DOI: https://doi.org/10.54393/pjhs.v6i3.2837

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 6, Issue 03 (March 2025)

Original Article

OPEN ACCESS

Determination of Frequency and Risk Factors of Ureteral Stent Encrustations in a Tertiary Care Hospital

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ARTICLE INFO

Keywords:
Ureteral Stent Encrustation, Urolithiasis, Urinary Tract Infection, Proteinuria

How to Cite:
Mobin, M., Ali, A., Shafiq, M. U., Zafarullah, ., & Ali, B. (2025). Determination of Frequency and Risk Factors of Ureteral Stent Encrustations in a Tertiary Care Hospital: Frequency and Risk Factors of Ureteral Stent Encrustations. Pakistan Journal of Health Sciences, 6(3),276-279. https://doi.org/10.54393/pjhs.v6i3.2837

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Received date: 6th February, 2025
Acceptance date: 24th March, 2025
Published date: 31st March, 2025

ABSTRACT

Ureteral stent encrustation is a common problem, with incidence rates rising from 9% at 6 weeks to over 75% after 12 weeks of indwelling time. **Objective:** To determine the frequency and associated risk factors of the ureteral stent encrustation in patients with urolithiasis. **Methods:** This was a prospective descriptive study, conducted at the Department of Urology, JPMC, Karachi, Pakistan. All patients who visited to JPMC and fulfilled the inclusion criteria were included in the study after their consent. Stent duration was grouped into ≥ 6 weeks and < 6 weeks. The stent removal was done under general or local anesthesia. All the collected data were entered into the pre-defined study proforma. **Results:** Mean ± SD of age was 39.60 ±12.06 years. In the distribution of gender, 43 (58.9%) were male while 30 (41.1%) were female. Ureteral stent encrustation was noted in 11 (15.1%) patients. In the comparison of urinary tract infection and proteinuria, with and without ureteral stent encrustation was noted as 9.6% v/s 5.5% and 11% v/s 4.1%, and the p-value was found to be highly significant i.e., $p < 0.0001$. **Conclusions:** This study concluded that ureteral stent encrustation was prevalent in patients with urolithiasis. It is significantly associated with urinary tract infection and proteinuria. However, more prospective and well-controlled trials are needed to validate the current findings.

INTRODUCTION

Ureteral stent encrustation remains a noteworthy clinical challenge, with current studies stating a 26.8% incidence rate for stents retained beyond 12 weeks [1].This problem arises from the deposition of minerals on stent surfaces, influenced by several factors such as bacterial biofilm formation, patient-specific metabolic conditions and prolonged indwelling time [2]. The median indigenous time for encrustation-prone stents is 35 days compared to 28 days in non-encrustation cases, highlighting temporal risks [3].Bacterial cultures affect over 90% of long-term indwelling stents, with biofilm-forming pathogens like E. coli enhancing crystal nucleation by pH alterations and urease activity [4].Evolving evidence highlights the multifactorial pathophysiology, where acclimatizing film formation precedes either direct mineral deposition or bacterial culture [5].The current advancements in radiomics and machine learning validate 78.8% specificity to detect encrustations through CT-based texture analysis, contributing promising diagnostic tools [6].The risk factors related to the patient include persistent UTI (urinary tract infection), chronic renal failure, and diabetes mellitus, which modify urinary composition and promote lithogenic conditions [7].Contemporary research emphasizes material innovations, including heparin-

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coated stents and biodegradable polymers, which reduce encrustation by 50% compared to conventional models [8]. These developments emphasize the need for personalized stent selection and indwelling time optimization in tertiary care settings to mitigate encrustation-related complications.

The prevalence of urolithiasis is high in Pakistan due to its geographic location in the stone belt, and several risk factors have been identified in different scientific studies. Data on associated factors of ureteral stent encrustation is also available globally, but from Asia, it's scarce, and from Pakistan, almost non-existent. Different diseases have different prevalences globally, depending on lifestyle modifications, management, diet, socioeconomic conditions, and geographical location. There is no local study available, that figures out the frequency and associated factors of ureteral stent encrustation.

This study was designed to find out the frequency of ureteral stent encrustation and factors associated with patients with urolithiasis.

METHODS

It was a prospective descriptive study, conducted at the Department of Urology, JPMC, Karachi, Pakistan. The study was approved by the Ethical Review Committee of Sindh Institute of Urology (SIUT) with reference number SIUT/CRP/0124. The study was completed within six months from September 2020 to March 2021 after the approval of the synopsis. The sample size was calculated by using a confidence level of 95% (Z-value = 1.96), a margin of error of 5% (0.05) and a proportion of population of stent encrustations of 5% (0.05) and the calculated sample size was 72 and the current study sample size was 73. Data were calculated by using a convenience sampling technique [9]. 73 patients with the ureteral stent in situ in managing urolithiasis were studied. The diagnosis of ureteral stent encrustation was determined by ureteral stent weight before and after treatment with an acidic solution. Patients aged 15-65 years of both genders were included; ureteral stent placement in the stone's management disease. Patients who agreed to participate were involved after signing the consent form and answering a questionnaire performa. Data regarding patients' baseline information, such as age, gender, and duration of stent insertion, was collected. The urine samples were taken for laboratory investigations, including routine examination and Culture and Sensitivity testing. The blood samples were drawn for serum calcium, phosphate, and uric acid testing. After inclusion, stent duration was grouped into ≤6 weeks and >6 weeks. Stent removal was done under general or local anesthesia. After Ureteral stent removal, the outcome variable i.e., ureteral stent encrustation and its associated factor, was assessed by a urology consultant the principal investigator. Data analysis was carried out by using SPSS version 20.0. Mean and Standard deviation were calculated for numerical variables, including age, serum calcium, serum phosphate, serum uric acid, and urinary pH. Calculation of percentage and frequencies was performed for categorical variables i.e, gender, duration of stent placement, ureteral stent encrustation, UTI, and proteinuria. Effect modifiers were controlled through stratification of age, gender, duration of stent placement, serum calcium, serum phosphate, serum uric acid, and urinary pH by appropriate Chi-Square / Fisher's Exact test, considering two-sided P ≤ 0.05 as criterion of statistical significance.

RESULTS

A total of 80 patients with ureteral stent in situ were involved, 73 patients who met the inclusion criteria. 5 patients were excluded because of their ureteral stenting done in the management of neoplasia of the colon, and other excluded patients were owed to insufficient data or termination of the medical follow-up.

Table 1: Characteristics of the Patients

Adverse Effect	Mean ± SD	Percentage (%)
Age (Years)	39.60 ± 12.06	-
Serum Calcium (mg/dl)	10.18 ± 0.53	-
Serum Phosphate (mg/dl)	4.31 ± 0.35	-
Serum uric acid (mg/dl)	4.40 ± 0.67	-
Urinary PH	6.40 ± 0.29	-
Duration of Stent (Weeks)	11.48 ± 20.11	-
Gender	Male	58.9%
	Female	41.1%
Frequency of Stent Encrustation		15%

The mean age of the patients were 39.60 ± 12.06 years. Mostly, patients were male (58.9%) and (41.1%) were female. The mean values were: Serum calcium 10.18±0.53 mg/dl, Serum phosphate 4.31±0.35 mg/dl, serum uric acid 4.40±0.67 mg/dl, Urinary PH 6.40±0.29 and duration of the stent was 11.48±20.11 weeks. Out of 73 patients, 11 patients had ureteral stent encrustation. The frequency of the ureteral stent encrustation in the study was 15%. There were a statistically significant differences about the UTI, proteinuria, age group, duration, serum calcium, serum uric acid, and urinary pH between the patients by means of and short of ureteral stent encrustation, as presented in table 2. Patients with stent encrustation had high serum calcium, serum uric acid, urinary pH, and proteinuria. Patients with encrustation had a higher frequency of urinary tract infections as compared with patients without encrustation. The middle age group (>40 years) suffered more with encrustation when compared with younger age groups (16-40 years). There were no statistical differences regarding serum phosphate and gender, amongst patients with and without encrustation, presented in table 2.

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Table 2: Comparison of Ureteral Stent Encrustation with Associated Factors

Variables		Ureteral Stent Encrustation		p-Value
		Yes Frequency (%)	No Frequency (%)	
Urinary Tract Infection	Yes	7 (9.6%)	4 (5.5%)	0.0001
	No	4 (5.5%)	58 (79.5%)	
Proteinuria	Yes	8 (11.0%)	3 (4.1%)	0.0001
	No	3 (4.1%)	59 (80.8%)	
Age Group (Years)	16-40	4 (5.5%)	44 (60.3%)	0.032
	>40	7 (9.6%)	18 (24.7%)	
Gender	Male	7 (9.6%)	36 (49.3%)	0.500
	Female	4 (5.5%)	26 (35.6%)	
Duration (In weeks)	>6 weeks	3 (4.1%)	42 (57.5%)	0.014
	≤6 weeks	8 (11.0%)	20 (27.4%)	
S.Calcium (mg/dl)	9-10	4 (5.5%)	48 (65.8%)	0.010
	>10	7 (9.6%)	14 (19.2%)	
S.Phosphate (mg/dl)	3-4	2 (2.7%)	48 (65.8%)	0.166
	>4	9 (12.3%)	14 (19.2%)	
S. Uric Acid (mg/dl)	3-4	2 (2.7%)	48 (65.8%)	0.0001
	>4	9 (12.3%)	14 (19.2%)	
Urinary pH	5-6	4 (5.5%)	6 (8.2%)	0.038
	>6	7 (9.6%)	56 (76.7%)	

DISCUSSION

Ureteral stents are devices used for the decompression of the upper urinary tract in the presence or anticipation of the upper urinary tract obstruction. Two types of ureteral obstruction are present i.e., internal and external. Internal obstruction may be due to stone, stricture, and edema after the ureteral intervention; external obstruction can be because of compression by neoplastic growth and retroperitoneal fibrosis. The ureteral stents are also used in rehabilitative urological surgeries to promote healing [10]. These stents help dilate the ureter, decompress the upper urinary tract, and prevent occlusion [11]. However, ureteral stent insertion can also be associated with side effects and complications such as infection, discomfort, lumen occlusion, and ureteral stent encrustation in the urinary tract [12]. These side effects also compromise the excellence of care and become a significant financial burden to healthcare.There are different additional procedures required to remove an encrusted stent; therefore, cases of a kept stent made up 16% of endourology lawsuits [11].In addition to that prolonged stent duration also increased the risk of chronic kidney diseases.These complications lead to hospitalization after stent removal because of sepsis and urinary tract infections. The management of ureteric obstruction has been markedly changed by the use of ureteric stents, which provide relief in renal colic, hydronephrosis, and renal failure.Ureteral stent routine placement can be recommended for the management of urolithiasis but is commonly applied after endourology procedures [13].The encrustation of the ureteral stents might be because of the deposition of the biological layers, uropathogenic and urinary salts.Some studies suggest UTIs are the major culprit in the formation of the organic layer; similar to the study's findings [14].Different designs and materials of ureteral stents experimented but encrustation is yet another concern.Migration, stone formation, and fragmentation of stents are serious complications of long-term forgotten stents which increase with a longer duration of the indwelling stent [15].The etiology of the encrustation is still unclear even after the formation of the hydrophilic coating on stents. Age and gender distribution varied among different studies of ureteral stent encrustation.These study outcomes were based on the adult age group between 39.60 ± 12.06 years of age, whereas Hsu JS *et al.*, study was based on of 60.1 ± 12.1 year's age group [16].We and other similar studies also reported the predominantly male gender for ureteral stent encrustation [17].This study found ureteral stent encrustation in 15.1% of patients, which is close to another study reported from Pakistan, i.e., 10.5% of ureteral stent encrustation cases [18].One of the previous studies reported ureteral stent encrustation in 22% of cases [11]. Waseda Y *et al.*, documented encrustation in 27% of patients from Japan [19]. In the distribution of associated factors of ureteral stent encrustation, 11 (15.1%) were urinary tract infections, while 11(15.1%) were proteinuria. In comparison, urinary tract infection and proteinuria were noted as 9.6% v/s 5.5% and 11% v/s 4.1% among patients with ureteral stent encrustation, having a highly significant p-value of 0.0001. However, Soria F *et al.*, found a large number of urinary tract infections among patients of ureteral stent encrustation [20].Regarding ureteral stent encrustation, we found significant differences in age group i.e., $p = 0.032$, duration of stent placement $p = 0.014$, serum calcium $p = 0.010$, serum uric acid $p < 0.0001$, urinary PH $p = 0.038$ while the insignificant difference was reported in gender $p = 0.500$ and serum phosphate $p = 0.166$.

CONCLUSIONS

This study concluded that ureteral stent encrustation was prevalent among the patients in the middle age group with urinary tract infection, proteinuria, elevated serum calcium, and uric acid, and increased urinary pH. To validate these findings, larger-scale, well-controlled prospective trials are needed.

Authors Contribution

Conceptualization: MM
Methodology: MUS
Formal analysis: MUS
Writing, review and editing: MM, AA, Z, BA

All authors have read and agreed to the published version of the manuscript

DOI: https://doi.org/10.54393/pjhs.v6i3.2837

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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