ORIGINAL ARTICLE

COMPARISON OF STONE-FREE RATES FOLLOWING EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL) AND RETROGRADE INTRARENAL SURGERY (RIRS) FOR RENAL PELVIC STONES MEASURING 1–2 CM

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ABSTRACT

Objective: This study aimed to determine the effectiveness of extracorporeal Shock Wave Lithotripsy and retrograde Intrarenal Surgery on obtaining stone-free status for renal pelvic stones measuring 1-2 cm in diameter.

Material & Methods: This quasi-experimental study was conducted at the Department of Urology, Khyber Teaching Hospital, Peshawar, where a total of 60 patients with renal pelvic stones measuring 1–2 cm were randomly assigned to two equal groups: ESWL (n = 30) and RIRS (n = 30). Stone clearance was assessed on the 7th postoperative day using ultrasound and X-ray KUB.

Results: The mean age of participants in Group A (ESWL) increased to 41 years (SD = 10.67), while the mean in Group B (RIRS) increased to 42 years (SD = 9.09). For Group A (ESWL), the sample included 20 males and 10 females, representing 67% and 33%, respectively. For Group B (RIRS), 21 participants were males, and 9 were females, accounting for 70% and 30%, respectively. The Chi-square test results indicate no statistically significant difference between the two groups regarding gender ratio (p = 0.7813). The data indicated that the patients with renal pelvic stones of 1–2 cm were more likely to be stone-free after retrograde intrarenal surgery (RIRS) than after extracorporeal shock wave lithotripsy (ESWL). In the RIRS group, 73% were stone-free, while only 33% were stone-free in the ESWL group (p = 0.0019).

Conclusion: The study finds that RIRS is more effective than ESWL for managing 1-2cm renal pelvic stones. RIRS achieves higher stone-free rates, especially when anatomical difficulties and challenges associated with ESWL are common, and it can precisely locate stones and utilize advanced laser treatment features.

Keywords: stone-free rate, renal pelvic stones, urolithiasis, retrograde Intrarenal surgery, extracorporeal Shock Wave lithotripsy.

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INTRODUCTION

Urolithiasis, also known as kidney stones, is a common medical condition affecting thousands of people worldwide. Research indicates that up to 50% of sufferers experience a recurrence of stones within five years. [1, 2] Those struggling with kidney stones often endure symptoms such as severe pain, hematuria, urinary tract infections, reduced kidney function, and, in severe cases, kidney failure. In developing countries, the prevalence of urolithiasis is estimated to range from 10% to 15%, but only 1–2% of symptomatic patients seek treatment at medical facilities. [3] As the number of cases continues to rise, there is an urgent need for effective and accessible treatment options.

Several techniques are used to treat kidney stones, including extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS). ESWL, a non-invasive procedure, is popular because it is easy to perform, doesn't require surgery, and is available in most healthcare settings. [4, 5] However, ESWL has limitations. For instance, it is less effective in overweight patients, has difficulty with radiolucent stones (which aren't visible on X-rays), and may cause headaches in those with urinary tract infections. Conversely, RIRS, a minimally invasive technique, has shown excellent outcomes for stones measuring 1–2 cm, with higher stone-free rates and fewer follow-up procedures compared to ESWL. [6-8] Despite these advantages, ESWL remains the first-line treatment for renal pel-

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vic stones smaller than 2 cm, as recommended by the 2012 European Association of Urology (EAU) guidelines. In clinical practice, choosing between ESWL and RIRS for 1–2 cm renal pelvic stones often depends on factors such as resource availability and the healthcare professional's preference. However, there is a lack of robust randomized controlled trials comparing the two approaches, creating a gap in the evidence.

This study aims to address this gap by directly comparing the effectiveness of ESWL and RIRS in reaching a stone-free status for renal pelvic stones measuring 1–2 cm. We hypothesize that RIRS will be more effective than ESWL in achieving stone-free rates for this stone size.

MATERIALS AND METHODS

This quasi-experimental study was conducted at the Department of Urology, Khyber Teaching Hospital, Peshawar, from June 7, 2023, to January 6, 2024. Sixty patients with renal pelvic stones measuring 1-2 cm were enrolled in the study.

The sampling process was regulated by clearly defined inclusion and exclusion criteria, which ensured the homogeneity and validity of the results. Ethical approval from Khyber Medical College was obtained, and all participants provided written informed consent before enrollment. The following criteria were used to select participants:

1. Patients aged between 18 and 60 years.
2. A single renal pelvic stone measuring 1–2 cm, confirmed by ultrasound and non-contrast CT KUB.
3. Renal Function: Normal RFT, defined as serum creatinine < 1.2 mg/dL or eGFR > 60 mL/min/1.73 m^2.
4. No prior surgical interventions for urolithiasis.
5. Consent: Willingness and ability to provide written informed consent.
6. Patients were excluded from the study if they met any of the following conditions:
7. Stone Size: Larger than 2cm with multiple stones.
8. Radiolucent Stones: Stones not detectable on imaging.
9. Pregnancy: Pregnant women were excluded.
10. Infections: Active urinary tract infection (defined as a positive urine culture with > 10^5 CFU/mL). These patients were excluded until completion of antibiotic therapy and confirmation of sterile urine.
11. Comorbidities: Uncontrolled comorbidities, such as:
12. Uncontrolled diabetes mellitus (HbA1c > 8%).
13. Uncontrolled hypertension (BP > 160/100 mmHg).
14. Coagulopathies: Patients with coagulopathies or those on anticoagulant therapy that could not be temporarily discontinued.
15. Anatomical Abnormalities: Any anatomical abnormalities of the urinary tract that could complicate the procedure.

Patients were consecutively recruited from the urology outpatient clinic at Khyber Teaching Hospital. Diagnosis of renal pelvic stones was confirmed using ultrasound and non-contrast CT KUB. All eligible individuals were contacted, and those willing to participate in the study signed informed consent forms.

The patients were allocated into two equal groups of 30 patients each based on the planned treatment modality. Group A consisted of patients who underwent extracorporeal shock wave lithotripsy under local anesthesia. Group B consisted of patients who underwent retrograde intrarenal surgery with flexible ureteroscopy under general anesthesia.

TREATMENT PROTOCOLS

The ESWL Protocol: The treatment was done in either the supine or the lateral position, following its own routine methodology. Pain relief (analgesia) was provided as needed.

• The RIRS Protocol: During flexible ureteroscopy, the patient was positioned in lithotomy. The patient was relaxed and secure while general anesthesia was administered, enabling laser lithotripsy to break the stones.

Postoperative stone clearance was assessed on day 7 by ultrasound and X-ray KUB. Any leftover fragments were noted.

OUTCOME MEASURES

The main deliverable was the stone-free rate, defined as the primary outcome: the absence of stones on the imaging scan. The secondary outcomes include: 1. Complications: Any unfavorable results from the procedure. 2. Pain Levels: The degree of pain experienced by patients after surgery. 3. Recovery Time: The period during which the patient is fully functional and able to perform regular activities.

DATA ANALYSIS

We used SPSS version 25 software to conduct the analysis. Percentages described categorical data, while

continuous variables were summarized as means with standard deviations. Chi-square tests were applied for categorical variables, and t-tests were used for continuous variables. We considered results statistically significant at $p < 0.05$.

RESULTS

The mean age of participants in Group A (ESWL) increased to 41 years (SD = 10.67), while the mean in Group B (RIRS) increased to 42 years (SD = 9.09). The data indicated that the patients with renal pelvic stones of 1–2 cm were more likely to be stone-free after retrograde intrarenal surgery (RIRS) than after extracorporeal shock wave lithotripsy (ESWL). In the RIRS group, 73% were stone-free, while only 33% were stone-free in the ESWL group ($p = 0.0019$).

An independent samples t-test revealed no statistically significant difference between the two groups ($p = 0.6974$). Thus, age was relatively constant in the two groups, eliminating the potential risk of age confounding the results (Table 1).

For Group A (ESWL), the sample included 20 males and 10 females, representing 67% and 33%, respectively. For Group B (RIRS), 21 participants were males, and 9 were females, accounting for 70% and 30%, respectively. The Chi-square test results indicate no statistically significant difference between the two groups regarding gender ratio ($p = 0.7813$). see table 2 for details.

Group A had an average pelvic stone duration of 1 year, with a standard deviation of 1.31, while Group B had an average duration of 1 year, with a standard deviation of 1.37. An independent samples t-test comparing the two groups' mean and standard deviation showed no statistically significant difference (Table 3). This indicates that the stone's chronicity was similarly represented in both treatment groups. ($p=1.000$).

In ESWL (Group A), the mean stone size was 1.3cm (SD ± 0.57), while in RIRS (Group B), the mean stone size was 1.5cm (SD ± 0.61). An independent samples t-test showed that the mean stone sizes in both groups are not significantly different ($p=0.1946$). Both groups exhibited a similar distribution of stone sizes, indicating no bias toward a specific size in either treatment (Table 4).

Overall, Group A (ESWL) had 33% of patients who were stone-free (table 5), while Group B (RIRS) had 73%. A Chi-square test showed that the difference in stone-free rates between the two groups was statistically significant ($p=0.0019$).

This suggests that RIRS is more effective than ESWL in achieving stone-free status for renal pelvic stones, considering the study's limitations.

When the stone-free rate is broken down by age, a gap appears between the two age groups. For the 20-to-30-year age range, there is no significant difference ($p = 0.0618$). However, in the 31 to 50-year age group, there is a statistically significant difference ($p = 0.0134$), showing that the RIRS group is more successful in achieving a stone-free status. This finding should be noted in the data analysis (Table 6).

In the stone-free rate analysis, stratifying by sex revealed significant differences (Table 7). In men, there was a significant difference in achieving stone-free status between the two groups ($p = 0.0346$), indicating that RIRS produces better outcomes in this subgroup. In female patients, a difference in stone-free status was also observed ($p=0.0372$), suggesting better outcomes with RIRS.

In the two groups analyzed, the rate of being stone-free varied significantly at the 1cm stone threshold ($p = 0.0096$). For 2 cm stones, the difference was not significant ($p=0.0858$); however, the RIRS group appeared to have better outcomes (Table 8). This suggests that RIRS is more effective for smaller stones (1 cm), whereas both techniques are comparable in terms of free status for larger stones.

Table No 1: Age Distribution of Study Groups:

Age Range	Group A (ESWL) n (%)	Group B (RIRS) n (%)
20-30 Years	11 (37%)	12 (40%)
31-50 Years	19 (63%)	18 (60%)
Total	30 (100%)	30 (100%)
Mean ± SD (years)	41 ± 10.67	42 ± 9.09 (P-Value: 0.6974)

Table No 2: Gender Distribution of Study Groups:

Gender	Group A (ESWL) n (%)	Group B (RIRS) n (%)
Male	20 (67%)	21 (70%)
Female	10 (33%)	9 (30%)
Total	30 (100%)	30 (100%)

Table No 3: Duration of Pelvic Stone:

Duration of Pelvic Stone	Group A (ESWL) n (%)	Group B (RIRS) n (%)	Mean ± SD (years)
≤ 1 Year	13 (43%)	14 (47%)	1 ± 1.31
> 1 Year	17 (57%)	16 (53%)	1 ± 1.37
Total	30 (100%)	30 (100%)	

Table No 4: Stone Size Distribution:

Stone Size	Group A (ESWL) n (%)	Group B (RIRS) n (%)	Mean ± SD (cm)
1 cm	21 (70%)	22 (73%)	1.3 ± 0.57
2 cm	9 (30%)	8 (27%)	1.5 ± 0.61
Total	30 (100%)	30 (100%)	

Table No 5: Overall, Stone-Free Rate:

Stone-Free	Group A (ESWL) n (%)	Group B (RIRS) n (%)
Yes	10 (33%)	22 (73%)
No	20 (67%)	8 (27%)
Total	30 (100%)	30 (100%)

Table No 6: Stone-Free Rate Stratified by Age Distribution:

Age Range	Stone-Free	Group A (ESWL) n	Group B (RIRS) n	P-value
20-30 Years	Yes	4	9	0.0618
	No	7	3	
	Total	11	12	
31-50 Years	Yes	6	13	0.0134
	No	13	5	
	Total	19	18	

Table No 7: Stone-Free Rate Stratified by Gender:

Gender	Stone-Free	Group A (ESWL) n	Group B (RIRS) n	P-value
Male	Yes	7	15	0.0346
	No	13	6	
	Total	20	21	
Female	Yes	3	7	0.0372
	No	7	2	
	Total	10	9	

Table No 8: Stone-Free Rate Stratified by Stone Size:

Stone Size	Stone-Free	Group A (ESWL) n	Group B (RIRS) n	P-value
1 cm	Yes	7	16	p = 0.0096
	No	14	6	
	Total	21	22	
2 cm	Yes	3	6	p = 0.0858
	No	6	2	
	Total	9	8	

DISCUSSION

This research emphasizes the superiority of RIRS over ESWL in achieving a stone-free state in patients with pelvic stones measuring 1-2 cm. Although ESWL is a non-invasive procedure accessible to almost all patients, its effectiveness is often limited by stone size, as well as the patient's anatomy and radiological features. [4, 5] Conversely, RIRS, while not completely minimally invasive, can precisely target the stone using a laser, resulting in a high stone removal rate. [7, 8] The results of this study support previous research demonstrating RIRS's advantages over ESWL in providing better outcomes for patients with similarly sized stones (8, 9). For example, Resorlu et al. (2013) reported high stone-free rates for medium-sized kidney stones, highlighting the clinical effectiveness of RIRS. [3] Additionally, laser lithotripsy during RIRS effectively breaks down stones, decreases the need for additional procedures, and improves patient outcomes. [7, 9] The primary benefit of RIRS is its ability to overcome certain physical limitations that can hinder the success of ESWL.

For example, patients with kidney stones or hydronephrosis located at the lower pole of the kidneys tend to be very challenging to treat with limb shock wave lithotripsy and stone manipulation using ESWL. [4, 5] In these cases, RIRS achieves more complete stone clearance and a lower likelihood of leaving fragments behind. [7, 8] However, this study has limitations that warrant attention. The main characteristics of this study are its relatively small sample size and the short follow-up period. Future research should focus on long-term follow-up with larger patient populations.

CONCLUSION

The study concludes that RIRS is more effective than ESWL for managing 1-2 cm renal pelvic stones. RIRS shows higher stone-free rates, especially when anatomical difficulties and challenges typical of ESWL are present. It also offers the ability to accurately locate stones and utilizes advanced laser features.

Healthcare professionals should include specifics about the individual patient, such as stone characteristics, its location, and the patient's anatomy, when developing the operative plan. While RIRS remains the most appropriate approach for treating 1-2 cm stones, especially when resources and expertise are readily available, ESWL may also be useful in certain cases.

Further research is required to explore the supporting outcomes of RIRS, such as long-term impacts, cost-effective options, and patient experiences, to fully validate these benefits of the RIRS procedure. There should also be an effort to expand the use of RIRS across different patients and healthcare systems to facilitate access to advanced treatment options.

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Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Rehman IU	✓	✓	×	×	✓	×
Ullah H	✓	×	✓	✓	✓	×
Ali M	✓	✓	×	×	×	✓
Sabir M	✓	×	✓	✓	✓	×
Iqbal MA	✓	✓	×	×	×	✓
Shah SAB	✓	×	✓	✓	✓	×

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This study was approved by the Institutional Ethical Review Board of Khyber Teaching Hospital, Peshawar, Pakistan Vide No. 43/DME/KTH, Dated: 16/01/2025