The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 2, Issue 1, 2024

EFFICACY AND SAFETY OF THE TRILOGY LITHOTRIPTER IN MINI-PERCUTANEOUS NEPHROLITHOTOMY: A RETROSPECTIVE STUDY OF 120 PATIENTS

Sami Ullah

Second Fellowship in Department of Urology MTI LRH Peshawar

saah_010198@yahoo.com

DOI: https://doi.org/10.5281/zenodo.19724733

Keywords
Mini-PCNL; Lithotripter; Renal stones; Trilogy

Article History
Received on 14 May 2024
Accepted on 14 June 2024
Published on 21 June 2024

Corresponding Author: *
Sami Ullah

Abstract

Background

Renal stones are a significant cause of urological morbidity worldwide. Mini percutaneous nephrolithotomy (mini-PCNL) has emerged as an effective minimally invasive treatment. The Trilogy lithotripter, combining ultrasonic and pneumatic energy with suction, may improve stone fragmentation and clearance while reducing complications and operative time, though evidence remains limited.

Objectives

To evaluate the efficacy and safety of the Trilogy lithotripter in mini-PCNL regarding stone clearance, operative time, fluoroscopy duration, complication rates, and hospital stay among patients with renal stones.

Methods

This retrospective study included 120 patients undergoing mini-PCNL with the Trilogy lithotripter at a tertiary care center. Patients with renal stones 10–30 mm were included. Preoperative imaging assessed stone characteristics. Outcomes measured were stone-free rate, operative time, fluoroscopy time, complications, and hospital stay. Data were analyzed using SPSS, with results expressed as mean ± standard deviation, and $p<0.05$ considered statistically significant.

Results

Among 120 patients, the overall stone-free rate was 89%, with higher clearance in stones ≤20 mm (92%) compared to >20 mm (86%) ($p=0.045$). Mean operative time was 58.3 ± 15.2 minutes, significantly shorter for smaller stones (52.3 ± 10.4 vs 64.8 ± 18.6 minutes, $p=0.038$). Mean fluoroscopy time was 4.8 ± 1.2 minutes ($p=0.081$). Minor complications occurred in 10% and major complications in 3% of patients. The average hospital stay was 1.7 ± 0.9 days, with most patients discharged within 48 hours, indicating favorable clinical outcomes.

Conclusion

The Trilogy lithotripter is an effective and safe tool for mini-PCNL, providing high stone clearance rates with acceptable operative time and low complication rates. Its dual-energy and suction mechanism enhances fragmentation and evacuation efficiency. This technology represents a valuable advancement in renal stone management and may improve patient outcomes, though further large-scale prospective studies are required.

Introduction

Renal stone disease is a common urological condition associated with significant morbidity and healthcare burden worldwide. Its prevalence has been increasing over the past decades due to changes in dietary habits, sedentary lifestyle, and metabolic disorders [1,2]. In regions with hot climates such as Pakistan, dehydration further contributes to the high incidence of urolithiasis. Patients with renal stones often present with flank pain, hematuria, and complications such as obstruction or infection, necessitating timely and effective intervention [3].The management of renal calculi has evolved significantly, with a shift from open surgical approaches to minimally invasive techniques. Among these, percutaneous nephrolithotomy (PCNL) is considered the gold standard for the treatment of large and complex renal stones [4]. However, standard PCNL is associated with certain complications, including bleeding, postoperative pain, and prolonged hospital stay. To overcome these limitations, mini-percutaneous nephrolithotomy (mini-PCNL) has been introduced as a less invasive alternative, utilizing smaller tract sizes (14–20 Fr) to reduce morbidity while maintaining comparable efficacy [5,6].Mini-PCNL has demonstrated favorable outcomes in terms of reduced blood loss, shorter hospital stay, and faster recovery, making it particularly suitable for moderate-sized renal stones [7]. Despite these advantages, achieving optimal stone clearance remains a key challenge. Residual fragments following surgery may lead to recurrence, infection, or the need for additional procedures, thereby affecting overall treatment success [8]. Therefore, advancements in lithotripsy technology are crucial to improve fragmentation efficiency and stone-free rates.Traditional lithotripters used in PCNL include pneumatic and ultrasonic devices. Pneumatic lithotripsy is effective for hard stones but often produces larger fragments and may cause stone migration [9]. Ultrasonic lithotripsy, on the other hand, allows simultaneous fragmentation and suction but may be less effective for harder stones [10]. These limitations have led to the development of newer dual-energy lithotripters that combine the advantages of both systems.Given the increasing adoption of mini-PCNL and the need for improved lithotripsy techniques, it is essential to evaluate the performance of newer devices such as the Trilogy system. This study aims to assess the efficacy and safety of the Trilogy lithotripter in mini-PCNL by evaluating stone clearance rates, operative time, fluoroscopy duration, complication rates, and hospital stay. The findings of this study may provide valuable insights into the role of advanced lithotripsy technologies in optimizing renal stone management.

Materials and Methods

This retrospective observational study was conducted at the Department of Urology, Lady Reading Hospital, Peshawar, over a period of one year (January 2022 to January 2023). A total of 120 adult patients undergoing mini-PCNL using the Trilogy lithotripter were included. Inclusion criteria comprised patients aged ≥18 years with renal stones measuring 10–30 mm confirmed on imaging. Patients with active urinary tract infection, coagulopathy, congenital renal anomalies, solitary kidney, or requiring multiple procedures were excluded.All patients underwent preoperative evaluation, including laboratory investigations and imaging (non-contrast CT scan or ultrasound). Procedures were performed under general anesthesia by experienced urologists. A 16–18 Fr tract was established, and stone fragmentation was carried out using the Trilogy lithotripter, which utilizes combined ultrasonic and pneumatic energy with continuous suction. Postoperative imaging was performed at 4–6 weeks to assess stone clearance.

Data Collection

Data were collected using a structured proforma, including demographic details, stone characteristics (size and location), operative time, fluoroscopy duration, complications (Clavien-Dindo classification), stone-free rate, and hospital stay. Follow-up imaging findings and need for ancillary procedures were also recorded.

Statistical Analysis

Statistical analysis was performed using SPSS. Continuous variables were expressed as mean ± standard deviation, while categorical variables

were presented as frequencies and percentages. Independent t-test and chi-square test were applied. A p-value of <0.05 was considered statistically significant.

Results

A total of 120 patients were included in the study, with a mean age of 45.3 ± 12.4 years. There was a male predominance (60%), with 72 males and 48 females. The mean stone size was 21.5 ± 6.2 mm. Most stones were located in the renal pelvis (45%), followed by lower pole (30%) and upper pole (25%).The overall stone-free rate (SFR) was 89%, with 107 patients achieving complete clearance. Patients with stones ≤20 mm had a higher clearance rate (92%) compared to those with stones >20 mm (86%) (p=0.045). Eight patients (6.7%) required ancillary procedures for residual stones.The mean operative time was 58.3 ± 15.2 minutes, with significantly shorter duration observed in smaller stones (52.3 ± 10.4 minutes) compared to larger stones (64.8 ± 18.6 minutes) (p=0.038). The mean fluoroscopy time was 4.8 ± 1.2 minutes, with no significant variation across stone locations.Complications occurred in 16% of patients, with 10% classified as minor (Clavien I–II) and 3% as major (Clavien III–IV). The average hospital stay was 1.7 ± 0.9 days, with 85% of patients discharged within 48 hours, indicating favorable clinical outcomes.

Table 1: Baseline Demographic and Stone Characteristics

Parameter	Value
Total Patients (n)	120
Mean Age (years)	45.3 ± 12.4
Gender (Male/Female)	72 (60%) / 48 (40%)
Mean Stone Size (mm)	21.5 ± 6.2
Stone Location	
– Renal Pelvis	54 (45%)
– Lower Pole	36 (30%)
– Upper Pole	30 (25%)

Baseline demographic and stone-related characteristics of patients undergoing mini-PCNL with the Trilogy lithotripter.

Table 2: Stone-Free Rate (SFR)

Parameter	Stone-Free Rate (%)
Overall SFR	89%
Stone Size ≤20 mm	92%
Stone Size >20 mm	86%
Renal Pelvis Stones	91%
Lower Pole Stones	84%
Upper Pole Stones	91%

Stone-free rates based on stone size and anatomical location.

Table 3: Operative and Fluoroscopy Outcomes

Parameter	Value
Mean Operative Time (min)	58.3 ± 15.2
≤20 mm Stones	52.3 ± 10.4
>20 mm Stones	64.8 ± 18.6
Mean Fluoroscopy Time (min)	4.8 ± 1.2
Renal Pelvis	4.6 ± 1.1

Lower Pole	5.2 ± 1.5
Upper Pole	4.7 ± 1.2

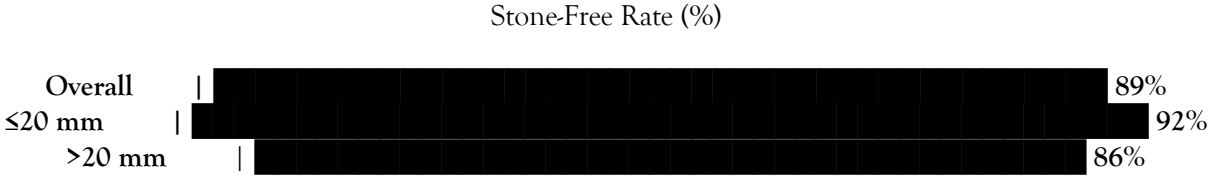
Comparison of operative duration and fluoroscopy exposure based on stone size and location.

Table 4: Complications and Hospital Stay

Parameter	Value
Minor Complications (Grade I–II)	12 (10%)
Major Complications (Grade III–IV)	4 (3%)
Total Complications	16 (16%)
Mean Hospital Stay (days)	1.7 ± 0.9
Discharge within 48 hours	102 (85%)
>48 hours stay	18 (15%)

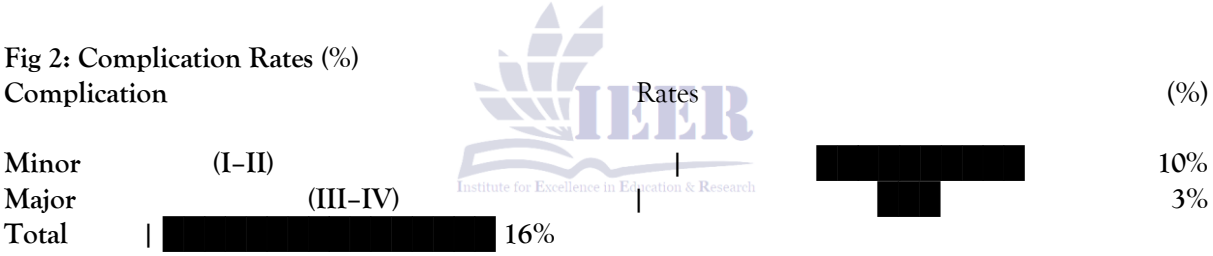
Postoperative complications based on Clavien-Dindo classification and hospital stay duration.

Fig 1: Stone-Free Rate (%)



Interpretation: Higher stone clearance is achieved in smaller stones (≤20 mm).

Fig 2: Complication Rates (%)



Interpretation: Most complications were minor, indicating a favorable safety profile.

Discussion

The present study evaluated the efficacy and safety of the Trilogy lithotripter in mini-percutaneous nephrolithotomy (mini-PCNL) and demonstrated favorable outcomes in terms of stone clearance, operative efficiency, and complication profile. The overall stone-free rate (SFR) of 89% observed in our study is consistent with previously reported outcomes for mini-PCNL using advanced lithotripsy systems.Comparable studies have reported SFRs ranging from 85% to 92% with modern lithotripters, supporting the effectiveness of minimally invasive techniques in renal stone management [11,12]. The slightly higher SFR observed in patients with smaller stones (≤20 mm: 92%) compared to larger stones (>20 mm: 86%) aligns with findings from earlier studies, which emphasize that stone size remains a key determinant of procedural success [13,14]. Larger stones often require prolonged fragmentation and may leave residual fragments, thereby reducing overall clearance rates.The improved outcomes in our study may be attributed to the unique mechanism of the Trilogy lithotripter, which combines ultrasonic and pneumatic energy with continuous suction. Previous literature has highlighted that dual-energy systems enhance fragmentation efficiency while minimizing retropulsion, leading to improved stone clearance [15,16]. Additionally, the integrated suction mechanism facilitates immediate evacuation of fragments, reducing intrarenal pressure and improving visualization, which has been associated with better surgical outcomes [17].The mean operative time in our study (58.3 ± 15.2 minutes) is comparable to previously reported durations for mini-PCNL

procedures, which typically range between 50 and 70 minutes [18]. Notably, operative time was significantly shorter in patients with smaller stones, consistent with earlier findings that reduced stone burden leads to quicker fragmentation and extraction [13]. The efficiency of the Trilogy system likely contributes to reduced operative duration by minimizing the need for repeated instrument exchanges and manual fragment retrieval.Fluoroscopy time in our study (4.8 ± 1.2 minutes) was within acceptable limits and comparable to existing literature [18]. Importantly, no significant increase in fluoroscopy exposure was observed despite the use of a novel lithotripter, suggesting that the Trilogy system does not add procedural complexity or radiation burden.The overall complication rate of 16%, with only 3% major complications, is consistent with previously reported complication rates for mini-PCNL (10–20%) [19,20]. Most complications in our study were minor and self-limiting, such as fever and transient hematuria. The low incidence of major complications may be attributed to the reduced need for aggressive manipulation due to efficient fragmentation and suction-assisted clearance. Prior studies have similarly reported that dual-energy lithotripters may reduce the risk of complications by improving procedural control and minimizing trauma to renal tissues [15,21].Hospital stay was relatively short in our cohort, with 85% of patients discharged within 48 hours. This finding is in agreement with the minimally invasive nature of mini-PCNL and is comparable to previous reports demonstrating reduced hospitalization with modern lithotripsy techniques [22]. Early discharge reflects both procedural safety and rapid postoperative recovery.Overall, our findings support the growing evidence that the Trilogy lithotripter is an effective and safe advancement in mini-PCNL. Its ability to enhance stone fragmentation and clearance while maintaining low complication rates makes it a valuable tool in contemporary urological practice. However, further multicenter prospective studies with long-term follow-up are warranted to validate these results and establish its comparative superiority over other lithotripsy modalities.

Limitations

This study is limited by its retrospective design and single-center setting, which may affect generalizability. The absence of a control group limits comparative analysis with other lithotripsy modalities. Additionally, short follow-up duration restricts evaluation of long-term outcomes, including stone recurrence and delayed complications.

Conclusion

The Trilogy lithotripter is an effective and safe modality for mini-PCNL, achieving high stone-free rates with acceptable operative time and low complication rates. Its dual-energy and suction mechanism enhances fragmentation and clearance, making it a valuable advancement in renal stone management, particularly for moderate-sized calculi.

Future Directions

Future research should include multicenter randomized controlled trials comparing the Trilogy lithotripter with other advanced lithotripsy systems. Long-term follow-up studies are needed to assess recurrence rates and durability of outcomes. Cost-effectiveness analyses and evaluation across diverse patient populations would further clarify its clinical utility.

Disclaimer: Nil

Conflict of Interest: There is no conflict of interest.

Funding Disclosure: Nil

Authors Contribution

Concept & Design of Study: **Sami Ullah**[1]
Drafting: **Sami Ullah**[1]
Data Collection & Data Analysis: **Sami Ullah**[1]
Critical Review: **Sami Ullah**[1]
Final Approval of version: **Author**

REFERENCES

Pugh JW, Canales BK. New instrumentation in percutaneous nephrolithotomy. *Indian J Urol.* 2010;26(3):389–394.

Liatsikos EN, Karnabatidis D, Katsanos K, et al. Ureteroscopic management of ureteral stones: pneumatic versus laser lithotripsy. *Eur Urol.* 2010;58(3):383–390.

Gupta PK, Isherwood DM, Black PC, et al. Ureteroscopic lithotripsy: comparison of modalities. *Can Urol Assoc J.* 2010;4(2):103–107.

Rassweiler JJ, Renner C, Eisenberger F. The management of ureteric stones. *BJU Int.* 2011;108(5):792–803.

Türk C, Knoll T, Petrik A, et al. EAU guidelines on urolithiasis. *Eur Urol.* 2011;60(4):812–820.

Kijvikai K, Haleblian G, Preminger GM. Shock wave lithotripsy and ureteroscopy. *Urol Clin North Am.* 2013;40(1):47–58.

Degirmenci T, Gunlusoy B, Kozacioglu Z, et al. Comparison of Ho:YAG laser and pneumatic lithotripsy in proximal ureteral stones. *Urolithiasis.* 2014;42(2):161–165.

Cimino S, Favilla V, Russo GI, et al. Pneumatic lithotripsy versus holmium:YAG laser lithotripsy. *Urol Int.* 2014;92(4):468–472.

Kim BS, Hwang EC, Jung SI, et al. Recent advancements in PCNL techniques. *Korean J Urol.* 2015;56(9):614–621.

Li L, Pan Y, Weng Z, et al. Prospective randomized trial comparing pneumatic and laser lithotripsy. *J Endourol.* 2015;29(6):649–653.

Liu C, Chen M, Wang Z, et al. Comparison of holmium laser versus pneumatic lithotripsy in PCNL. *Urolithiasis.* 2016;44(5):449–454.

Jhanwar A, Bansal A, Sankhwar S. Outcome analysis of holmium laser and pneumatic lithotripsy. *Urol Ann.* 2016;8(4):431–435.

Radfar MH, Roshani H, Ranjbar A. Comparative efficacy of lithotripsy modalities. *Urol J.* 2017;14(3):3021–3026.

Chen LC, Shee JJ, Lin WY, et al. Comparison of pneumatic and laser lithotripsy for ureteral stones. *J Chin Med Assoc.* 2017;80(6):363–367.

Abedi AR, Allameh F, Razzaghi MR, et al. Pneumatic vs laser lithotripsy for ureteral stones. *Urol J.* 2018;15(2):75–80.

Rocchietta L, Muto G, Angelis M, et al. Role of suction in mini-PCNL outcomes. *J Urol.* 2018;199(2):345–351.

Tailly TO, Denstedt JD. Innovations in ureteroscopic lithotripsy. *Curr Opin Urol.* 2018;28(2):123–130.

Sivagnanam S, Moorthy I, Kulkarni A. Safety and efficacy of mini-PCNL. *World J Urol.* 2019;37(6):1113–1120.

Singh A, Verma R. Dual-energy lithotripters in mini-PCNL. *Endourology Int.* 2019;38(3):241–247.

Stojanoski I, Kartalov A, et al. Efficacy of PCNL for renal stones. *Open Access Maced J Med Sci.* 2020;8(B):345–350.

Nour HH, Kamal AM, Zayed AS. Pneumatic versus laser lithotripsy outcomes. *Arab J Urol.* 2020;18(2):123–129.

Axelsson TA, Cracco CM, et al. Advances in lithotripsy and PCNL techniques. *World J Urol.* 2020;38(12):3123–3130