

Assessing the Factors Affecting the Success of Ureteral Double-J (DJ) Stenting in Patients with Obstructing Ureteric Calculus: A Prospective Study

Dr. Somdutt Sharma¹, Dr. Umesh Sharma²

¹Department of Urology and Renal Transplant, ABVIMS & Dr Ram Manohar Lohia Hospital - New Delhi

²Senior Resident, Department of Urology and Renal Transplant, ABVIMS & Dr Ram Manohar Lohia Hospital - New Delhi

Corresponding Author Email: [somdutt394\[at\]gmail.com](mailto:somdutt394[at]gmail.com)

Contact - 9953820405

Abstract: ***Objective:** To study the demographic, clinical and radiological factors that affect the success of DJ (Double J) ureteral stenting in patients with obstructing ureteric calculus. **Study Method:** Single centre prospective observational study. 51 patients aged > 18 years with single unilateral ureteric calculus with features of infected hydronephrosis and those with delay in definitive surgery (due to delayed pre - anesthetic clearance - untreated severe co - morbidities) were included in the study. Demographical and clinical factors like Age, Gender, BMI, Duration of symptoms were recorded from clinical history. Radiological factors like Stone laterality (Right/Left), site of ureteric stone, stone Size, degree of hydronephrosis, ureteric wall thickness, were taken from NCCT KUB/CT Urography findings. After assessment, patients were taken for Cystoscopy Guided DJ stent insertion. Patients were divided into 2 groups - Successful DJ stent insertion, Failed DJ stent insertion. **Results:** Overall, the factors like age, gender, BMI, stone laterality, and stone location were non - significant in predicting the success of DJ stent insertion. However, the study factors such as duration of symptoms, stone size, degree of hydronephrosis and ureteric wall thickness ($p > 0.005$) were statistically significant to predict the success of DJ stent insertion. A cutoff value of Ureter wall thickness of 3.15 mm was highly predictive and in cases with a value higher than this calculation, the insertion of the DJ stent beyond the stone was not possible requiring additional procedures for renal drainage such as percutaneous nephrostomy insertion. **Conclusion:** Overall, the study factors like duration of symptoms, stone size, degree of hydronephrosis and ureteric wall thickness were statistically significant to predict the success of DJ stent insertion. These factors can be easily assessed non - invasively, based on clinical history, examination and radiological investigations. By anticipating potential difficulty in DJ stent placement pre - operatively, patients can be directly taken up for percutaneous nephrostomy insertion, thereby preventing multiple procedure and additional complications.*

Keywords: Obstructing ureteric calculus; DJ stent; Infected hydronephrosis; Ureteric wall thickness

1. Introduction

Urolithiasis is a common disease. The lifetime prevalence of kidney stone disease is estimated between 1% to 15%, influenced by factors like age, gender, race, and geographic location¹. Among these calculi, obstructing ureteric stones with signs of urinary tract infection constitute a genuine urological emergency. Any suggestion of fever in patients with ureteric stones strongly indicates infection proximal to the obstruction site. Regardless of the clinical presentation of the patient, there should be a low threshold for initiating urgent urinary tract drainage. Upper tract drainage is also required in patients with obstructed ureteric calculi, in whom definitive surgery is delayed due to various factors (delay in pre - anaesthetic clearance due to untreated co - morbidities), to prevent functional decline of the kidney.

This drainage can be achieved either by inserting ureteral stent (DJ stent) or percutaneous nephrostomy tube. Randomized controlled studies have not demonstrated any significant difference in the efficacy of drainage or complication rate between these procedures, nor differences in time to defervescence in the febrile patients.^{2, 3} One previous study demonstrated that the majority of urologists prefer internal ureteral stent insertion for relieving the obstruction.⁴ However, in some cases, insertion of the stent may be difficult due to various patient - related and stone - related factors. This study aimed at studying such

demographic, clinical and radiological factors affecting the insertion of DJ stent in obstructed ureteric calculi, providing a distinct advantage for the practicing urologists to predict the probability of successful stent passage in such cases pre - operatively. This is relevant in tertiary care centres with heavy workload and long waiting list for surgeries where patients with failed DJ stenting in obstructed calculi, are taken up for second procedure (percutaneous nephrostomy), thereby further using manpower and resources.

If this study can anticipate difficulty in DJ Stent insertion based on the factors included, direct placement of a nephrostomy tube, will be better and safe approach, thereby preventing double procedure and associated complications as well as saving time and resources, especially in high volume centres and resource limited settings. Several studies have attempted to delineate various predictive factors that could indicate stone impaction during definitive surgery⁵, however there is only one study to the best of our knowledge, which delineated the factors predicting the success of DJ stent insertion in obstructed ureteric calculi.⁶ Hence this study was conducted.

2. Materials & Methods

Place of Study: Department of Urology and Renal Transplantation, ABVIMS & Dr. R. M. L. Hospital, New Delhi - 110001

Volume 13 Issue 10, October 2024

Fully Refereed | Open Access | Double Blind Peer Reviewed Journal

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Study Design: Single Centre Prospective Observational Study

Study Duration: 18 months, 1st November 2022 to 30th April 2024.

Sample Size Calculation: The sample size was calculated based of previous studies according to the formula given by Lemeshow et al, 1990: the proposed sample size for the study was 51.

Inclusion Criteria:

Patients aged > 18 years with obstructing ureteric calculus with features of infected hydronephrosis and those with delay in definitive surgery (delay in pre - anesthetic clearance - untreated co - morbidities) planned for DJ Stent insertion

Exclusion Criteria:

- Multiple ureteric calculi
- Previous stone - related procedures,
- Pregnancy
- Genito - urinary anomalies

Factors Assessed are:

- Age
- Gender
- BMI (Kg/m²)
- Duration of symptoms (from onset of renal colic to DJ stent insertion)
- Stone Laterality (Right/Left)
- Site of ureteric stone (upper - from PUJ to upper sacro - iliac joint /mid - from upper to lower sacro - iliac joint/lower - from lower sacro - iliac joint till VUJ)
- Stone Size (transverse diameter in mm)
- Degree of Hydroureteronephrosis (mild - Grade 1 and 2/moderate - Grade 3/severe - grade 4)
- Ratio of psoas thickness to posterior abdominal wall thickness at the site of ureteric calculus (in upper and mid ureteric stones - measured at forty - five degrees from antero - posterior plane)
- Ureter Wall Thickness at the site of obstructing calculus (measured from inner ureteric wall to outer ureteric wall at the site of ureteric calculus in axial CT KUB images)

Study Method

- 1) All the patients who presented to our outpatient department between 1st November 2022 to 30th April 2024 with features of renal colic (flank pain - radiating/non radiating with/without dysuria/fever) were evaluated.
- 2) Detailed clinical history was taken, assessment of vital signs and clinical examination was done. Patient underwent relevant haematological, biochemical,

urinalysis and radiological investigations (USG Whole Abdomen).

- 3) If the preliminary radiological investigations were suggestive of renal/ureteric calculi, NCCT KUB/CT Urography was done.
- 4) Those patients with unilateral single ureteral calculus associated with flank pain, fever, urinary tract infection, raised leucocyte count, varying degree of hydro - ureteronephrosis, and those with single unilateral obstructed calculus with delay in definitive surgery due to delayed pre - anesthetic clearance (due to untreated co - morbidities) requiring upper tract drainage and were planned for DJ Stent insertion were included in the study.
- 5) Total 51 patients were included in this study.
- 6) Demographical and clinical factors like Age, Gender, BMI, Duration of symptoms were recorded from clinical history. Radiological factors like Stone laterality, Site of ureteric stone, Stone Size, degree of hydroureteronephrosis, Ratio of psoas thickness to posterior abdominal wall thickness at the site of ureteric calculus, Ureter Wall Thickness were taken from NCCT KUB/CT Urography findings.
- 7) After this evaluation, patients were taken for retrograde DJ Stenting under local anesthesia under antibiotic cover. All the cases were done by a single surgeon.
- 8) Cystoscopy was done through 21 - french sheath and 30 - degree telescope. After the visualization of ureteric orifice, the hydrophilic straight/angled guidewire (0.032inch) was inserted into the ureteral orifice through a 5 French ureteral catheter. It was advanced until the floppy tip coiled in the renal pelvis as determined fluoroscopically on C - arm.
- 9) A standard polyurethane 4.7 - Fr internal ureteral stent (26 cm) was inserted in all cases. The DJ stent was pushed into the cystoscope until the proximal end of the stent was seen entering the distal ureter. Then the pusher was placed over the guidewire, and it was used to slide the stent over the guidewire into the ureter and up into the renal pelvis.
- 10) If the hydrophilic guidewire could not negotiate beyond the obstructing stone, ureteral catheter was advanced just proximal to stone under fluoroscopic guidance & zebra guidewire was negotiated. Failure to pass guidewire beyond stone after above techniques was considered as DJ stent insertion failure.
- 11) Patients were divided into two groups:
 - a) Group A - Successful DJ Stent Insertion
 - b) Group B - Failed DJ Stent Insertion
 - Factors included in the study were recorded for each group and analyzed.
 - In patients with failed DJ stenting, USG guided PCN insertion was done.

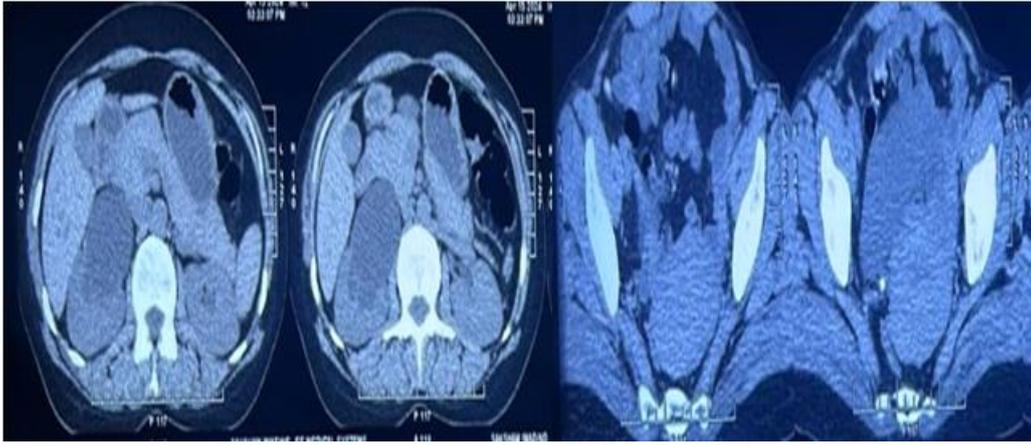


Figure 1: Right Side Hydronephrosis secondary to Right Lower Ureteric Calculus

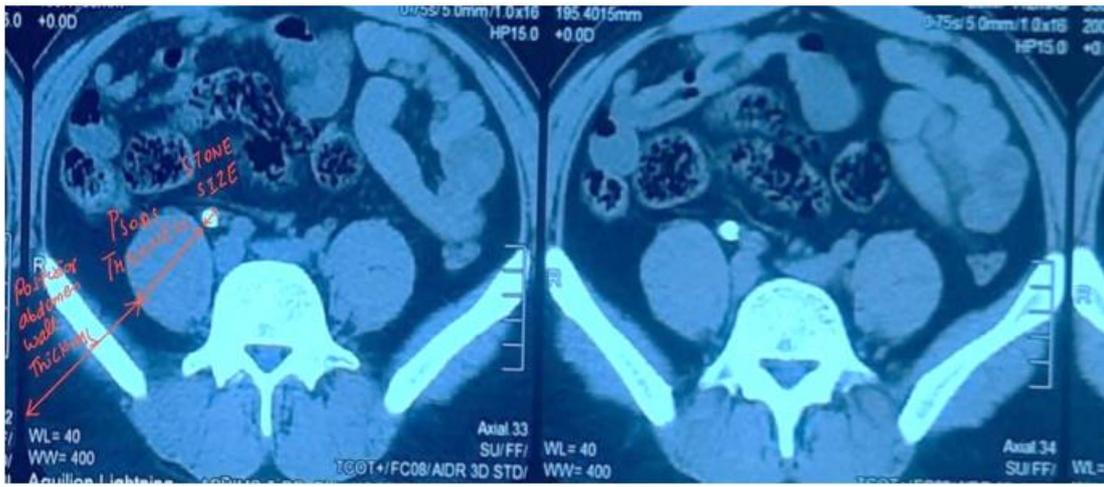


Figure 2: Right Upper Ureteric Calculus



Figure 3: Armamentarium for DJ Stenting

Statistical Analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using IBM SPSS (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 25 for Windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The data were checked for normality before statistical analysis using Kolmogorov Simonov test. The unpaired t test

(for quantitative data to compare two independent observations) was applied. The chi square test was used for qualitative data comparison of all clinical indicators. The level of significance was set at $P \leq 0.05$.

3. Results

Table 1: Descriptive Statistics of Study Subjects (n=51)

	Minimum	Maximum	Mean	Std. Deviation
Age (years)	22	81	45	14.36
BMI (kg/m ²)	21.9	30.4	26.12	1.97
Duration of symptoms (Days)	15.00	90.00	41.82	19.41
Stone size (Transverse diameter in mm)	6.00	15.00	10.21	2.64
Ureter wall thickness (mm)	1.40	4.70	2.74	0.97

Table 2: Detailed Analysis of the Study factors (n=51)

Patient and Stone Related Parameters	Group 1 DJ stent Insertion - Successful (n=32)	Group 2 DJ stent Insertion - Failure (n=19)	P Value (Significance <0.05)
Gender			0.48
1. Male	17	12	
2. Female	12	7	
Age (Years)	44.7 ± 14.6	45.3 ± 14.1	0.88
BMI (Kg/m ²)	25.1 ± 1.7	26.9 ± 1.4	0.19
Duration of Symptoms (Days)	34.5 ± 12.71	54.16 ± 22.63	0.02
Stone laterality			0.40
1. Right	13	10	
2. Left	19	9	
Stone Location in Ureter			0.31
1. Upper	16	11	
2. Middle	5	5	
3. Lower	11	3	
Stone Size (Transverse diameter in mm)	9.43 ± 2.29	11.52 ± 2.73	0.001
Degree of Hydronephrosis			0.001
1. Mild (Grade 1, 2)	3	0	
2. Moderate (Grade 3)	18	6	
3. Severe (Grade 4)	11	13	
Ratio of Psoas thickness to posterior abdominal wall thickness (at the site of stone)	0.29 ± 0.05	0.306 ± 0.05	0.49
Ureteric Wall thickness (in mm)	2.25 ± 0.37	4.46 ± 0.30	0.001

Overall, the factors like age, gender, BMI, stone laterality, and stone location were non - significant in predicting the success of DJ stent insertion. However, the study factors such as duration of symptoms, stone size, degree of hydronephrosis and ureteric wall thickness were statistically significant (p>0.05) to predict the success of DJ stent insertion.

The cut - off value of ureteric wall thickness to determine the success of DJ Stent insertion was calculated using ROC curve.

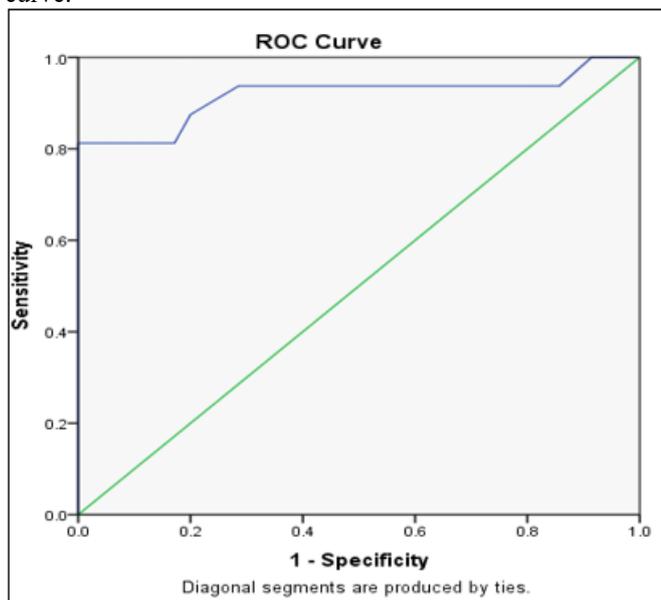


Table 3: Cut off Value of Ureter Wall Thickness

Area	Cut off	P value	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.93	3.15	0.000 (S)	.84	1.000

A cutoff value of 3.15 mm was highly predictive and in cases with a value higher than this calculation, the insertion of the DJ stent beyond the stone was not possible requiring additional procedures for renal drainage such as percutaneous nephrostomy insertion. Sensitivity, Specificity, PPV, NPV and Accuracy of Ureteric Wall Thickness to determine success of DJ Stent Insertion were 90%, 73.85%, 68.57%, 76.25% and 78.57% respectively

4. Discussion

Urolithiasis is a prevalent disease with a significant burden on health and economy. The obstructed kidney with signs of urinary tract infection (UTI) and/or anuria is a urological emergency. Timely decompression is often necessary in patients with infected hydronephrosis caused by obstructing renal or ureteric calculi. There are two options for urgent decompression of obstructed collecting systems: a) placement of an indwelling ureteral stent b) percutaneous placement of a nephrostomy tube. Randomized controlled studies have not demonstrated any significant difference in the efficacy of drainage or complication rates of both procedures.²⁻³ Despite their common and effective use everywhere, certain difficulties may be encountered during DJ stenting due to various patient related and stone related factors. There are scant studies for assessing these factors.

This hospital - based study included 51 patients with unilateral single ureteral calculus associated with flank pain, fever, urinary tract infection, raised leucocyte count, varying degree of hydro - ureteronephrosis, and those with single unilateral obstructed calculus with delay in definitive surgery due to delayed pre - anesthetic clearance (due to untreated co - morbidities) requiring upper tract drainage and were planned for DJ Stent insertion. This study was conducted for assessing the patient related and stone related factors that can predict the success of DJ Stent insertion in patients with obstructed ureteric calculus.

49% of the study participants were between 20 - 40 years age group while 37.3% study population was in 40 - 60 years age group. The mean age of the study participants was 45 ± 14.36 years with a range of 22 - 81 years. In the study participants, with successful DJ stent insertion, the mean age was 44.78 ± 14.6 years, while in those with failed stenting, the mean age was 45.37 ± 14.1 years. In this study, 56.9% study participants were males and 43.9% were females. In patients with successful DJ stent insertion, 53.1% were males, while in patients with failed DJ stenting 63.2% were males. The mean BMI of study population was $26.12 \pm 1.97 \text{ kg/m}^2$. Mean BMI in patients with successful DJ stenting was 25.58 kg/m^2 while in those failed DJ stenting it was 27.04 kg/m^2 which is comparable to the previous study by Sarica et al, ⁶ in which the overall mean BMI of the study participants was $26.9 \pm 0.44 \text{ kg/m}^2$ with $27.03 \pm 0.59 \text{ kg/m}^2$ in success group and $26.82 \pm 0.62 \text{ kg/m}^2$ in the failure group. 45.1% patients had stone on the right side

Overall, 52.9 % participants had upper ureteric stone, while 19.6% had mid - ureteric and 27.5% study population had lower ureteric calculus. Of these patients, 16 (50%), 5 (15.6%) and 11 (34.4%) study participants had upper, mid and lower ureteric stone respectively, in the DJ stenting success group (n=32), while 11 (57.9%), 5 (26.3%), 3 (15.8%) had stone in upper, mid and lower ureter respectively in the failure group (n=19). The mean ratio of psoas thickness to posterior abdominal wall was evaluated to demonstrate whether increased psoas thickness leading to curvature in ureter could lead to difficulty in DJ stent insertion. In participants with successful DJ stenting the mean ratio was 0.29 ± 0.05 while it was 0.306 ± 0.05 in failure group. The association with DJ stenting was non - significant.

Overall, the factors like age, gender, BMI, stone laterality, stone location, and ratio of psoas thickness to posterior abdominal wall thickness were non - significant in predicting the success of DJ stent insertion ($p > 0.005$).

The mean duration of symptoms before stenting in the present study was 41.8 ± 19.4 days which is similar to the previous study by Elibol et al, ⁷ in which the mean duration of symptoms before intervention was 1.36 months (~40.8 days). The association was statistically significant ($p > 0.05$). In our study, the prolonged duration of symptoms before intervention could be due to late presentation. Patients are initially evaluated and managed outside and later referred to our tertiary care centre. In the current study, overall, 21 (41.2%) participants had severe hydronephrosis, while 25 (49%) and 5 (9.8%) participants had moderate and mild hydronephrosis respectively. Of these participants, in

the DJ stenting success group (n=32), the proportion of mild, moderate and severe hydronephrosis was 9.4% (n=3), 56.2% (n=18) and 11 (34.4%) while in failure group (n=19), study participants had 31.6% (n=6) moderate and 68.4% (n=13) severe hydronephrosis. DJ stenting did not fail in patients with mild hydro - ureteronephrosis. DJS insertion and degree of hydronephrosis showed statistically significant results with more success in mild and moderate hydronephrosis and failure being more common in severe hydronephrosis cases.

The mean stone size (transverse diameter) overall was $10.21 \pm 2.64 \text{ mm}$ in the present study, with a range of 6 - 15mm. In the study participants with successful DJ stent insertion the mean stone size was $9.43 \pm 2.29 \text{ mm}$ while it was $11.52 \pm 2.73 \text{ mm}$ in the failure group. It was higher than the previous study by Elibol et al, ⁷ in which the mean stone size was $7.35 \pm 2.55 \text{ mm}$ and lower than the study by Yoshida et al, ⁸ in which the mean stone size was 15mm in the impacted stone group.

The mean ureteric wall thickness at the site of stone in the overall study population was $2.74 \pm 0.97 \text{ mm}$ with a range of 1.4 to 4.7mm. In the study participants, in whom the DJ stent was successfully inserted, the mean ureter wall thickness was $2.25 \pm 0.37 \text{ mm}$ while it was $4.46 \pm 0.30 \text{ mm}$ in the failure group. These results were statistically significant ($p = 0.001$). In the study by Ozbir S et al, ⁵ overall, the mean ureteric wall thickness was $2.4 \pm 1.0 \text{ mm}$ with thickness of $3.6 \pm 0.7 \text{ mm}$ in the impacted stone group. In another study by Sarica et al., ⁶ the mean ureteric wall thickness in the internal stent success group was $2.5 \pm 0.8 \text{ mm}$ and in failure group it was $4.3 \pm 0.9 \text{ mm}$. In our study, the cutoff value of 3.15 mm was highly predictive of DJ stent insertion success/failure and in cases with a value higher than this calculation, the insertion of the DJ stent beyond the stone was not possible requiring additional procedures such as percutaneous nephrostomy tube placement. Sensitivity, Specificity, PPV, NPV and Accuracy of Ureteric Wall Thickness to determine success of DJ Stent Insertion were 90%, 73.85%, 68.57%, 76.25% and 78.57% respectively This association of ureteric wall thickness to DJ stent insertion success was statistically significant ($p = 0.001$) In our study, 32 (62.74%) participants had successful DJ stent insertion while DJ stenting failed in 19 (37.26%) participants. The DJ stenting was done under local anesthesia which could have resulted in higher failure rate owing to pain associated with the procedure.

Based on the demographical, clinical and radiological factors assessed in the study, this study can help in anticipating difficult DJ stenting in patients with obstructed ureteric calculi. Overall, the study factors like duration of symptoms, stone size, degree of hydronephrosis and ureteric wall thickness were statistically significant to predict the success of DJ stent insertion. These factors can be easily assessed non - invasively, based on clinical history, examination and radiological investigations which are routinely done for the evaluation and management of ureteric calculi. By anticipating potential difficulty in DJ stent placement pre - operatively, patients can be directly taken up for percutaneous nephrostomy insertion, thereby preventing multiple procedure and additional complications, ultimately leading to better patient outcomes and more efficient use of medical

resources specially in high volume centres and resource limited settings.

5. Limitations

The sample size of this study was small because only those patients with infected hydronephrosis and those who were temporarily unfit for definitive surgery due to delay in pre - anaesthetic clearance were included, hence generalizability is limited.

- 1) DJ stenting was done under local anaesthesia, which could have impacted the results owing to difference in pain perception in the study participants.
- 2) Literature is limited for the assessment of these factors in patients requiring DJ stenting; hence direct comparison could be done with only one study.

6. Conclusion

The present study investigated several patient and stone related demographic, clinical and radiological factors affecting the success of DJ stent placement in patients with unilateral single ureteral calculus associated with flank pain, fever, urinary tract infection, elevated leucocyte count, varying degree of hydronephrosis and those with single unilateral obstructed calculus with delay in definitive surgery due to delayed pre - anaesthetic clearance. Factors such as age, gender, BMI, stone laterality, stone location and ratio of psoas thickness to posterior abdominal wall thickness were found to be non - significant in predicting the success of DJ stent insertion. However, the study factors like duration of symptoms, stone size, degree of hydronephrosis and ureteric wall thickness were statistically significant to predict the success of DJ stenting. These factors can be assessed non - invasively, through clinical history, examination and radiological investigations which are routinely done for the evaluation and management of ureteric calculi. Based on the statistically significant factors of this study, in cases where difficult DJ stenting is anticipated, urologists should consider percutaneous nephrostomy directly. This approach can prevent the need of multiple procedures, reducing associated complications, and saving time and resources, particularly in high - volume tertiary care centres. Despite these promising insights, there are potential limitations of this study. Therefore, larger, multi - centre studies are necessary to confirm these results and provide more comprehensive data for predicting the success of DJ stent placement.

Conflict of Interest - The authors declare that they have no conflict of interest.

Ethical Considerations and Consent - Ethical clearance was taken from Institutional Ethics Committee. Written and informed consent was obtained from the patients.

Acknowledgement - Declared none

Funding Statement - No funding received.

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