectional analysis. In order to find possible variables linked to DJS encrustation, we used logistic regression models, both univariate and multivariate.***
Results: ***The study enrolled 778 patients, with a mean age of 41.64±17.67 years and an average stent indwelling time of 199.13±191.38 days. 161 (20.7%) patients reported having DJS encrustation. The results of the univariate analysis revealed that several factors, including gender, BMI, history of urinary stone disease, indwelling time, urine acidification, and recurrent UTI, may contribute to DJS encrustation. However, multivariate analysis demonstrated that male gender (HR: 1.80, p: 0.018), lack of urine acidification (HR: 30.99, p: <0.001), and prolonged stent indwelling time (HR: 1.01, p: <0.001) were the only independent risk factors. We removed all encrusted and non-encrusted DJS endoscopically and found that patients with neglected DJS had higher reported DJS-related complications.***
Conclusion: ***Our study identified the potential risk factors associated with DJS encrustation. Educating patients about these risk factors, the appropriate timing for removal, and the potential complications of neglected DJS may aid in reducing their occurrence.***

Keywords: Double J, encrustation, indwelling time, ureter, urine acidification

1. Introduction

Ureteral double-J stent (DJS) serves as a reliable adjunct in managing urinary tract obstruction .[1] Various urological procedures routinely implement these stents to ensure the continued patency of the ureters post-operatively.[2] Additionally, DJSs facilitate the resolution of postoperative edoema and promote the healing of ureteral injuries .[3]

Although there have been significant improvements in stents' material quality, length, flexibility, and double-J design, their insertion can lead to a wide range of complications .[4] We have documented both short- and long-term complications, but neglected stents tend to cause the most serious ones .[5, 6] Pain in the kidneys after putting in a stent, blood in the urine, trouble urinating, and urinary tract infections are all common. However, there is a big worry about stent encrustation and stone formation when stents are not taken care of .[7, 8]

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Various procedures may be necessary to retrieve neglected DJS, including shock wave lithotripsy (SWL), ureteroscopy, and percutaneous techniques. Open surgery, on the other hand, is seldom required .[9, 10]

Determining the frequency and possible causes of DJS encrustation was the primary objective of this research. In addition, we detailed the documented complications of DJS and how to remove them.

2. Patients and methods

Patients undergoing DJS removal at two Cairo, Egypt, university hospitals' urology departments between July 2017 and November 2023 were included in this cross-sectional study. The local institutional review board (IRB) gave their approval for the study to be conducted as a retrospective observational study before data collecting began. Patients using silicon stents, those undergoing frequent stent replacements, or those with missing medical records were not included in the study.

All patients had an X-ray of the kidneys, ureters, and bladder taken before the stent was removed. Patients with left-over DJS (indwelling time >6 months) underwent an NCCT scan of the abdomen. We used contrast imaging investigations to get a better look at the calyceal anatomy if necessary. All patients had standard laboratory testing, including urinalysis, urine culture, serum creatinine, CBC, and liver function.

The DJS removal was performed under spinal, general, or urethral topical (lidocaine or xylocaine) anesthesia using a rigid cystoscope and grasping forceps. Under fluoroscopy guidance, we gently removed the stent in cases with minimal stent encrustation. We administered one shockwave lithotripsy (SWL) session to the stent in cases with marked encrustation, followed by an endoscopic removal trial. In cases with retained DJS, Before introducing the semirigid or flexible ureteroscope, a guide wire was passed into the ipsilateral ureter and advanced to the pelvicalyceal system. After fragmenting the stent encrustation using a holmium-YAG laser lithotripter, we used forceps to gently remove the stent. In some cases, with large bladder or kidney stones on stent coils, cyst lithotripsy and percutaneous nephrolithotomy (PNL) were required for stent removal. In cases of fragmented and upward stent migration, retrograde or antegrade removal was performed as necessary. In cases of lengthy procedures and vigorous instrumentation, an external ureteral catheter, also known as a DJS, was implanted at the end of the procedure.

Details such as age, gender, BMI, past history of UTIs, laboratory results (such as urinalysis, urine culture, serum creatinine, and blood sugar), frequency of urine acidification while stent indwelling, purpose of DJS placement, type of DJS material, duration of indwelling, and complications were examined and analyzed.

The intraoperative findings determined the DJS status at the time of removal, either encrusted or non-encrusted. The variables expected to be associated with DJS encrustation were analyzed. Both the preoperative imaging and the surgical observations established that the DJS encrustation was the accumulation of mineral crystals on the stent's surface.

2.1.Data Analysis

Our statistical software of choice was SPSS version 28, which we used to examine the data. For every variable in the study, we ran descriptive statistics and checked for normalcy in the quantitative variables. Applying the Kolmogorov-Smirnov and Shapiro-Wilk tests, we determined if the data distribution was normal. The most common ways to describe numerical data are median, range, standard deviation, and interquartile range (IQR), whereas percentages are used for categorical data. We compared the two sets of data using the independent t-test for normally distributed numbers and the Mann-Whitney U test for variables with non-normal distributions. For categories, we employed Fisher's exact test and chi-square. Stent encrustation was determined using a logistic regression analysis. Each potential variable influencing stent encrustation was tested using a univariate approach. Included in the logistic multivariate regression stepwise model were factors that were significant in the univariate analysis. We displayed the results of the regression analysis using the odds ratio (OR) and the confidence interval (CI). The significance test results were expressed as two-tailed probability. Assuming a p-value less than 0.05, differences were deemed significant.

Participants in this cross-sectional study were men and women who, between July 2017 and November 2023, had DJS removed at the urology departments of two Cairo, Egypt, university hospitals. The local IRB gave their approval for the retrospective observational study before data collecting began. Incomplete medical data, individuals undergoing frequent stent replacements, and patients using silicon stents were all removed from the study.

All patients were subjected to an abdominal X-ray of the KUB (kidneys, ureters, and bladder) prior to implant removal. For patients who had neglected DJS (indwelling time >6 months), an abdominal non-contrast computed tomography (NCCT) was applied. We turned to contrast imaging investigations when we wanted a better understanding of the calyceal architecture. Blood work included urinalysis, culture of urine, serum creatinine, CBC, and evaluation of liver function in every single instance.

Under spinal, general, or urethral topical anesthetic (lidocaine or xylocaine), a rigid cystoscope and gripping forceps were used to remove the DJS. Stents with minor encrustation were delicately removed under fluoroscopy direction. In instances of severe encrustation, we subjected the stent to a single shockwave lithotripsy (SWL) session before conducting an endoscopic removal experiment. When dealing with cases involving retained DJS, a semirigid or flexible ureteroscope was introduced after a guide wire was placed into the ipsilateral ureter and advanced to the pelvicalyceal system. After a holmium-YAG laser lithotripter was used to break up the stent encrustation, a forceps maneuver was used to gently remove the stent. It was necessary to perform cyst lithotripsy and percutaneous nephrolithotomy (PNL) in order to remove stents that were covered by big stones from the bladder or kidney. Retrograde or antegrade removal was done as needed for stents that migrated upward or those that were fractured. Extensive surgeries requiring strong instrumentation often required the insertion of an external ureteral catheter, or DJS, towards the conclusion of the treatment.

Every participant's demographic information was carefully examined and analyzed, including their age, gender, BMI, medical history (including urinalysis, urine culture results, serum creatinine, and blood sugar), the reason for stent indwelling, the type of DJS material, the duration of indwelling, and any complications that may have occurred.

The intraoperative findings dictated whether the DJS was encrusted or non-encrusted when it was removed. We looked at the factors that people might think would be related to DJS encrustation. Intraoperative and preoperative imaging both confirmed the presence of mineral crystals on the stent surface, which was referred to as DJS encrustation.

Analyzing Data

Statistical Package for the Social Sciences (SPSS) version 28 was used for data analysis. We checked the normalcy of all quantitative variables and ran descriptive statistics on all study variables. Using the Kolmogorov-Smirnov and Shapiro-Wilk tests, we determined if the data distribution was normal. We used mean, standard deviation, median, range, and interquartile range (IQR) to summarize numerical data and percentages to summarize categorical data. For numerical variables with normally distributed distributions, we compared the two groups using the independent t-test; for non-normally distributed distributions, we used the Mann-Whitney test. For the categorical variables, we utilized Fisher's exact test and chi-square. The factors that could be used to forecast the occurrence of stent encrustation were investigated using logistic regression. All factors thought to influence stent encrustation were subjected to a univariate analysis. We used factors that were significant in the univariate analysis in the logistic multivariate regression stepwise model. The odds ratio (OR) and confidence interval (CI) were used to present the regression analysis. As two-tailed probabilities, we presented the results of the significance test. A p-value less than 0.05 was used to determine statistical significance.

3. Results

A total of 778 patients had complete medical records and were included in the data analysis. The mean age of patients was 41.64±17.67 years. There were 458 males (62.3%) with a male-to-female ratio of 1.6:1. The main reason for DJS insertion was urinary stone disease in 90.2% of patients. Overall, 162 (20.7%) patients had DJS encrustation. The median duration of stent indwelling in patients with encrusted DJS was 273 days compared to 125 days in patients with non-encrusted stents (p=0.001). Male gender, history of urinary stone disease, and stent indwelling time were significantly higher in patients with an encrusted DJS. Daily use of oral vitamin C during the stent indwelling time was significantly higher in patients with non-encrusted stents.

Table 1: Demographic data and characteristics of patients with and without double-J stent encrustation.

Variables	Overall (n=778)	Encrustation (n=161)	No Encrustation (n=617)	p value
Age, years				
Mean (SD)	41.64 (17.67)	42.21 (16.06)	41.47 (18.10)	0.851
Min., Max.	2, 80	3, 77	2, 80	
Median (IQR)	43 (25)	40 (23)	44 (25.5)	
Gender, n (%)				
Male	485 (62.3)	123 (76.4)	362 (58.7)	0.005
Female	293 (37.7)	38 (23.6)	255 (41.3)	
BMI				
Mean (SD)	25.42 (2.85)	24.88 (2.77)	25.56 (2.85)	0.004
Min., Max.	17.5, 34	17.6, 33	17.5, 34	
Median (IQR)	25.6 (4.7)	24.9 (4.1)	25.8 (4.6)	
History of urinary stone, n (%)				0.001
No	76 (9.8)	7 (4.3)	69 (11.2)	
Yes	702 (90.2)	154 (95.7)	548 (88.8)	
Kidney	405 (57.7)	89 (57.8)	316 (57.7)	
Ureter	208 (29.6)	49 (31.8)	159 (29.0)	
Kidney/ureter	89 (12.7)	16 (10.4)	73 (13.3)	
Preoperative serum creatinine, mg/dL				
Mean (SD)	1.27 (0.66)	1.36 (0.82)	1.25 (0.61)	0.108
	0.5, 8.7	0.8,8.70	0.5, 7.7	
	1.1 (.3)	1.10 (0.4)	1.1 (0.3)	

Variables	Overall	Encrusted	Non-encrusted	P value
Min., Max.				
Median (IQR)				
Indwelling time, days				
Mean (SD)	199.13 (191.4)	370.24(312.2)	154.49 (105.9)	0.001
Min., Max.	17, 2894	98, 2894	17, 609	
Median (IQR)	164.50 (162)	273 (219)	125 (141)	
Urine acidification, n (%)				0.001
Yes	355 (45.6)	7 (4.3)	348 (56.4)	
No	423 (54.4)	154 (95.7)	269 (43.6)	

BMI, Body mass index; IQR, Interquartile range; SD, Standard deviation; Min., Minimum; Max., Maximum

The demographics and the baseline characteristics of patients, overall and in patients with encrusted and non-encrusted DJS, are summarized in Table 1.

In patients with encrusted DJS, the stents were simply removed by using a cystoscope in 65.2% (105/161) or a ureteroscope in 12.4% (20/161). Of the remaining 36 patients, 24 needed fragmentation of stent encrustation before stent removal, and 12 needed percutaneous antegrade removal either due to inaccessible migrated stents in 7 or concomitant large renal stone(s) requiring percutaneous nephrolithotripsy in 5. In all patients, the stents were removed endoscopically, and only one patient needed 2 operative sessions for stent removal.

Table 2: Univariate and multivariate logistic regression models for the variables associated with double-J stent encrustation.

Variables	Univariate analysis		Multivariate analysis	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Age	1.42 (0.69, 2.92)	0.334	---	---
BMI	0.99 (0.90, 1.08)	0.802	---	---
Male gender	0.56 (0.33, 0.95)	0.032	1.80 (1.11, 2.94)	0.018
Diabetes mellitus	1.78 (0.90, 3.53)	0.098	---	---
Urine acidification	0.03 (0.01, 0.08)	<0.001	30.99 (12.70, 75.56)	<0.001
History of stone	---	0.998	---	---
Duration per day	1.01 (1.00, 1.01)	<0.001	1.01 (1.01, 1.01)	<0.001
Recurrent UTI	1.71 (0.99, 2.96)	0.054	---	---
Stone location	0.87 (0.64, 1.18)	0.378	---	---

BMI: Body mass index; UTI: Urinary tract infection.

The results of the univariate analysis indicated that several variables may contribute to the DJS encrustation, including gender, BMI, history of stone disease, indwelling time, urine acidification, and recurrent UTI. However, multivariate logistic regression models demonstrated that male gender, the lack of urine acidification, and the longer duration of indwelling stents were the predictive factors for stent encrustation .Table 2

Table 3: Relation between the indwelling time of double-J stent and stent complications.

Variables	Overall (n=778)	Neglected (n=159)	Non-neglected (n=619)	P value
Recurrent UTI	423 (54.4)	108 (67.9)	315 (50.9)	0.043
Irritative LUTS	259 (32.3)	137 (86.2)	122 (19.7)	0.014
Hematuria	257 (33.0)	139 (87.4)	118 (19.1)	0.014
Stent encrustation	161 (20.7)	103 (64.8)	58 (9.4)	<0.001
Stent migration	19 (2.1)	16 (10.1)	3 (0.5)	<0.001
Stent fragmentation	16 (2.1)	16 (10.1)	0	<0.001

Data presented as numbers (percentages)

LUTS, Lower urinary tract symptoms; UTI: Urinary tract infection.

The most commonly reported complications of DJS were urinary tract infection (UTI) (54.4%), hematuria (33.0%), and irritative lower urinary tract symptoms (LUTS) (32.3%), followed by stent encrustation, migration (2.1%), and fragmentation (2.1%). All DJS-related complications were significantly higher in patients with neglected DJS Table 3 .

4. Discussion

The ureteral DJS has some adverse effects, with stent encrustation being the most troublesome. This can increase the treatment burden and negatively impact the patient's quality of life .[11] Knowing the predictive factors for stent encrustation is essential for its prevention and treatment .[9]

In the present study, 20.7% of patients with indwelling DJS had encrustation around the stents. The other studies have shown a wide variability regarding the prevalence of encrustation, with a reported prevalence rate ranging from 9.2 % to 76.3 % .[9, 12–15]

The exact explanation for this wide variability is unknown; however, it may probably be due to differences in the targeted population and indwelling time in each study. Despite the great variability, most of the studies showed a high prevalence.

In the current study, DJS encrustation was higher with prolonged indwelling time and in neglected stents. The median duration of DJS with encrustation was 273 days (range: 98 and 2894 days).

Studies conducted by El-Faqih et al. and Bauzá et al. have shown that ureteric stent encrustation tends to increase over time. We observed encrustation in around 70–76% of patients after 2–3 months on average .[12, 16] Our research supports these conclusions.

Several reports have identified the duration of indwelling as the sole risk factor for encrusted stents .[9, 17, 18] In their investigation, Nerli et al. defined DJS removal after 4 months as a delay in removal, which can lead to various complications, including encrustation .[19]

Effective communication between the treating urologist and the patient is crucial. Vanderbrink et al. suggest using a computerised tracking system for patients with DJS to minimise the number of ignored stents .[20] Ather et al. reported a 1.2% to 12.5% reduction in the duration of stent indwelling by implementing a software programme that notified the urologist that the stent needed attention .[21]

Researchers have investigated various risk factors concerning DJS encrustation, such as diabetes mellitus, stone recurrence, and recurrent UTIs. Many studies have found a higher prevalence of stent encrustation among stone formers .[12] However, our study did not identify recurrent UTI and a history of urinary stones as risk factors for stent encrustation.

Our study findings indicate a higher frequency of DJS encrustation among male patients, with a reported prevalence of 26.9%, compared to 15.9% in females. However, multivariate analysis revealed that gender is not an independent risk factor for DJS encrustation.

Being overweight and having chronic kidney disease (CKD) with high serum creatinine levels makes people more likely to get UTIs, urinary stones, and DJS encrustation .[22] Singh et al. demonstrated that elevated serum creatinine, prolonged stent indwelling, poor compliance, and UTIs are predisposing factors for encrustation [8]. The present study reported no significant association between preoperative serum creatinine levels and stent encrustation. Huang et al. observed that individuals with CKD are less likely to develop encrustation in their stents. Researchers attribute this phenomenon to their unique physiological status, which inhibits stone formation by decreasing urine calcium levels as the glomerular filtration rate (GFR) declines .[9, 23]

Patients with a history of stone disease are believed to be more likely to develop ureteral stent encrustation .[13, 24] Robert and colleagues performed a clinical study on 40 patients; they found that patients with a history of stone disease had about a threefold increased risk of DJS encrustation compared to non-stone-formers .[25] The current study found that stone disease is not a risk factor for stent encrustation.

As with other studies, this one found that making urine more acidic could lower the number of cases of ureteral stent encrustation. This is likely because of the higher number of UTIs, bacterial biofilm formation, and stent encrustation in alkaline urine .[13, 14–26]

Study limitations: Despite the large sample size, the present study has limitations that must be considered. Firstly, the study's retrospective nature may have led to potential recall bias. Secondly, some important data, such as urine pH and oral fluid intake, were missing. These data could potentially impact the development of DJS encrustation.

5. *Conclusion*

Our study has demonstrated that male gender, lack of urine acidification, and prolonged stent indwelling time are significant risk factors associated with the development of DJS encrustation. Educating patients about the appropriate timing for removal and the potential complications of neglected DJS may aid in reducing their occurrence..

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