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COMPARISON OF STONE FREE RATE BETWEEN EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY AND URETEROSCOPIC LASERTRIPSY IN THE MANAGEMENT OF PROXIMAL URETERAL STONES

Original Research

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ABSTRACT

Background: Proximal ureteric stones are a common urological condition, affecting up to 12% of the population. While smaller stones may pass spontaneously, larger stones often require active intervention to prevent complications such as obstruction and renal impairment. Treatment options have evolved from invasive surgeries to less invasive modalities like extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic lasertripsy (URS laser). Selecting the optimal modality is critical for maximizing stone clearance and minimizing complications.

Objective: To compare the stone-free rates and clinical outcomes of ESWL and URS laser in the management of proximal ureteral stones.

Methods: This randomized controlled trial was conducted at the Department of Urology, Institute of Kidney Diseases, Peshawar, from September 2024 to February 2025. A total of 166 patients diagnosed with proximal ureteric stones on non-contrast CT KUB were enrolled and equally divided into two groups. Group A (n=83) underwent ESWL using the Storz Modulith SLX-F2 lithotripter, while Group B (n=83) received URS laser using a semi-rigid ureteroscope with Holmium:YAG laser lithotripsy. Data were recorded using a structured proforma and analyzed with SPSS version 23. Stone-free status was assessed by CT KUB one-month post-treatment.

Results: The mean age was 39.18 ± 11.95 years in Group A and 39.19 ± 11.24 years in Group B ($p = 0.339$). The stone-free rate was significantly higher in Group B (92.8%, n=77) compared to Group A (47%, n=39) ($p = 0.001$). The overall complication rate was 26.5% in Group A and 37.3% in Group B ($p = 0.008$). Re-treatment was required in 48.2% (n=40) of Group A patients and 7.2% (n=6) in Group B ($p = 0.001$). No ureteral perforations were reported in either group.

Conclusion: URS laser provides a significantly higher stone-free rate and lower need for re-treatment compared to ESWL in the management of proximal ureteric stones, supporting its use as a preferred treatment option.

Keywords: Extracorporeal Shockwave Lithotripsy, Holmium: YAG Laser, Proximal Ureteral Stones, Randomized Controlled Trial, Stone-Free Rate, Ureteroscopy, Ureterolithiasis.

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INTRODUCTION

Urinary stone disease is an increasingly prevalent urological condition, with global studies consistently reporting a rising trend in its incidence (1). Among the various types, ureteric stones affect nearly 12% of the population and represent a significant burden on healthcare systems due to their frequency and associated complications (2). Proximal ureteral stones, located in the upper segment of the ureter, are particularly problematic as they often result in intense flank pain, hematuria, hydronephrosis, and potential renal impairment when left untreated or if they become impacted (3). While smaller stones frequently pass spontaneously, larger stones—especially those exceeding 10 mm in diameter—typically require medical intervention due to their limited potential for spontaneous expulsion. Over the past few decades, technological advancements have markedly transformed the management of urinary tract stones. The development of minimally invasive procedures has significantly improved patient outcomes by reducing surgical trauma and hospital stay while enhancing procedural efficacy (4,5). Presently, up to 95% of ureteric stones can be successfully managed with such approaches (6). This shift in clinical practice reflects the broader transition from traditional open surgeries to more refined endourological techniques, including ureteroscopic lithotripsy, percutaneous nephrolithotomy (PCNL), and laparoscopic ureterolithotomy (7). Two primary interventions currently employed for proximal ureteric stones are extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic laser lithotripsy (URS laser). ESWL, a non-invasive method introduced by Chaussy in 1982, uses focused shockwaves to fragment stones and is generally performed without anesthesia (8,9). In contrast, URS laser involves direct endoscopic visualization and fragmentation of the stone using laser energy, necessitating anesthesia but offering a more controlled and targeted approach (10,11). Although both modalities are widely accepted, there remains ongoing debate about their comparative effectiveness, particularly in terms of achieving complete stone clearance. ESWL, while less invasive, is often associated with lower stone-free rates, especially in patients with larger or denser calculi. URS laser, despite being minimally invasive, tends to yield higher stone-free outcomes (12). Given the clinical importance of achieving complete stone clearance to minimize recurrence and complications, it is crucial to evaluate the relative efficacy of these two procedures. This study, therefore, aims to compare the stone-free rates of ESWL and URS laser in the management of proximal ureteric stones within our clinical setting. By providing robust evidence on the success of these treatment modalities, the research seeks to guide urologists in selecting the most effective approach for optimal patient care.

METHODS

This randomized controlled trial was conducted at the Department of Urology, Institute of Kidney Diseases, Peshawar, over a six-month period from September 1, 2024, to February 28, 2025, following approval from the Institutional Review and Ethical Board (Certificate No. 457/Chairman/R&E/Committee). The study aimed to evaluate and compare the stone-free rates of extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic laser lithotripsy (URS laser) in patients diagnosed with proximal ureteric stones. Patients of either gender aged between 18 and 60 years were considered eligible if they had radiologically confirmed proximal ureteric calculi, as defined in the operational criteria. Individuals with active urinary tract infections, known chronic kidney disease, or pregnancy were excluded to minimize confounding variables and procedural risks. Sample size estimation was performed using the World Health Organization (WHO) calculator, based on an anticipated stone-free rate of 64.2% for ESWL and 83.3% for URS lasers, with a power of 80%, a 95% confidence interval, and a 5% margin of error. This resulted in a total sample size of 166 patients, who were enrolled using consecutive non-probability sampling. All participants were thoroughly briefed regarding the study's purpose, procedures, and potential benefits. They were assured that participation would involve no additional risk, and informed written consent was obtained in compliance with ethical guidelines.

Participants were randomly and equally allocated into two groups through a simple randomization process. Group A (n = 83) underwent ESWL using the Storz Modulith SLX-F2 electromagnetic lithotripter. Each session consisted of 3,000 shockwaves, with energy levels gradually increased from low to high based on patient tolerance and procedural response. Pre-procedural prophylaxis included empirical antibiotics and analgesics to reduce infection risk and improve patient comfort. Group B (n = 83) underwent URS laser using a 6.5/7 Fr semi-rigid ureteroscope. Stone fragmentation was achieved using a Holmium: YAG laser with a 300–600-micron fiber. A Foley catheter was inserted postoperatively in all patients in Group B and removed after 24 hours. The primary outcome was the stone-free rate, defined as complete absence of visible stones or presence of clinically insignificant residual fragments less than 4 mm on follow-up non-contrast CT KUB imaging performed one-month post-treatment. Any postoperative complications arising within one month were documented. Patients who had significant residual fragments requiring further intervention received repeat ESWL in Group A and repeat URS laser in Group B. All procedures and evaluations were performed under the supervision of a consultant urologist with a minimum of five years of post-fellowship experience, ensuring procedural consistency and clinical oversight. Data were collected using a structured proforma and analyzed using IBM SPSS version 23. The Shapiro-Wilk test was applied to assess the normality of continuous variables. Means and standard deviations were calculated for numerical variables such as age, stone size, and stone density, while categorical

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variables like gender, stone-free rates, complication rates, and retreatment frequencies were summarized using frequencies and percentages. Comparative analysis between the two groups was conducted using the Chi-square test, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 166 patients were enrolled in the study and equally distributed into two groups, with 83 patients undergoing extracorporeal shockwave lithotripsy (Group A) and 83 patients undergoing ureteroscopic laser lithotripsy (Group B). Baseline characteristics including age, gender, side of stone, stone size, and stone density were comparable between the two groups. The mean age of patients in Group A was 39.18 ± 11.95 years, while in Group B it was 39.19 ± 11.24 years (p = 0.339). Gender distribution was also similar, with males comprising 56.6% in Group A and 53.01% in Group B, and females 43.38% and 46.99% respectively (p = 0.640). The laterality of stones was identical in both groups, with 54.21% on the right side and 45.79% on the left (p = 1.0). The mean stone size was 11.96 ± 1.58 mm in the ESWL group and 12.69 ± 1.75 mm in the URS laser group (p = 0.146), and the mean stone density was 1055 ± 92 Hounsfield Units in Group A and 1264 ± 144 HU in Group B (p = 0.621). A statistically significant difference was observed in the primary outcome. The stone-free rate in Group B (URS laser) was markedly higher, with 92.81% (77 out of 83 patients) achieving complete clearance compared to only 47% (39 out of 83 patients) in Group A (p = 0.001). Regarding postoperative complications, Group B experienced a higher overall complication rate (37.3%) compared to Group A (26.5%) (p = 0.008). Fever occurred in 4.8% of patients in Group A and 12% in Group B. Hematuria was reported in 14.5% of Group A and 25.3% of Group B. Stein Strasse, a known complication associated with ESWL, developed in 7.2% of patients in Group A but was absent in Group B. No cases of ureteral perforation were reported in either group.

The need for re-treatment was significantly higher in Group A, where 48.2% of patients required additional sessions, as opposed to only 7.2% in Group B (p = 0.001), reflecting the superior efficacy of the URS laser in achieving stone clearance with fewer interventions. Based on this analysis, a notable trend emerged: in patients with stones ≤12 mm, both treatment modalities performed better; however, URS laser showed a superior stone-free rate of 95.56% compared to 60% in the ESWL group. Conversely, for stones >12 mm, the stone-free rate dropped significantly in Group A (27.27%) but remained relatively high in Group B (89.47%), suggesting URS laser was far more effective in managing larger stones. A similar pattern was observed with stone density. Among patients with stone densities ≤1200 HU, the stone-free rate was 58.33% in the ESWL group, while it was 90% in the URS group (as derived). For higher-density stones (>1200 HU), stone clearance in the ESWL group dropped dramatically, while URS still maintained high effectiveness. These findings reinforce that both stone size and density are key determinants of treatment success, particularly favoring URS laser for larger or denser calculi.

Table 1: Comparative Analysis of ESWL and URS Laser in the Management of Proximal Ureteric Stones: Clinical Outcomes and Procedural Efficacy

Parameter	Group A (n)	Group B (n)	p value
Number of patients	83	83	
Age (in years ±S.D.)	39.18 ± 11.95 years	39.19 ± 11.24 years	0.339
Gender No. (%)			
Male	47 (56.6%)	44(53.01%)	0.640
Female	36 (43.38%)	39(46.99%)	
Stone side No. (%)			
Right	45 (54.21%)	45 (54.21%)	1.0
Left	38 (45.79)	38 (45.79)	
Mean Stone size (mm)	11.96 ± 1.58 mm	12.69± 1.75 mm	0.146
Mean stone density (HU)	1055 ± 92 HU	1264 ± 144 HU	0.621
Stone free rate No. (%)	39 (47%)	77 (92.81%)	0.001
Complications (overall) No. (%)	22 (26.5%)	31 (37.3%)	0.08
No complications	61 (73.5%)	52 (62.71%)	
Fever	4 (4.8%)	10(12%)	
Hematuria	12 (14.5%)	21(25.3%)	
Stein Strasse	6(7.2%)	0	
Perforation	0	0	

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Parameter	Group A (n)	Group B (n)	p value
Re-treatment rate No. (%)	40 (48.2%)	6 (7.2%)	0.001

Group A=ESWL, Group B= URS laser
S.D.= Standard deviation
HU= Hounsfield unit

Table 2: Subgroup Analysis of Stone-Free and Complication Rates

Subgroup	Group	Total Patients	Stone-Free Patients	Stone-Free Rate (%)	Complication Rate (%)
Size ≤ 12 mm	Group A (ESWL)	50	30	60	20
Size >12 mm	Group A (ESWL)	33	9	27.27	36.36
Size ≤ 12 mm	Group B (URS)	45	43	95.56	31.11
Size >12 mm	Group B (URS)	38	34	89.47	44.74
Density ≤ 1200 HU	Group A (ESWL)	60	35	58.33	25
Density >1200 HU	Group A (ESWL)	23	4	17.39	30.43
Density ≤ 1200 HU	Group B (URS)	40	36	90	30
Density >1200 HU	Group B (URS)	43	41	95.35	44.19

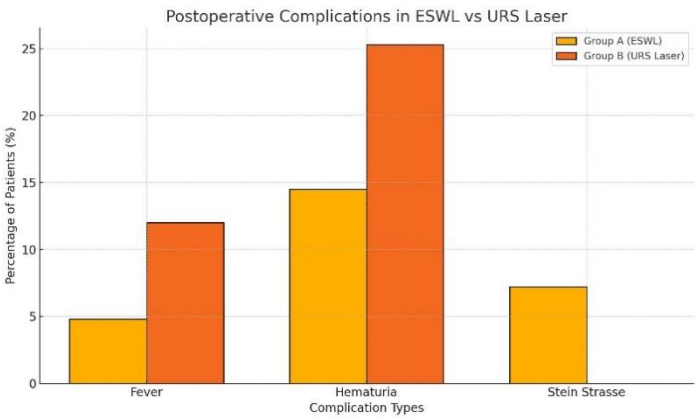

Figure 1 Postoperative Complications in ESWL vs URS Laser

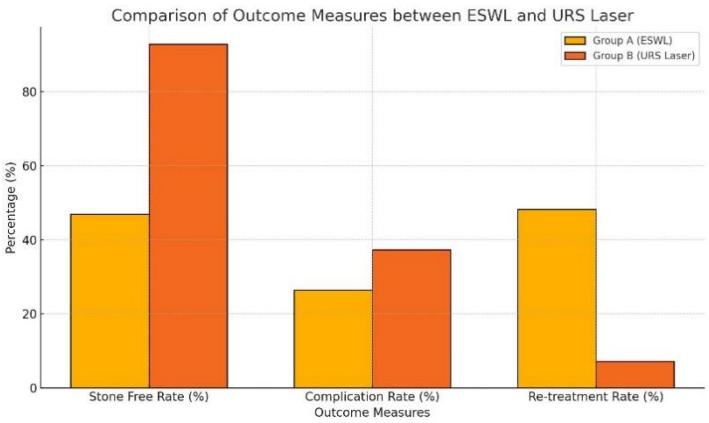

Figure 2 Comparison of Outcome Measure Between ESWL and URS Laser

DISCUSSION

This randomized clinical trial was conducted to compare the clinical outcomes of extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic laser lithotripsy (URS laser) in the management of proximal ureteric stones. A total of 166 patients were randomized into two treatment arms. Baseline characteristics such as age, gender, and stone laterality were comparable across both groups, which minimized confounding and strengthened the internal validity of the outcome comparisons. The mean stone size and stone density, although slightly higher in the URS group, were not statistically significant, reflecting a well-balanced distribution between the two groups (13). The study demonstrated a significantly higher stone-free rate in the URS laser group (92.8%) compared to the ESWL group (47%). This finding aligns with multiple previous studies that have consistently reported superior stone clearance with ureteroscopic holmium:YAG laser lithotripsy, especially for stones larger than 1 cm. Studies conducted in different clinical settings have shown similar trends, where ureteroscopic intervention provided better stone clearance compared to ESWL, particularly in patients with impacted or dense calculi (14,15). The high efficacy of the URS laser observed in this study reinforces its value as a primary treatment modality in patients with proximal ureteric stones. Complication rates in both groups were within acceptable clinical ranges, though slightly higher in the URS group (37.3%) compared to the ESWL group (26.5%). Fever and hematuria were the most commonly reported complications, while Stein Strasse occurred only in the ESWL group. Despite the higher incidence of complications in the URS group, none were severe or life-threatening, and no cases of ureteric perforation were reported in either group. These findings reflect the generally safe profile of both procedures, with a trade-off between invasiveness and efficacy (16,17).

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The need for retreatment emerged as a major differentiator between the two interventions. Nearly half of the patients in the ESWL group required additional sessions (48.2%), whereas only a small fraction of the URS group (7.2%) needed further intervention. These results support existing literature indicating that ureteroscopy, although more technically demanding and invasive, offers a higher likelihood of achieving complete clearance in a single session (18). From a clinical perspective, fewer retreatments translate into reduced hospital visits, quicker recovery, and less financial burden on healthcare systems and patients. Subgroup analysis based on stone size and density provided further insight into procedural outcomes. ESWL was notably less effective in stones >12 mm and with higher densities, whereas URS maintained a consistently high stone-free rate across these subgroups. This highlights the importance of individualizing treatment choices based on stone characteristics, with URS being particularly advantageous in complex cases (19). Among the strengths of this study is its randomized design, which reduces selection bias, and the standardized outcome assessment using post-treatment CT KUB, providing objective and reliable results. The study also provides valuable local data for urologists practicing in similar healthcare settings, potentially aiding decision-making for patients with proximal ureteric stones.

Nevertheless, the study has certain limitations. Being a single-center study conducted at the Institute of Kidney Diseases, Peshawar, the findings may not be generalizable to broader populations. Additionally, the URS procedures were performed by multiple surgeons, introducing variability in technique and operator experience, which could influence outcomes. Furthermore, the exclusive use of holmium: YAG laser for URS limits the applicability of results to centers using alternative lithotripsy technologies such as pneumatic lithoclasts. The study also did not evaluate pain scores, hospital stay duration, or patient satisfaction, which are relevant outcome measures in urological practice. Future studies should focus on multicenter trials with larger sample sizes and consider incorporating cost-effectiveness analysis, patient-reported outcomes, and longer follow-up to assess recurrence. Comparative evaluation of different laser technologies and standardized surgical protocols may also offer greater insights into optimizing procedural success and safety (20).

In summary, this study demonstrated that ureteroscopic laser lithotripsy offers significantly higher stone-free rates and lower retreatment needs compared to ESWL, particularly in patients with larger or denser stones. While both methods are generally safe, URS appears to provide more definitive treatment, making it a preferred option in selected patients with proximal ureteric calculi.

CONCLUSION

This study concluded that ureteroscopic laser lithotripsy offers superior clinical effectiveness compared to extracorporeal shock wave lithotripsy in the management of proximal ureteric stones, primarily due to its higher stone clearance and lower retreatment requirement. These findings highlight the importance of adopting URS laser as a frontline therapeutic option in appropriate clinical scenarios. Nevertheless, treatment decisions should remain patient-centered and be guided by individual stone characteristics, clinical context, and the availability of surgical expertise. This research adds valuable evidence to support more informed, outcome-oriented choices in urological practice.

AUTHOR CONTRIBUTION

Author	Contribution
Nauman ul Mulk	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Khizer Zaman	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Tayyib	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Abdul Haseeb*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Raza Muhammad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Saad Hamid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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REFERENCES

1. Thomas F, Córdoba A, López Silva M, Caruso D, Hernández R, Sanguinetti H. [Pneumatic lithotripsy vs Holmium: YAG Laser lithotripsy for the treatment of ureteral stones.]. Arch Esp Urol. 2021;74(8):768-73.
2. Huang HS, Lu ZH, Liu CJ. Ureterorenoscopic (URS) Lithotripsy and Balloon Dilation Cause Acute Kidney Injury and Distal Renal Tubule Damage: A Prospective Study. Biomed Res Int. 2022;2022:5505969.
3. Ulvik Ø, Æsøy MS, Juliebø-Jones P, Gjengstø P, Beisland C. Thulium Fibre Laser versus Holmium:YAG for Ureteroscopic Lithotripsy: Outcomes from a Prospective Randomised Clinical Trial. Eur Urol. 2022;82(1):73-9.
4. Lai S, Jiao B, Diao T, Seery S, Hu M, Wang M, et al. Optimal management of large proximal ureteral stones (>10 mm): A systematic review and meta-analysis of 12 randomized controlled trials. Int J Surg. 2020;80:205-17.
5. Anastos H, Yaghoubian AJ, Khusid JA, Chandhoke RA, Lundon DJ, Sadiq AS, et al. Reverse Trendelenburg Positioning Minimizes Stone Retropulsion During Ureteroscopic Laser Lithotripsy: A Prospective Randomized Study. J Endourol. 2023;37(6):660-6.
6. Sabhan AH. Comparison of immediate versus post-stenting ureteroscopy for ureteral stones treatment. J Med Life. 2023;16(12):1745-9.
7. Geraghty R, Lombardo R, Yuan C, Davis N, Tzelves L, Petrik A, et al. Outcomes of Flexible Ureteroscopy vs Extracorporeal Shock Wave Lithotripsy for Renal Stones in Pediatric Patients: A European Association of Urology Urolithiasis Guidelines Systematic Review and Meta-Analysis. J Urol. 2023;210(6):876-87.
8. Haas CR, Knoedler MA, Li S, Gralnek DR, Best SL, Penniston KL, et al. Pulse-modulated Holmium:YAG Laser vs the Thulium Fiber Laser for Renal and Ureteral Stones: A Single-center Prospective Randomized Clinical Trial. J Urol. 2023;209(2):374-83.
9. Harper JD, Lingeman JE, Sweet RM, Metzler IS, Sunaryo PL, Williams JC, Jr., et al. Fragmentation of Stones by Burst Wave Lithotripsy in the First 19 Humans. J Urol. 2022;207(5):1067-76.
10. Panthier F, Solano C, Chicaud M, Kutchukian S, Candela L, Doizi S, et al. Thulium fiber laser versus pulsed Thulium:YAG for laser lithotripsy during flexible ureteroscopy. Lasers Med Sci. 2024;39(1):294.
11. Guo Z, Wang Z, Weng X, Tang Y, Wu D, Cheng F, et al. The safety and efficacy of Sotn ureteroscopy for renal and upper ureteral calculi: a prospective multicenter randomized controlled trial. Minerva Urol Nephrol. 2024;76(2):221-9.
12. Gong Z, Li Y, Zhang H, Pan C, Li J, Liu G, et al. Prospective comparison of extracorporeal shock wave lithotripsy and ureteroscopy in distal ureteral stones. Urolithiasis. 2023;51(1):86.
13. Shalaby EA, Abdelhalim KM, Bakr M, El-Lilly AA, Elkoushy MA. Impact of forced diuresis on retropulsion of disintegrated ureteral calculi during semi-rigid ureteroscopy: a double-blind randomized-controlled study. Urolithiasis. 2022;50(4):465-72.
14. Wang D, Xu Y, Liu Z, Liang J, Lai D, Guan W, et al. Using vacuum-assisted ureteral access sheath in the treatment of complex steinstrasse. Urolithiasis. 2023;51(1):89.
15. Wang P, Zhan Y, Li J, Liu G, Li Z, Bai S. Comparison of shock wave lithotripsy and ureteroscopy in patients with proximal ureteral stones under the COVID-19 pandemic. World J Urol. 2023;41(3):797-803.
16. Yildiz AK, Doluoglu OG, Kacan T, Keseroglu BB, Ozgur BC, Karakan T. A new position utilizing the effect of gravity in proximal ureteral stones, ureteroscopic lithotripsy in the reverse Trendelenburg position: a prospective, randomized, comparative study. World J Urol. 2023;41(12):3695-703.
17. Percutaneous Nephrolithotomy Versus Laparoscopy in the Management of Large Proximal Ureteral Stones: The Experience of Two Different Settings | Urology Journal [Internet]. [cited 2025 Mar 7].
18. Pneumatic lithotripsy for large ureteral stones: is it the first line treatment? | International Urology and Nephrology [Internet]. [cited 2025 Mar 7].
19. Flexible Ureterorenoscopy versus Extracorporeal Shock Wave Lithotripsy for the treatment of upper/middle calyx kidney stones of 10–20 mm: a retrospective analysis of 174 patients | SpringerPlus [Internet]. [cited 2025 Mar 7].
20. Comparison of Outcomes of Extracorporeal Shockwave Lithotripsy with Ureteroscopic Lasertripsy for Management of Proximal Ureteral Stones. J Coll Physicians Surg Pak. 2024 Jan 1;34(01):101–4.

