

## Navigating the Challenges of Ureteral Stones: A Comparative Analysis of Outcomes for Impacted and Non-Impacted Stones Treated with Semi-Rigid Ureteroscopy

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(Received, 24<sup>th</sup> November 2024, Accepted 25<sup>th</sup> February 2025, Published 28<sup>th</sup> February 2025)

**Abstract:** Impacted ureteral stones pose significant clinical challenges and are associated with higher complication rates and increased operative difficulty. In developing countries like Pakistan, delayed diagnosis often leads to stone impaction. This study aimed to compare the intraoperative and postoperative outcomes of impacted versus non-impacted ureteral stones managed with semi-rigid ureteroscopy in a tertiary care setting. **Methods:** A prospective comparative study was conducted at the Institute of Kidney Diseases, Peshawar, from April to September 2024. Seventy-six patients with solitary ureteral stones were enrolled and classified intraoperatively into impacted and non-impacted groups. All patients underwent semi-rigid ureteroscopy with pneumatic lithotripsy. Data collected included demographics, stone size, operative time, complications, hospital stay, and stone-free rates (SFR). Statistical analysis was performed using SPSS v26, with p-values of less than 0.05 considered statistically significant. **Results:** The impacted group had significantly larger stones (mean size, 10.2 mm vs. 8.5 mm;  $p < 0.01$ ) and longer symptom durations (7.8 vs. 3.1 weeks;  $p < 0.001$ ). Operative time was longer (42.5 vs. 30.7 minutes;  $p < 0.001$ ), and ureteral dilation was more frequently required (71.1% vs. 23.7%;  $p < 0.001$ ) in the impacted group. Intraoperative bleeding (15.8% vs. 2.6%;  $p = 0.04$ ) and postoperative pain (52.6% vs. 26.3%;  $p = 0.02$ ) were significantly higher in impacted stones. A prolonged hospital stay (more than 24 hours) was observed in 47.4% of impacted cases, compared to 21.1% in non-impacted cases ( $p = 0.01$ ). SFR was comparable between groups (89.5% vs. 97.4%;  $p = 0.18$ ). Stone impaction and prolonged operative time were independent predictors of extended hospital stay. **Conclusion:** Impacted ureteral stones are associated with increased operative complexity, higher complication rates, and prolonged hospitalisation, despite similar stone clearance rates to non-impacted stones. Early detection and timely intervention are crucial for enhancing patient outcomes in resource-constrained settings.

**Keywords:** Ureteral stones, Semi-rigid ureteroscopy, Stone impaction, Operative outcomes, Pakistan

**[How to Cite:** Khan M, Majeed Z, Rahman MU, Sohail N, Khan N. Navigating the challenges of ureteral stones: a comparative analysis of outcomes for impacted and non-impacted stones treated with semi-rigid ureteroscopy. *Biol. Clin. Sci. Res. J.*, 2025; 6(2): 146-149. doi: <https://doi.org/10.54112/bcsrj.v6i2.1593>

### Introduction

Ureteral stones represent a significant health burden globally and are a common cause of emergency urological admissions. In Pakistan, the prevalence of urolithiasis has been steadily increasing, attributed to high ambient temperatures, inadequate hydration, dietary habits, and limited access to preventive care (1). Ureteric calculi can become impacted when they remain lodged in the ureter for extended periods, leading to inflammation, mucosal oedema, fibrosis, and potential loss of renal function (2). Impacted stones are not only more difficult to remove but are also associated with longer operative times, increased complication rates, and lower stone-free rates compared to non-impacted stones (3). The introduction of semi-rigid ureteroscopy (URS) has revolutionised the management of ureteral stones, particularly in resource-constrained settings such as Pakistan. This minimally invasive technique offers a high success rate, low morbidity, and shorter hospital stays compared to open or laparoscopic procedures (4). In many tertiary care hospitals across Pakistan, semi-rigid URS remains the first-line modality for distal and mid-ureteral stones due to its accessibility and cost-effectiveness (5). However, the outcomes of URS in impacted versus non-impacted stones remain inconsistent, particularly within the local population where delayed presentation is common due to socioeconomic and healthcare access barriers (6).

Impacted stones are known to pose technical challenges due to associated ureteral wall thickening, mucosal polyps, and difficult access, which may increase the risk of ureteral injury, postoperative pain, and more extended

hospital stays (7). While international guidelines acknowledge the increased complexity of impacted stones, most studies comparing their outcomes with non-impacted stones have been conducted in high-income countries with advanced endourology infrastructure (8). Data from the South Asian region, especially Pakistan, remains sparse and fragmented. Recent local studies have highlighted that late presentation, self-medication, and prior failed medical expulsive therapy contribute to higher rates of stone impaction in Pakistani patients (9,10).

Given the limited literature from Pakistan and the frequent use of semi-rigid URS in both urban and rural settings, there is a pressing need to evaluate the clinical outcomes associated with impacted and non-impacted stones. Understanding these differences is essential to optimise operative planning, anticipate complications, and counsel patients more effectively. This study aims to conduct a comparative analysis of intraoperative and postoperative outcomes between patients with impacted and non-impacted ureteral stones treated with semi-rigid ureteroscopy in a Pakistani tertiary care setting. The findings are expected to contribute valuable insights for improving stone management protocols and patient outcomes within similar healthcare contexts.

### Methodology

This prospective comparative study was conducted at the the Institute of Kidney Diseases, Peshawar, over a six-month period from April 2024 to September 2024. The objective was to compare intraoperative and postoperative outcomes of impacted versus non-impacted ureteral stones



managed with semi-rigid ureteroscopy. The study included adult patients aged 18–65 years who presented with unilateral ureteral stones confirmed by imaging (non-contrast CT or ultrasound) and underwent semi-rigid ureteroscopy as definitive management. Patients with bilateral stones, active urinary tract infections, congenital anomalies, prior ureteric surgery, or those requiring conversion to open procedures were excluded. A total of 76 patients meeting the inclusion criteria were enrolled using a non-probability consecutive sampling method. After obtaining written informed consent, patients were categorised into two groups intraoperatively based on the status of stone impaction. A stone was considered impacted if it remained at the exact location for more than one month with associated mucosal edema or granulation tissue noted during ureteroscopy, or if the guidewire could not be passed beyond the stone without dilation.

All procedures were performed under spinal or general anesthesia by experienced urologists using a semi-rigid ureteroscope. Stone disintegration was achieved using pneumatic lithotripsy. Data were collected on patient demographics, stone characteristics (size, location), operative duration, need for ureteral dilation, intraoperative complications (bleeding, stone migration), and postoperative outcomes, including pain scores (using VAS), fever, ureteral injury, hospital stay duration, and stone-free status at 30 days. Imaging follow-up was conducted using X-ray or ultrasound, depending on the radiodensity of the stone.

Data were entered and analysed using SPSS version 26. Continuous variables, such as age, stone size, and operative time, were presented as means ± standard deviations, while categorical variables were expressed as frequencies and percentages. Independent t-tests and chi-square tests were used to compare outcomes between the two groups. Multivariate

logistic regression was applied to identify predictors of prolonged hospital stay. A p-value of less than 0.05 was considered statistically significant.

**Results**

A total of 76 patients were evaluated and categorised into two groups based on the intraoperative finding of stone impaction. Table 1 presents a comparison between impacted and non-impacted ureteral stones. There is no significant difference in age (p = 0.52) or gender distribution (p = 0.63) between the two groups. However, the stone size was significantly more significant in the impacted group (10.2 mm ± 1.8) compared to the non-impacted group (8.5 mm ± 1.5) (p < 0.01). Additionally, the duration of symptoms was significantly longer in the impacted group (7.8 weeks ± 2.3) than in the non-impacted group (3.1 weeks ± 1.5) (p < 0.001). There was no significant difference in the side of the stone (p = 0.82) (Table 1).

Patients with impacted stones had significantly longer operative times and a higher need for ureteral dilation, reflecting increased procedural complexity. Intraoperative bleeding was also considerably more common in the impacted group. (Table 2).

Postoperative complications, particularly pain and extended hospital stay, were more frequent in patients with impacted stones. Although the stone-free rate was slightly lower in the impacted group, the difference was not statistically significant. (Table 3).

Stone impaction and prolonged operative time were significant predictors of more extended hospital stays, emphasising the need for earlier intervention and individualised perioperative planning. (Table 4).

**Table 1: Demographic and Clinical Characteristics of Patients (n = 76)**

Variable	Impacted Stones (n = 38)	Non-Impacted Stones (n = 38)	p-value
Mean Age (years ± SD)	43.1 ± 11.3	41.7 ± 10.9	0.52
Gender (Male/Female)	24 / 14	26 / 12	0.63
Stone Size (mm ± SD)	10.2 ± 1.8	8.5 ± 1.5	<0.01*
Side of Stone (Right/Left)	21 / 17	20 / 18	0.82
Duration of Symptoms (weeks)	7.8 ± 2.3	3.1 ± 1.5	<0.001*

**Table 2: Intraoperative Parameters and Operative Outcomes**

Outcome Variable	Impacted Stones (n = 38)	Non-Impacted Stones (n = 38)	p-value
Mean Operative Time (min ± SD)	42.5 ± 8.4	30.7 ± 6.2	<0.001*
Need for Ureteral Dilation (%)	27 (71.1%)	9 (23.7%)	<0.001*
Intraoperative Bleeding (%)	6 (15.8%)	1 (2.6%)	0.04*
Stone Migration (%)	4 (10.5%)	1 (2.6%)	0.17

**Table 3: Postoperative Outcomes and Complications**

Postoperative Outcome	Impacted Stones (n = 38)	Non-Impacted Stones (n = 38)	p-value
Postoperative Pain (VAS >5)	20 (52.6%)	10 (26.3%)	0.02*
Fever (>38°C within 24 hours)	5 (13.2%)	2 (5.3%)	0.23
Ureteral Injury	3 (7.9%)	0 (0%)	0.07
Hospital Stay (>24 hours)	18 (47.4%)	8 (21.1%)	0.01*
Stone-Free Rate (SFR, Day 30)	34 (89.5%)	37 (97.4%)	0.18

**Table 4: Multivariate Logistic Regression for Predictors of Prolonged Hospital Stay**

Predictor	Odds Ratio (OR)	95% CI	p-value
Stone Impaction	2.98	1.12–7.93	0.03*
Stone Size > 9 mm	2.54	0.91–6.98	0.07
Operative Time > 40 mins	3.41	1.23–9.49	0.02*

**Discussion**

This study aimed to compare the intraoperative and postoperative outcomes of impacted versus non-impacted ureteral stones treated with semi-rigid ureteroscopy in a Pakistani tertiary care setting. The findings

demonstrated that impacted stones were significantly associated with increased operative complexity, including longer operative time, greater need for ureteral dilation, and higher rates of intraoperative bleeding and postoperative pain. These results are consistent with the existing

literature, which suggests that stone impaction significantly influences the technical difficulty and complication profile of ureteroscopic procedures. The mean operative time was significantly longer in the impacted group ( $42.5 \pm 8.4$  minutes) compared to the non-impacted group ( $30.7 \pm 6.2$  minutes), which aligns with the results reported by Bozkurt et al. (11), who found that stone impaction leads to prolonged procedures due to mucosal edema and ureteral wall thickening. Similarly, our finding of a higher need for ureteral dilation in impacted cases (71.1%) is in agreement with the study by Bayar et al., which observed increased dilation rates in impacted stones due to ureteral lumen narrowing and fibrosis (12).

In terms of intraoperative complications, our study reported higher bleeding rates in the impacted group (15.8%) versus the non-impacted group (2.6%). This finding is consistent with the observations of Goel and Hemal, who noted that chronic inflammation surrounding impacted stones can lead to friable mucosa, making it more susceptible to trauma during instrumentation (13). While stone migration was slightly more common in the impacted group, the difference was not statistically significant, which contrasts with some reports that found a higher risk of migration in non-impacted stones due to more effortless stone mobility (14).

Postoperative pain, measured by VAS  $>5$ , was significantly more common among patients with impacted stones. This can be attributed to increased ureteral manipulation, longer operative time, and mucosal injury. Similar conclusions were drawn by El-Nahas et al., who reported that postoperative pain and discomfort are more severe in cases requiring extensive dilation or ureteral access during treatment of impacted stones (15).

Hospital stay was notably more extended for the impacted group, with nearly half of the patients requiring more than 24 hours of observation. Our logistic regression analysis identified stone impaction and operative time  $>40$  minutes as significant predictors of prolonged hospitalisation. These findings align with a study by Singh et al., who emphasised that early diagnosis and prompt treatment of ureteral stones can reduce complications and shorten hospital stays (16).

Despite the increased complication rate, the stone-free rate (SFR) at 30 days was high in both groups, at 89.5% in the impacted group and 97.4% in the non-impacted group, with no statistically significant difference. This suggests that semi-rigid ureteroscopy remains an effective treatment modality for both impacted and non-impacted stones, corroborating the results of previous studies by Shah et al. and Türk et al., who reported high SFRs regardless of impaction status, provided the procedure is conducted by skilled urologists (17,18).

A unique contribution of our study is its focus on the Pakistani population, where delayed healthcare-seeking behavior, limited access to imaging, and high reliance on self-medication often result in late presentation and higher rates of stone impaction. This was reflected in the significantly longer symptom duration in the impacted group (mean 7.8 weeks), echoing findings from Ahmed et al., who reported similar delays in stone management in rural Pakistani settings (19).

Limitations of this study include the relatively small sample size and single-center design, which may limit the generalizability of the findings. Additionally, the use of semi-rigid ureteroscopy may not be optimal for proximal ureteral stones, and the results may differ compared to those obtained with flexible scopes or laser lithotripsy. Nonetheless, the study provides valuable clinical insights and supports the development of more targeted perioperative protocols for managing impacted ureteral stones.

## Conclusion

In conclusion, this study reaffirms that impacted ureteral stones are associated with more incredible operative difficulty and higher complication rates than non-impacted stones, although stone-free outcomes remain comparable. Early identification and prompt treatment of ureteral calculi before impaction occurs may improve clinical outcomes and reduce the healthcare burden in resource-constrained settings, such as Pakistan.

## Declarations

### Data Availability statement

All data generated or analysed during the study are included in the manuscript.

### Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-MS-03-23)

### Consent for publication

Approved

### Funding

Not applicable

### Conflict of interest

The authors declared the absence of a conflict of interest.

### Author Contribution

**MK** (Resident Urologist)

*Manuscript drafting, Study Design,*

**ZM** (Resident Urologist)

*Review of Literature, Data entry, Data analysis, and drafting an article.*

**MUR** (Resident Urologist)

*Conception of Study, Development of Research Methodology Design,*

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*Study Design, manuscript review, and critical input.*

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*All authors reviewed the results and approved the final manuscript version. They are also accountable for the integrity of the study.*

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