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# Comparison of Extracorporeal Shock Wave Lithotripsy (ESWL) With and Without DJ Stenting in Proximal Ureteric and Renal Pelvis Stones

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## ABSTRACT

**Introduction**: Urolithiasis requires effective management. ESWL is common for proximal ureteric and renal pelvis stones, but the role of routine DJ stenting is debated. This study evaluates its impact on stone clearance for 1.5–2 cm stones.

**Study Design and Setting:** A prospective comparative cohort study was conducted over a six-month period from September 2024 to February 2025.

**Methodology:**A total of 70 patients with renal pelvis or proximal ureteric stones (1.5–2.0 cm, =1000 HU) were enrolled through non-probability consecutive sampling and divided into two equal groups: Group A (ESWL without DJ stent) and Group B (ESWL with DJ stent) by simple randomization through lottery technique. Patients underwent up to five ESWL sessions using the Dornier Sigma Plus 2 lithotripter. Treatment success was defined as complete stone clearance confirmed by X-ray KUB and ultrasound one month after the final session. Data were analyzed using SPSS version 26, Chi square tests were applied, with significance set at p = 0.05

**Results:**Stone clearance was achieved in 29 (82.9%) patients in the DJ stent group and 27 (77.1%) in the non-stented group. Statistical analysis revealed no significant difference between the groups (p = 0.550). Subgroup analysis by stone size, density, and Body Mass Index (BMI) showed no clear correlation with treatment success.

**Conclusion**: The findings indicate that routine DJ stenting does not notably improve stone clearance in ESWL for 1.5–2 cm proximal ureteric and renal pelvis stones. A selective, risk-based stenting approach is advised, particularly in resource-constrained settings.

**Keywords:** Lithotripsy, Shock Wave**,** Stents, Urolithiasis, Kidney Calculi, Treatment Outcome, Risk Factors, Minimally Invasive

**How to cite this Article:**
Ansari A, Valecha NK, Ali A, Khan A, Mujeeb A, Siddiqui H. Comparison of Extracorporeal Shock Wave Lithotripsy (ESWL) With and Without DJ Stenting in Proximal Ureteric and Renal Pelvis Stones. J Bahria Uni Med Dental Coll. 2025;15(3): 213-8 DOI: https://doi.org/10.51985/JBUMDC2025615



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Received: 12-04-2025 1st Revision: 22-05-2025
Accepted: 30-06-2025 2nd Revision: 23-06-2025

## INTRODUCTION

Urolithiasis, or urinary stone disease, is a globally prevalent urological condition characterized by the formation of calculi in the kidney, ureter, or bladder. It often necessitates medical or surgical intervention due to complications such as acute renal colic, urinary tract infections, hematuria, and obstructive uropathy. The incidence and recurrence of stone disease have increased worldwide, driven by dietary, metabolic, and genetic factors. Various treatment modalities are available, including Extracorporeal Shock Wave Lithotripsy (ESWL), ureteroscopy (URS), percutaneous nephrolithotomy (PCNL), and open or laparoscopic surgery. The choice of modality depends on several variables, such as stone size, location, density, patient anatomy, and resource availability.[1] Among these, ESWL has gained popularity as a non-invasive technique since its introduction in the early 1980s. It utilizes focused acoustic shockwaves to fragment stones into smaller pieces, which are then naturally passed through the urinary tract without surgical extraction.[2] ESWL is particularly effective for stones located in the renal pelvis or proximal ureter and measuring less than 2 cm, offering advantages such as reduced morbidity, shorter hospital stays, and minimal postoperative pain.[3]

However, the success of ESWL is not universal and varies based on stone and patient factors. Stone size is one of the most critical determinants of ESWL outcome. Stones smaller than 1.5 cm tend to respond favorably, while larger stones (1.5–2 cm) often exhibit incomplete fragmentation, increasing the risk of complications. High stone burden can lead to the formation of "steinstrasse"—a condition in which fragmented stones obstruct the ureter, causing flank pain, infection, hydronephrosis, or even renal damage.[4] In an attempt to mitigate these risks, the use of ureteral double-J (DJ) stents has become a standard adjunctive measure. These stents maintain the patency of the ureter, facilitate the passage of stone fragments, and help reduce post-ESWL obstruction. Nonetheless, the blanket application of DJ stents in all ESWL patients remains controversial. While theoretically beneficial, stents can also result in adverse effects, including lower urinary tract symptoms (frequency, urgency, dysuria), hematuria, infection, migration, and encrustation. Moreover, their insertion and removal add to healthcare costs and patient discomfort, making the decision to use them more complex, particularly in low- and middle-income countries.[5,6] Numerous studies have explored the necessity and impact of DJ stenting before ESWL, yielding mixed results. A prospective study assessed outcomes in stented and non-stented patients undergoing ESWL for proximal ureteric stones and found no significant difference in stone clearance or complication rates between the two groups. Their findings suggested that routine pre-ESWL stenting may be unnecessary and that a more selective approach based on patient risk factors may be more appropriate.[7,8] While ESWL remains a cornerstone of stone management, its long-term effectiveness has plateaued, partly due to overuse or misuse of adjunctive interventions like stents. and individualized treatment planning should be encouraged rather than a "one-size-fits-all" strategy, encouraging clinicians to reserve stenting for selected cases.[9, 10] The need for high-quality evidence is thereby emphasized to better understand the safety and efficacy of ESWL and its adjuncts. This calls for comprehensive evaluation of outcomes like stone-free rate, retreatment necessity, and adverse events to guide decision-making.[11] The European Association of Urology (EAU) Guidelines on Urolithiasis (2022) echo this sentiment, recommending DJ stenting only in select scenarios such as solitary kidneys, urinary tract infections, significant obstruction, or anatomical abnormalities.[12]

In light of the ongoing debate regarding the necessity and effectiveness of ureteral stenting prior to extracorporeal shock wave lithotripsy (ESWL), the present study was designed to evaluate and compare the clinical outcomes of ESWL performed with and without double-J (DJ) stenting in patients diagnosed with proximal ureteric and renal pelvis stones measuring between 1.5 and 2 cm. This stone size range represents an intermediate category where the decision to place a stent remains particularly controversial. The primary objective of the study is to determine whether routine pre-ESWL DJ stenting confers a significant clinical advantage in terms of stone clearance, prevention of complications such as steinstrasse, and reduction in the need for secondary interventions, or whether its use may be safely omitted in patients who do not present with predisposing high-risk features such as solitary kidney, urinary tract infection, or anatomical abnormalities. This research holds particular relevance in resource-limited healthcare settings like Pakistan, where cost-effectiveness and optimization of medical resources are crucial. By systematically analyzing outcomes including stone-free rates, incidence of post-procedural complications, frequency of hospital readmissions, and patient-reported discomfort or urinary symptoms, the study aims to provide data-driven clarity. Ultimately, the findings may contribute toward a more individualized, patient-centered, and economically viable approach to the management of urolithiasis in diverse clinical contexts.

## METHODOLOGY

This Prospective Comparative Cohort study was conducted at the Department of Urological Surgery and Transplantation, Ward 19, Jinnah Postgraduate Medical Centre (JPMC), Karachi, over a period of six months i.e. from September, 2024 to February, 2025. A non-probability consecutive sampling technique was used to enroll patients from the outpatient department. Eligible patients were assessed and randomly allocated to one of the two treatment groups using a simple randomization technique. Based on a power analysis using PASS 2020 software, a total of 70 patients were included in the study—35 in Group A (ESWL without DJ stent) and 35 in Group B (ESWL with DJ stent). The study achieved a statistical power of 81.1% to detect a difference of 33.34% between the two groups, using a two-sided Fisher's Exact Test at a significance level of 0.05.[5]

Inclusion criteria comprised patients of either gender, aged between 15 and 55 years, with renal pelvis or proximal ureteric stones sized between 1.5 and 2.0 cm and a density of <=1000 Hounsfield Units as confirmed by CT KUB with negative urine culture and sensitivity report. Patients with previously positive urine cultures were included only if the infection had been treated. Exclusion criteria included active bacterial infection, bleeding disorders, multiple stones, severe skeletal malformations or obesity, pregnancy, solitary kidney, pyonephrosis or sepsis, distal obstruction, stones outside the defined size range, or stones located in the other locations other than renal pelvis or proximal ureter. Patients who were not able to tolerate pain in ESWL sessions despite adequate analgesia were also excluded from the study.

After obtaining ethical approval from the College of Physicians and Surgeons of Pakistan and the institutional review board, IRB no: NO.F.2-81/2024-GENL/95/JPMC. Eligible patients were assessed and randomly allocated to one of the two treatment groups.

Prior to ESWL, patients underwent imaging (CT KUB, X-ray, or ultrasound) and laboratory evaluations including renal function, coagulation profile, and urine culture. Positive cultures were treated before the procedure. Patients fasted for 4–6 hours and received preoperative analgesics, such as intramuscular diclofenac or intravenous paracetamol, approximately 30–45 minutes before treatment. After checking blood pressure, pulse rate and temperature, demographic and clinical details were recorded on a structured proforma. Patients underwent maximum of five sessions scheduled fortnightly, in the Lithotripsy Suite of the Department of Urological Surgery and Transplantation. All procedures were performed under supervision of a consultant urologist with a minimum of five years of post-fellowship experience.

All extracorporeal shock wave lithotripsy (ESWL) procedures were performed using the Dornier Sigma Plus 2 lithotripter (Dornier MedTech, Germany). This device utilizes electromagnetic shock wave generation technology for non-invasive stone fragmentation. It is equipped with dual imaging modalities, including fluoroscopy and ultrasound. The patient is positioned on an ergonomically designed therapy table that facilitates optimal alignment with the focal point of the shock waves. The patient positioned supine or prone based on stone location. Stone targeting was achieved using fluoroscopic or ultrasonographic guidance. During each 45-minute session, 2500–3000 shockwaves were delivered at a frequency of 60–90 per minute, the shockwaves were administered at an initial low frequency and energy level i.e. 1.0–1.5 kV, which was gradually increased to optimize fragmentation while minimizing tissue injury based on patient tolerance and fragmentation response. Throughout the procedure, real-time imaging was used to monitor stone fragmentation and reposition the patient if needed. Continuous monitoring of the patient's vital signs was performed by the procedural nursing team.

After the procedure, patients were transferred to a recovery room for observation for 1–2 hours. Pain control and hydration were ensured. If no immediate complications such as hematuria, hypotension, or severe pain were observed, the patient was discharged the same day with post-procedural instructions. These included advice on hydration (2–3 liters/day), antibiotics, alpha-blockers, pain management (oral analgesics), activity limitation for 48 hours, and signs of complications (e.g., fever, severe pain, hematuria, or inability to void).

Patients were advised to strain their urine to monitor stone fragment passage and scheduled for follow-up imaging (X-ray KUB and ultrasound) one month after the last session to assess stone clearance. A maximum of five ESWL sessions were allowed per patient, spaced fortnightly, based on fragmentation response and residual stone burden.

Treatment success was defined as complete stone clearance, assessed one month after the final ESWL session using X-ray KUB and ultrasonography. A stone-free status was confirmed by the absence of radio-opaque shadows on X-ray and hyperechoeic areas with acoustic shadows on ultrasound. Treatment failure was defined as the presence of steinstrasse requiring emergency intervention or the need for auxiliary procedures.

Data were analyzed using SPSS version 26 (Build 1.0.0.1275). Variables that were normally distributed were reported as mean ± standard deviation, while skewed variables were presented as medians along with interquartile ranges. Categorical variables, including gender and treatment outcomes, were expressed as frequencies and percentages. To assess the association between DJ stenting and treatment success, the Chi-square test was applied. If the assumptions of the Chi-square test were violated, Yates' corrected Chi-square test was used to account for small expected frequencies. Potential effect modification by age, BMI, and stone size was evaluated through stratification of the data. A p-value of =0.05 was considered statistically significant.

**RESULTS:**

Among the 70 patients studied, 35 were treated with DJ stents and 35 without. Stone clearance was successful in 29 (82.9%). Of all patients with successful clearance, 51.8% were from the stented group and 48.2% from the non-stented group. Table 1. Although the stented group showed a slightly higher success rate, statistical analysis revealed no significant difference between the groups. The Pearson Chi-square test yielded a p-value of 0.550, and similar findings were supported by the Fisher's Exact Test (2-sided p = 0.766; 1-sided p = 0.383).

Confidence intervals for stone clearance were 69.4%–96.3% in the DJ stent group and 62.7%–91.4% in the non-stented group, with notable overlap, reinforcing the conclusion that the use of DJ stents did not significantly affect stone clearance outcomes in this study population.

Size-Stratified Outcomes: Crosstab analysis comparing stone clearance success by stone size and DJ stenting status revealed that in both groups, smaller stones (15–16 mm) showed higher clearance rates (100% in most cases), while clearance rates declined with increasing stone size. Table 2. Although a trend toward higher stone clearance with smaller stone sizes was observed, the differences were not statistically significant in the stented group (p = 0.340), non-stented group (p = 0.445), or the combined cohort (p = 0.111).

Stone Density-Stratified Outcomes: The analysis showed a clear trend: *stone clearance success decreased as stone density increased*, regardless of DJ stenting. Patients with stone densities =700 HU had a 100% success rate in both groups. However, as density rose, success rates declined. Table 3

Although Chi-square tests showed no significant association

between stone density and clearance success in either group ($p > 0.05$), the Likelihood Ratio test for the combined data indicated a marginally significant result ($p = 0.035$), suggesting a possible trend toward reduced clearance with increasing stone density. BMI-Stratified Outcomes: Among 70 patients undergoing ESWL, the overall stone clearance rate was 80%. Clearance rates varied by BMI: overweight (85%) and underweight (100%) patients had the highest success, while obese patients had the lowest success rate. DJ stenting appeared more beneficial in normal and overweight individuals but not in obese patients. Table 4 Chi-square analysis revealed no statistically significant association between BMI and stone clearance in either group ($p > 0.05$). This may be attributed to the small sample sizes within each BMI subgroup, limiting the power to detect a true difference.

Table 1: Comparison of Success (Stone Clearance) Rate ESWL in patients with DJ stent vs. without DJ stent

| Group | Success (Yes) | Failure (No) | Success % | Failure % |
|---|---|---|---|---|
| With DJ Stent | 29 | 6 | 82.9% | 17.1% |
| Without DJ Stent | 27 | 8 | 77.1% | 22.9% |

Table 2: The table compares stone clearance success by stone size for patients undergoing ESWL with and without a DJ stent (stone sizes ranging from 15 to 20 mm). The Success Count/Total shows how many patients cleared their stones out of the total in each category

| Stone Size (mm) | With DJ Stent (Success Count / Total) | With DJ Stent (% Success) | Without DJ Stent (Success Count / Total) | Without DJ Stent (% Success) |
|---|---|---|---|---|
| 15 | 10/10 | 100.0% | 12/13 | 92.3% |
| 16 | 4/4 | 100.0% | 2/2 | 100.0% |
| 17 | 6/9 | 66.7% | 4/6 | 66.7% |
| 18 | 2/3 | 66.7% | 1/1 | 100.0% |
| 19 | 2/3 | 66.7% | 5/8 | 62.5% |
| 20 | 5/6 | 83.3% | 3/5 | 60.0% |
| **Total** | 29/35 | 82.9% | 27/35 | 77.1% |

Table 3: Table shows side-by-side comparison of stone clearance success rates across different stone density ranges (in Hounsfield Units) for patients undergoing ESWL with and without DJ stenting.

| Stone Density (HU) | With DJ Stent (Success / Total) | With DJ Stent (% Success) | Without DJ Stent (Success / Total) | Without DJ Stent (% Success) |
|---|---|---|---|---|
| 300–400 | – | – | 1/1 | 100.0% |
| 401–500 | – | – | 1/1 | 100.0% |
| 501–600 | 6/6 | 100.0% | 4/4 | 100.0% |
| 601–700 | 4/4 | 100.0% | 3/3 | 100.0% |
| 701–800 | 8/9 | 88.9% | 8/9 | 88.9% |
| 801–900 | ¾ | 75.0% | 3/4 | 75.0% |
| 901–1000 | 5/6 | 83.3% | 4/8 | 50.0% |
| 1001–1200 | 3/6 | 50.0% | 3/5 | 60.0% |
| **Total** | 29/35 | 82.9% | 27/35 | 77.1% |

Table 4: This table compares stone clearance success by BMI category in patients undergoing ESWL with and without DJ stenting.

| BMI Category | With DJ Stent (Success / Total) | With DJ Stent (% Success) | Without DJ Stent (Success / Total) | Without DJ Stent (% Success) |
|---|---|---|---|---|
| Underweight | 1/1 | 100.0% | 1/1 | 100.0% |
| Normal | 17/21 | 81.0% | 16/22 | 72.7% |
| Overweight | 10/11 | 90.9% | 7/9 | 77.8% |
| Obese | ½ | 50.0% | 1/3 | 33.3% |
| **Total** | 29/35 | 82.9% | 27/35 | 77.1% |

## DISCUSSION

This study evaluated how effective Extracorporeal Shock Wave Lithotripsy (ESWL) is for treating proximal ureteric and renal pelvis stones measuring 1.5 to 2 cm, comparing outcomes with and without the use of a Double-J (DJ) stent. The results showed a slightly higher stone clearance rate in the stented group (82.9%) versus the non-stented group (77.1%), but this difference wasn't statistically significant. These findings are consistent with previous research on the role of DJ stents in stone treatment.[8]

Tailly[10] highlighted that ESWL continues to be a key treatment for urolithiasis, especially as technology evolves and improves success rates for medium-sized stones. However, the benefits of adding a DJ stent remain controversial. Research by Pogula et al.[8] suggests that while stents may not significantly increase stone clearance, they can help prevent complications like ureteral blockages or the formation of steinstrasse. Similarly, our study didn't show a major advantage with stenting, although the slight increase in success rates may support its use in select cases.

Cao et al.[11] stressed that selecting the right patients and using proper technique are key to achieving good outcomes. The European Association of Urology also advises using DJ stents selectively, based on factors like stone size, location, and patient risk profile[12]; thus confirming ESWL's effectiveness for stones in the proximal ureter and renal pelvis, with a strong safety profile. Pansota et al.[13] found no significant difference in stone-free rates between patients who received stents and those who didn't. However, they did observe fewer complications in the stented group, suggesting that stenting might be justified in patients with larger stones or anatomical concerns.

When considering stone size, a slightly higher clearance rate was observed in patients with DJ stents, particularly those with larger stones—an observation consistent with findings from previous studies.[8] Stone size is a key factor influencing the effectiveness of ESWL. Park et al. and a meta-analysis published in 2007 reported a significant decrease in ESWL success rates for stones larger than 10 mm, dropping from 86% to 67.5%. Similar trends were observed in our study, where the success rate in the non-stented group declined from 100% for 15 mm stones to 60%

for stones measuring 20 mm.[14, 15]

Stone density also plays a significant role in determining the success of stone clearance following ESWL. In our study, stones with a Hounsfield Unit (HU) value of less than 800 had a success rate of approximately 97.78%, whereas the success rate dropped to 61.66% in stones with HU >800 among patients who underwent ESWL without prior DJ stenting. These findings are consistent with previously reported studies.[16]

BMI also has a negative impact on stone clearance rates following ESWL.[17] In our study, the success rate in the stented group declined from 100% in underweight individuals to 50% in those who were obese. Similarly, in the non-stented group, the success rate dropped from 100% in underweight patients to 33.3% in obese individuals.

There's also growing interest in using other therapies alongside ESWL to improve outcomes. For instance, alpha-blockers like tamsulosin have been shown to help pass stones more easily and reduce the need for multiple ESWL sessions.[18] Though this wasn't covered in our study, it reinforces the value of tailoring treatment to the individual patient.

One critical consideration is how DJ stents affect patients' quality of life. While they may help avoid complications, stents are often uncomfortable and can cause symptoms such as urinary urgency, blood in the urine, and painful urination.[11, 19] This reinforces the need to weigh the benefits against the potential discomfort when deciding whether to use a stent. This was not part of our study protocol but during follow-up visits of patients included in our study with DJ stent in situ similar bothersome symptoms were reported. In addition, the presence of a DJ stent may reduce ESWL efficacy by absorbing some of the shock wave energy and by inducing ureteral edema, which can hinder fragment passage. These factors may limit optimal stone fragmentation and clearance during treatment.[20]

Recent innovations in DJ stent technology aim to improve patient comfort and reduce complications. Biodegradable stents eliminate the need for removal procedures, while magnetic-tip stents allow easy outpatient removal without cystoscopy or anesthesia. Softer silicone stents and custom-length designs help reduce bladder irritation and stent-related symptoms. Although stent insertion is usually done under spinal or general anesthesia, selected patients may tolerate it under local anesthesia using flexible cystoscopy, though complete insertion without any anesthesia is generally not feasible due to discomfort.[21]

This study has a few limitations. Since it was conducted at a single center with a relatively small number of patients, the findings may not fully reflect outcomes in other settings. Also, the follow-up period was short, so long-term results like recurrence or late complications couldn't be assessed. Lastly, it focused only on ESWL with and without stents, without comparing other newer treatments like flexible ureteroscopy or mini-PCNL that might offer better outcomes for similar stones.

## CONCLUSION:

This Prospective Comparative Cohort study assessed the effectiveness of ESWL with and without DJ stenting for proximal ureteric and renal pelvis stones measuring 1.5–2 cm. The findings showed no statistically significant difference in stone clearance between stented and non-stented groups, despite a slightly higher success rate in the stented group. Additionally, stone size, density, and BMI did not show a consistent correlation with treatment success.These results support the use of a selective, rather than routine, approach to DJ stenting—tailoring its use based on individual patient risk factors. This strategy is particularly relevant in resource-limited settings, where cost-effectiveness is crucial.Overall, the study contributes to the ongoing discussion about the necessity of routine DJ stenting especially in resource-limited settings where cost-effective treatment strategies are essential in ESWL and highlights the need for larger, more targeted studies to further clarify when stenting may provide the greatest benefit.In conclusion, while routine stenting may not be required for all ESWL patients with proximal ureteric and renal pelvis stones, our findings suggest that there may be specific cases where stenting could still play a beneficial role.

**Authors Contribution:**
**Anum Ansari:** Data collection, Analysis and interpretation, Manuscript Drafting
**Naresh Kumar Valecha:** Conceived original idea, contributed to study design, critical revision of the manuscript, approval of final version for publication.
**Arif Ali Shaikh:** Supervision of study, critical revision of the manuscript.
**Ayesha Khan:** input on study design, data interpretation, critical revision of manuscript
**Abdul Mujeeb:** Provided clinical oversight, reviewed and revised the manuscript for accuracy.
**Hassan Siddiqui:** Contributed to data collection and assisted in the critical revision of the manuscript

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