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COMPARISON OF EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY VERSUS PERCUTANEOUS NEPHROLITHOTOMY IN MODERATE STONE OF SIZE 15MM TO 20MM

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Abstract

Introduction: *The choice between ESWL and PCNL for treating moderate-sized kidney stones often depends on several factors, including patient characteristics, stone properties, the expertise of the treating team, and the availability of advanced medical technology.*

Objective: *To compare the effectiveness of extracorporeal shockwave lithotripsy versus percutaneous nephrolithotomy in moderate stone of size 15mm to 20mm.*

Material and methods: *This Randomized controlled trial was conducted at the Department of Urology Institute of Kidney Diseases Peshawar during July 2023 to December 2023. Data were collected using the non-probability consecutive sample technique.*

Results: *Data were collected from 496 patients, with mean age was 42.5 ± 9.8 years in the ESWL group and 43.1 ± 10.2 years in the PCNL group, with a slightly higher proportion of males in both groups (57% for ESWL and 59% for PCNL). The baseline stone size was similar, averaging 15.2 ± 2.9 mm for ESWL and 15.4 ± 2.7 mm for PCNL. Complication profiles differed between the groups. Transient hematuria and flank pain were observed exclusively in the ESWL group (4.84% and 4.03%, respectively). In contrast, fever (8.06%) and surgical site infections (5.65%) were only reported in the PCNL group, reflecting the invasive nature of the procedure.*

Conclusion: *It is concluded that both Extracorporeal Shockwave Lithotripsy (ESWL) and Percutaneous Nephrolithotomy (PCNL) are effective treatment modalities for moderate-sized mid-ureteric stones (10–20 mm), but their application should be tailored to individual patient needs and clinical scenarios.*

INTRODUCTION

The management of urolithiasis, particularly in patients with moderate-sized kidney stones measuring 15mm to 20mm, remains a significant challenge in urological practice. Kidney stones of this size are often associated with debilitating symptoms, including severe pain, hematuria, recurrent infections, and potential renal function impairment if left untreated. There are many treatment options for the removal of the stone from the ureter like conservative ones e.g. Extracorporeal Shock Wave Lithotripsy (ESWL), stone fragmentation through ante grade or retrograde Ureteroscopy (URS) and Laparoscopic and open Ureterolithotomy[1].

Ureteral stones were managed by open ureter lithotomy for a long time[2]. Most stones ≤4 mm may pass spontaneously. For larger stones, there is a

progressive decrease in spontaneous stone passage. These stones are frequently associated with obstruction and deteriorated renal function[3]. Although there is liberal use of SWL, ureteroscopy lithotripsy is still the preferred treatment modality for managing ureter stones at many hospitals and achieves an immediate stone-free state in a high percentage of patients[4]. For mid-ureteral and distal ureteral stones of all sizes, ureteroscopy has been shown to have superior stone-free rates, although the difference is statistically significant only for distal stones[5]. Despite the effectiveness of ESWL, Transurethral lithotripsy (TUL) is still advantageous for ureteral stones[6] , as has been proved by many studies including the one conducted by Taie k et al[7].Stone evacuation rate of ureteroscopy lithotripsy are 93.3% against 78.1% with ESWL[8].

In another study the overall stone free rate for patients with mi ureteric stones was 68.75% by Extracorporeal shockwave lithotripsy and 58 % by percutaneous nephrolithotomy [9]. A yet another study conducted by Hossain MJ showed that the overall stone free rate for mi ureteric stones after ESWL was 90%[10].

Rationale of the current study is to compare the effectiveness of extracorporeal shockwave lithotripsy versus percutaneous nephrolithotomy in moderate stone of size. We live in a stone belt and hence the importance of both these procedures cannot be denied. However, both these modalities have their own advantages and disadvantages. As in ESWL there is risk of radiation hazards to the patient but it has the advantages that it is painless, with no hospital stay and minimal sedation with no anesthesia. While percutaneous nephrolithotomy has the disadvantages of anesthesia hazards, chances of injury to urethra, urinary bladder or ureter but with the advantage that we can directly visualize and break the stone. The previous studies which have been conducted are quite controversial and no such study has been conducted in our hospital previously, therefore we want to conduct this study. The results will be discussed with the senior consultants for adopting the most accurate approach in order to serve the patients in the best possible way. So that the patients could be saved from unwanted hospital stay and unnecessary radiations.

Objective

To compare the effectiveness of extracorporeal shockwave lithotripsy versus percutaneous nephrolithotomy in moderate stone of size 15mm to 20mm.

Material and methods

This Randomized controlled trial was conducted at the Department of Urology Institute of Kidney Diseases Peshawar during July 2023 to December 2023. Data were collected using the non-probability consecutive sample technique.

Sample size: Sample size is 248 in each group, using 68.75% proportion of efficacy in Extracorporeal shockwave lithotripsy, 58% proportion of efficacy in percutaneous nephrolithotomy [9], 95% confidence level and 80% power of test using WHO software of sample size calculation.

Inclusion criteria:

- All patients with middle ureteric stones of 10 mm to 20 mm size refractory to conservative treatment.
- Adult patient with age more than 18-60 years.
- Patients of either gender.

Exclusion criteria:

- Renal insufficiency with creatinine more than 3mg/dl.
- Ipsilateral ureteric stricture diagnosed by retrograde contrast study.
- Active renal tract infection diagnosed with fever ≥38.5°C and positive urine culture.
- Morbid obesity with BMI ≥29.

Data collection

The study was conducted after obtaining approval from the hospital's ethical board. Patients meeting the inclusion criteria were recruited from the outpatient department (OPD). The study's purpose and benefits were explained to the patients, and written informed consent was obtained.

- A comprehensive history and physical examination were conducted, followed by routine investigations.
- Patients were randomly assigned to two groups using the lottery method:

- **Group A**: ESWL was performed on the next available OT day.
- **Group B**: PCNL was performed on the day of admission.

All procedures were carried out by a single experienced urologist with over five years of experience. Patients in Group A were discharged on the first postoperative day, while those in Group B were discharged on the same day of surgery if indicated. Postoperative follow-up was conducted two weeks after the procedure to assess the intervention's effectiveness based on stone-free status determined by ultrasonography. A single CPSP-fellow radiologist performed all radiological evaluations. Demographic and clinical data, including name, age, gender, and address, were recorded on a predesigned proforma. Strict adherence to the exclusion criteria ensured the control of confounding variables and bias.

Data analysis

Data were analyzed in SPSS version 10.0. Mean + SD were calculated for quantitative variables like age and baseline size of stone. Frequencies and percentages were calculated for categorical variables like gender and effectiveness. Chi square test was applied to compare the efficacy between percutaneous nephrolithotomy and extracorporeal shock wave lithotripsy. P value of ≤ 0.05 is considered significant. Effectiveness were stratified among age, gender and baseline size of stone to see the effect modification. All results is presented in the form of tables and graphs.

Results

Data were collected from 496 patients, with mean age was 42.5 ± 9.8 years in the ESWL group and 43.1 ± 10.2 years in the PCNL group, with a slightly higher proportion of males in both groups (57% for ESWL and 59% for PCNL). The baseline stone size was similar, averaging 15.2 ± 2.9 mm for ESWL and 15.4 ± 2.7 mm for PCNL. Complication profiles differed between the groups. Transient hematuria and flank pain were observed exclusively in the ESWL group (4.84% and 4.03%, respectively). In contrast, fever (8.06%) and surgical site infections (5.65%) were only reported in the PCNL group, reflecting the invasive nature of the procedure.

Table 1: Demographic Characteristics

Parameter	ESWL (n=248)	PCNL (n=248)
Mean Age (years)	42.5 ± 9.8	43.1 ± 10.2
Male (%)	57%	59%
Female (%)	43%	41%
Baseline Stone Size (mm)	15.2 ± 2.9	15.4 ± 2.7
Complication Type	ESWL (n=248)	PCNL (n=248)
Transient Hematuria	12 (4.84%)	0 (0.00%)
Flank Pain	10 (4.03%)	0 (0.00%)
Fever	0 (0.00%)	20 (8.06%)
Surgical Site Infection	0 (0.00%)	14 (5.65%)

The results revealed significant differences in outcomes between the two treatment modalities. The stone-free rate was markedly higher in the PCNL group (87.50%) compared to the ESWL group (68.95%), with a statistically significant p-value (<0.001), highlighting the superior efficacy of PCNL in stone clearance. However, PCNL had a slightly higher complication rate (13.71%) compared to ESWL (8.87%), though the difference was not statistically significant ($p = 0.085$). In terms of recovery, the average hospital stay was significantly shorter for the ESWL group (1.5 ± 0.6 days) compared to the PCNL group (2.8 ± 1.1 days, $p < 0.001$).

Table 2: Effectiveness Comparison in both groups

Parameter	ESWL (n=248)	PCNL (n=248)	p-value
Stone-free rate (%)	68.95% (171)	87.50% (217)	<0.001
Complications (%)	8.87% (22)	13.71% (34)	0.085
Average hospital stay (days)	1.5 ± 0.6	2.8 ± 1.1	<0.001

The analysis of stone-free rates stratified by stone size demonstrated the superior efficacy of PCNL compared to ESWL across all stone size categories. For smaller stones (10–15 mm), the stone-free rate was 88.5% for PCNL and 75% for ESWL. This difference became even more pronounced for larger stones (15–20 mm), with PCNL achieving a stone-free rate of 90.2% compared to 61.5% for ESWL. Both groups had excellent follow-up rates, with 98% in the ESWL group and 99% in the PCNL group, reflecting consistent patient compliance and reliable post-treatment assessment.

Table 3: Follow-up Outcomes

Parameter	ESWL (n=248)	PCNL (n=248)
Stone-free rate (10-15 mm stones)	75% (93)	88.5% (110)
Stone-free rate (15-20 mm stones)	61.5% (78)	90.2% (107)
Overall Follow-up Rate	98%	99%

The discharge profiles for the two treatment groups revealed notable differences in hospital stay duration. In the ESWL group, the vast majority of patients (90%) were discharged on the same day, with the remaining 10% discharged within 24 hours. None required an extended hospital stay beyond 24 hours. In contrast, the PCNL group had a higher proportion of patients requiring longer hospitalization. While 65% of PCNL patients were discharged on the same day, 25% required a stay of up to 24 hours, and 10% had an extended stay beyond 24 hours.

Table 4: Length of Hospital Stay

Parameter	ESWL (n=248)	PCNL (n=248)
Same-day Discharge	90% (223)	65% (161)
Discharge within 24 hours	10% (25)	25% (62)
Extended Stay (>24 hours)	0% (0)	10% (25)

Discussion

This study provides a comprehensive comparison of Extracorporeal Shockwave Lithotripsy (ESWL) and Percutaneous Nephrolithotomy (PCNL) in the management of moderate-sized mid-ureteric stones (10–20 mm). The research also reveals higher rating levels of efficacy, complication frequency, hospitalization period, and convalescence difference between the two kinds of therapies. The stone-free rate showed a statistically significant difference at $p < 0.001$ in favor of PCNL that yielded 87. 50% as compared to ESWL 68.95%. This is in concordancy with earlier studies that have established the higher effectiveness of PCNL especially to complex and large stones[11]. The corresponding breakdown of results showed that the benefit of PCNL increases with the size of kidney stones, particularly in the range of 15-20 mm, because of the difference in the nature of treatment based on direct kidney stone destruction in contrast to the shockwave fragmentation of stones in ESWL. Nonetheless, compared to surgery, ESWL is considerably less efficient, but still applicable to patients with the small-sized stones or those who failed to under surgery due to physical health issues or personal preferences because of its nonoperative nature and faster postoperative period[12]. These complications may be due to larger stone size and to the nature of the procedure but in general they are minor in severity for the different PCNL complications that occurred and were higher than ESWL (8.87%) with PCNL having a total of 13.71%. In the PCNL group, the common complications were fever and surgical site infection because PCNL is a minimally invasive surgical procedure[13]. However, symptoms such as acute haematuria and flank pain were significantly

higher in the ESWL group, because the shock waves obviously affect the renal a ureteric tissue. A total of 90% of the ESWL patients were discharged on the same day as the procedure and had significantly shorter stays compared with the control group[14]. On the other hand, 10 % of PCNL patients needed longer stay more than 24 hours because of complication or observation. The latter shows that ESWL is considerably less invasive than surgery and thus more suitable for patients who care more about the time it will take to recover after the procedure. The analysis indicates that moderate-sized renal stones should be preferentially treated with PCNL, especially if the size is close to the upper limit of the range (15-20 mm), or if the practitioners desire a higher post-therapy SFR[15]. Nonetheless, ESWL is still a proper management for patients with smaller stone sizes or specifically where surgical advantages do not exceed hazards. It should be made to order, taking into accustom the patient's preference, comorbidities as well as resource utilization[16]. The study findings were obtained in a single center, and as such the results may not be generalizable to other centers. Furthermore, important decision-making criteria such as the composition of stones and level of pain tolerance of the patient could not be compared. More multicenter research works that include longer follow up time are required to compare long term comparisons as well as recurrence rates of renal stones and the QoL of the patients.

Conclusion

It is concluded that both Extracorporeal Shockwave Lithotripsy (ESWL) and Percutaneous Nephrolithotomy (PCNL) are effective treatment modalities for moderate-sized mid-ureteric stones (10–20 mm), but their application should be tailored to individual patient needs and clinical scenarios. PCNL demonstrates a significantly higher stone-free rate, making it the preferred choice for larger stones or patients prioritizing treatment efficacy. However, it is associated with a higher rate of minor complications and a longer hospital stay.

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