OPEN ACCESS ORIGNAL ARTICLE

A NOVEL SURVEY OF THE TREATMENT TRENDS AND TECHNICAL DETAILS FOR EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY.

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ABSTRACT

OBJECTIVES: This study aims to address that gap by examining the treatment patterns and technical aspects of extracorporeal shockwave lithotripsy (ESWL) in the local clinical context. **METHODOLOGY:** A descriptive survey-based study was conducted among urologists registered with the Pakistan Urology Association. Data were collected using a structured, web-based questionnaire, which was distributed via email to registered urologists. To improve response rates, a follow-up reminder was sent after one month. Responses were gathered over a six-month study period. **RESULTS**: The study found that 83.19% of urologists had direct access to an ESWL device, with most respondents (n=65) indicating trained technicians and (n=21) indicating medical officers as primarily responsible for operating the unit. Factors influencing ESWL decisions included stone size, location, density, composition, and renal anatomy. Stone density was the most prioritized factor, with 77 urologists using a cut-off value of <1000 Hounsfield units (HU) for eligibility. NSAIDs were the most commonly used analgesia during ESWL sessions. Routine antibiotics prophylaxis was not commonly practiced (n=67), however cephalosporins were preferred when pre-procedure antibiotics were administered. Ureteroscopy (n=81) was the most commonly adopted intervention, and X-ray KUB was the most used radiological method for post-ESWL evaluation. Furthermore, 89 urologists complied with European Association of Urology guidelines in deciding when to offer ESWL as s treatment modality. **CONCLUSION:** ESWL practices in Pakistan align with international standards, guided by stone characteristics. NSAIDs are commonly used, technicians operate units, but antibiotic use and post-procedure evaluation require standardization and training.

KEYWORDS: Extracorporeal shockwave lithotripsy; Pakistan; Survey; Urologist

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How to Cite This Article: Khan FM[1], Ahmed A[2], Kumar R[3], Memon WA[4], Nadeem S[5], Shah A[6] **A NOVEL SURVEY OF THE TREATMENT TRENDS AND TECHNICAL DETAILS FOR EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY.** J Peop Univ Med Health Sci. 2025:15(2) ,222-232.http://doi.org/10.46536/jpumhs/2025/15.02.645

Received On 19 MARCH 2025, Accepted On 15 JUNE 2025, Published On 30 JUNE 2025.

INTRODUCTION

Nephrolithiasis is the most prevalent urological disorder and significant public health challenge, with rising prevalence, incidence and high recurrence rate[1]. Worldwide, urolithiasis prevalence ranges from 1% to 13%, depending on the region [2]. In 2019, the Global Burden of Disease report recorded 115.5 million new cases,

604,308.9 Disability-Adjusted Life Years, and 13,278.9 deaths globally [2]. In Asia, it remains highly prevalent[3, 4], affecting 1% to 19.1% of the population, with 16% prevalence in Pakistan[1, 5], and has the highest incidence, due to its location within Asia's "stone-forming belt" and multiple lithogenic factors [1, 4].

Extracorporeal Shock Wave Lithotripsy (ESWL) is a widely used, minimally invasive treatment for urinary stones[6, 7]. Since its introduction in 1980, it quickly became the preferred option for renal calculi that do not pass spontaneously[8, 9]. Advances in minimally invasive techniques have since focused on enhancing the safety and effectiveness of stone management. However, ESWL use has declined over the past decade, mainly due to improvements in endoscopic technologies, better surgical techniques, and poor adherence to optimal ESWL practices [10]. Additionally, anatomical and physiological factors such as shock wave-resistant stones, steep infundibular pelvic angles, long lower pole calyces, narrow infundibula, and greater skin-to-stone distance limit ESWL effectiveness [11]. Despite this, European Association of Urology guidelines still recommend ESWL as the first-line treatment for medium-sized (<20 mm) upper urinary tract stones [12].

In Pakistan, the application of ESWL has been on the rise, attributed to the increasing accessibility of lithotripters. Nonetheless, as its use continues to grow, urologists face a range of operational and clinical challenges, underscoring the need for improved treatment protocols and criteria for patient selection. A review of the existing literature indicates that only one study by Yenigürbüz et al. has explored treatment trends and technical aspects of ESWL, focusing on experienced European endourologists over the past two to three decades. To date, no similar research has been conducted in Pakistan to assess national practices. This study aims to fill that gap by evaluating ESWL practices among urologists registered with the Pakistan Urology Association, with a focus on clinical indications, technical protocols, and equipment-related factors. Given that ESWL is a non-invasive procedure offering reduced hospital stays and faster recovery, the study highlights the importance of ensuring its appropriate use. Inadequate application of ESWL can lead to repeat or alternative interventions, highlighting the need for informed clinical decision-making to optimize patient outcomes and resource utilization.

METHODOLOGY

A prospective descriptive survey-based study was conducted at the Urology Department of Liaquat National Hospital & Medical College in Karachi, over a period of 6 months.

The sample size was calculated utilizing OpenEpi software, referencing a study by Yenigürbüz et al., which indicated that 48.5% of endourologists took part in an ESWL survey (13). The sample size was determined to be 119, utilizing a 95% confidence interval and a margin of error of 9%. To improve response rates, an invitation was extended to 164 urologists affiliated with the Pakistan Urology Association (PAUS).

A non-probability consecutive sampling technique was employed. The criteria for inclusion consisted of male and female urologists who held registration with the PAUS, whereas those urologists who opted not to participate were excluded from the study.

Before initiating data collection, study approval was secured. Given that no data pertaining to patients was gathered, the necessity for informed consent was considered irrelevant. A structured questionnaire was distributed via email to all registered urologists, and a follow-up reminder was issued after one month to enhance participation rates. A standardized proforma was used to collect demographic and professional information from participating urologists for this study. A

comprehensive questionnaire was designed to assess ESWL practices, divided into three sections: patient demographics and medical history, pretreatment preparations and anesthesia, and basic aspects of ESWL application. It evaluated factors influencing ESWL decisions, including patient and stone characteristics, as well as technical and anesthetic considerations.

The analysis of data was conducted using SPSS V 25. Quantitative variables were represented using median and range and qualitative variables, including gender, institution, qualification, and ESWL practice patterns, were examined through frequencies and percentages. Furthermore, the participation levels were evaluated by calculating the response rate for each question.

RESULTS

Majority of the participant were male 103(86.55%) and most of the urologists were relatively young, falling within the 30–40-year age group 66(55.46%). Regarding academic qualifications, the majority held FCPS (62.73%), with smaller proportions having additional qualifications. The post-residency experience of the participants varied, though most had between 1 to 5 years of experience 43(36.13%), followed by 6 to 10 years 28(23.53%) as shown in **figure 1**. More than half 64(55.17%) reported applying ESWL as a first-line treatment for stones in anomalous kidneys. Most urologists (93.28%) considered the Hounsfield Unit (HU) value in their decision-making, with thresholds varying 34.23% used 1000 HU as a cutoff, and 30.63% preferred 1200 HU as depicted in **figure 2**. In cases involving obese patients, only 44.44% used ESWL as a first-line option, often limiting it to patients with a BMI in the Grade I obesity range (30–35 kg/m²). Factors such as patient age (43.70%), socio-cultural status (17.65%), and previous procedures (49.58%) also influenced decision-making. A significant majority acknowledged comorbidities (63.03%) and anticoagulant use (89.08%) as influencing factors, with many holding anticoagulation for 5–7 days. Notably, the presence of a solitary kidney heavily influenced decision-making (84.48%). The details are given in **table 1**.

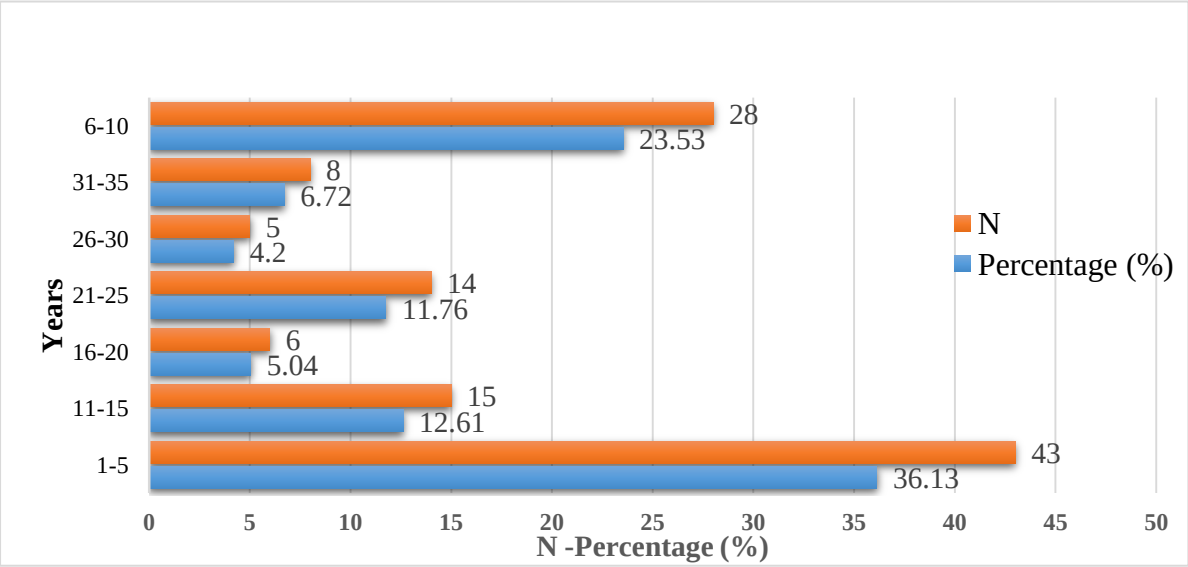

FIGURE 1: POST RESIDENCY EXPERIENCE OF UROLOGIST

Figure 2: *Hounsfield units (HU)* that affect the decision-making in ESWL application

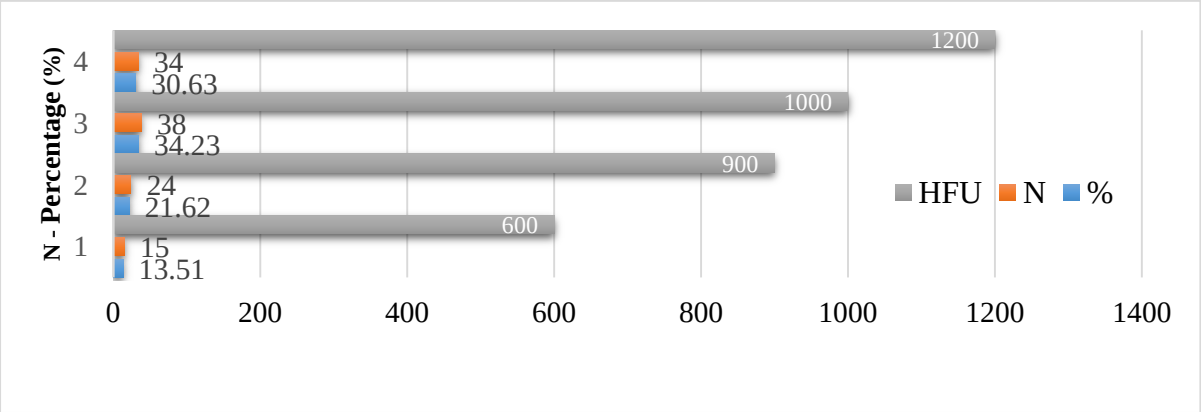

TABLE 1: FACTORS INFLUENCING UROLOGISTS' DECISION-MAKING IN ESWL APPLICATION.

Factors		n	%	Response rate (%)
Do you apply ESWL in appropriately-sized stones as the first option in anomalous (abnormal) kidneys?	No	52	44.83	70.73
	Yes	64	55.17	
Does Hounsfield Unit affect your decision?	No	8	6.72	72.56
	Yes	111	93.28	
Do you apply ESWL for appropriately-sized stones as the first option in obese patients?	No	74	62.18	72.56
	Yes	45	37.82	
If yes, then upto what BMI do you consider ESWL	Grade I obesity (BMI=30-35 kg/m2)	20	44.44	
	Grade II obesity (BMI=35-40 kg/m2)	14	31.11	
	Overweight (BMI=25-30 kg/m2)	11	24.44	
Does the age of the case affect your decision-making for ESWL?	No	67	56.30	72.56
	Yes	52	43.70	
Does the gender of the case affect your decision for ESWL?	No	111	93.28	72.56
	Yes	8	6.72	
Does the socio-cultural status of the case affect your decision for ESWL?	Maybe	34	28.57	72.56
	No	64	53.78	
	Yes	21	17.65	
Does the previous procedure for stone removal affect your decision for ESWL?	Maybe	32	26.89	72.56
	No	28	23.53	
	Yes	59	49.58	
Do previous ESWL treatments in the same case affect your decision for this ESWL session?	Maybe	13	10.92	72.56
	No	19	15.97	
	Yes	87	73.11	
Do the comorbidities present (Hypertension, diabetes mellitus, etc.) affect your decision for ESWL?	No	44	36.97	72.56
	Yes	75	63.03	
Does the use of anticoagulants affect your decision for ESWL?	No	13	10.92	72.56
	Yes	106	89.08	
For how many days do you hold anticoagulation before ESWL session	3	20	17.24	
	5	42	36.21	70.73
	7	54	46.55	
Does the presence of a solitary functioning kidney affect your decision for ESWL?	No	18	15.52	70.73
	Yes	98	84.48	

About one-fourth of respondents used pre-medication to manage patient anxiety. NSAIDs were the most common analgesic choice 71(66.36%), though some also used

narcotics or followed a step-wise analgesic ladder. Most urologists monitored patients during and after ESWL 98(82.35%) and 42.24% administered prophylactic antibiotics, with cephalosporins 18(36.74 %) and fluoroquinolones 10(20.40%) being preferred. A large majority 99(83.19%) viewed ESWL as a cost-effective modality, though only 37.82% performed bowel preparation before the procedure. DJ stenting was performed pre-procedure by 37.82%, mostly in cases involving stones >2 cm (35.55%). Most urologists used 3000 shockwaves in a single session for adults (45.4%), followed by 2000 (19.4%) as given in **table 2**.

TABLE 2: ESWL APPROACHES FOR PRETREATMENT PREPARATIONS AND ANESTHESIA.

Approaches		n	%	Response rate
Do you perform pre-medication for patient's anxiety?	No	88	73.95	72.56
	Yes	31	26.05	
How do you manage analgesia during the session? n=107	3 Step Analgesic Ladder	3	2.80	65.24
	As needed	11	10.28	
	IV analgesics	4	3.74	
	Narcotic Analgesic	6	5.61	
	No analgesia	8	7.48	
	NSAID	71	66.36	
	NSAID & narcotics	4	3.74	
Do you monitor your patients during and immediately after ESWL for hemodynamic changes?	No	21	17.65	72.56
	Yes	98	82.35	
Do you apply prophylactic antibiotics before ESWL? n=116	No	67	57.76	70.73
	Yes	49	42.24	
	Aminoglycosides	6	12.24	
	As per antibiogram	2	4.08	
	As per culture sensitivity	2	4.08	
Most preferred Pre procedure antibiotic	Cephalosporin	18	36.74	
	Cephalosporin + Aminoglycosides	2	4.08	
	Fluoroquinolones	10	20.40	
	Fluroquinolones + Cephalosporin	3	6.12	
	Pencillins	6	12.24	
Do you accept ESWL as a "cost-effective modality" when you consider all available minimally invasive alternatives for stone management?	No	20	16.81	72.56
	Yes	99	83.19	
Do you bowel prep the patient pre – procedure?	No	74	62.18	72.56
	Yes	45	37.82	
Do you perform Pre- procedure DJ stenting?	No	74	62.18	72.56
	Yes	45	37.82	
If yes, then in what stone size do you perform pre-procedure DJ stenting?	<1cm	3	6.66	
	>2cm	16	35.55	
	1-1.5cm	14	31.11	
	1.6-2.0cm	12	26.66	

When treating upper ureteral calculi, 68.07% preferred ureteroscopy as the first option, with only 31.93% opting for ESWL initially. ESWL was performed by trained technicians in 62.5% of cases. There was a near-even split in preferred patient positioning for lower ureteral stones prone (50.94%) and supine (49.06%). Energy levels were generally increased gradually during treatment by 85.71% of practitioners. While two-thirds did not use specific coupling maneuvers, the remaining third primarily used gel-based methods like ultrasound gel, KY-

Jelly, or hydrogel. Success was defined either as a stone-free state (28.45%) or the presence of clinically insignificant residual fragments (71.55%), most often defined as <3mm (55.17%). For pediatric cases, ultrasound was the preferred pre-ESWL imaging modality (63.87%). The median number of shockwaves was 2500, with most limiting the number of ESWL sessions to three [**figure 3]**.

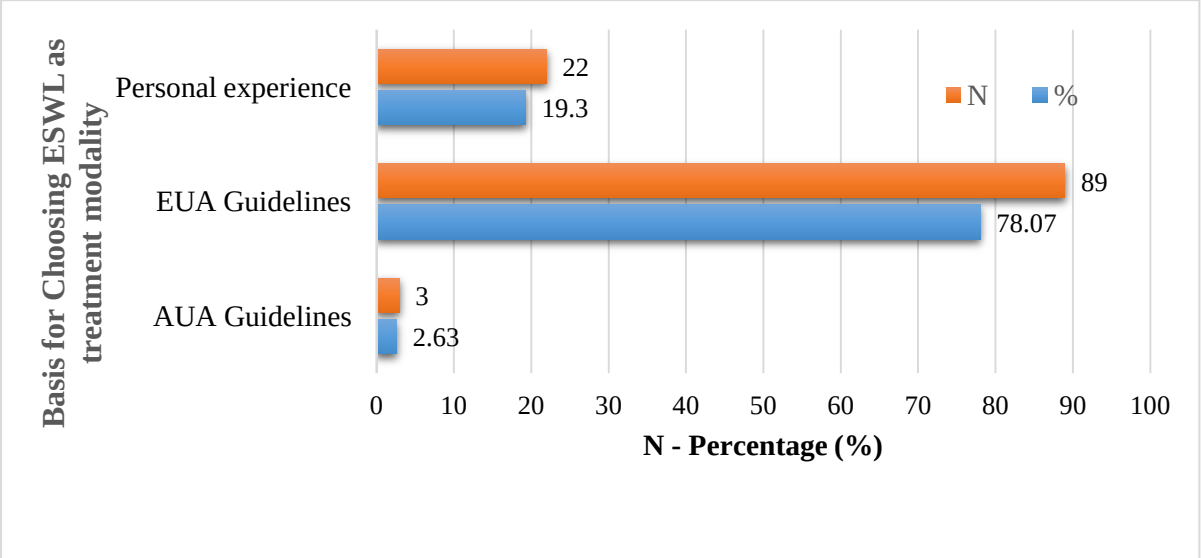

FIGURE 3: MAXIMUM NUMBER OF SESSIONS FOR THE SAME STONE

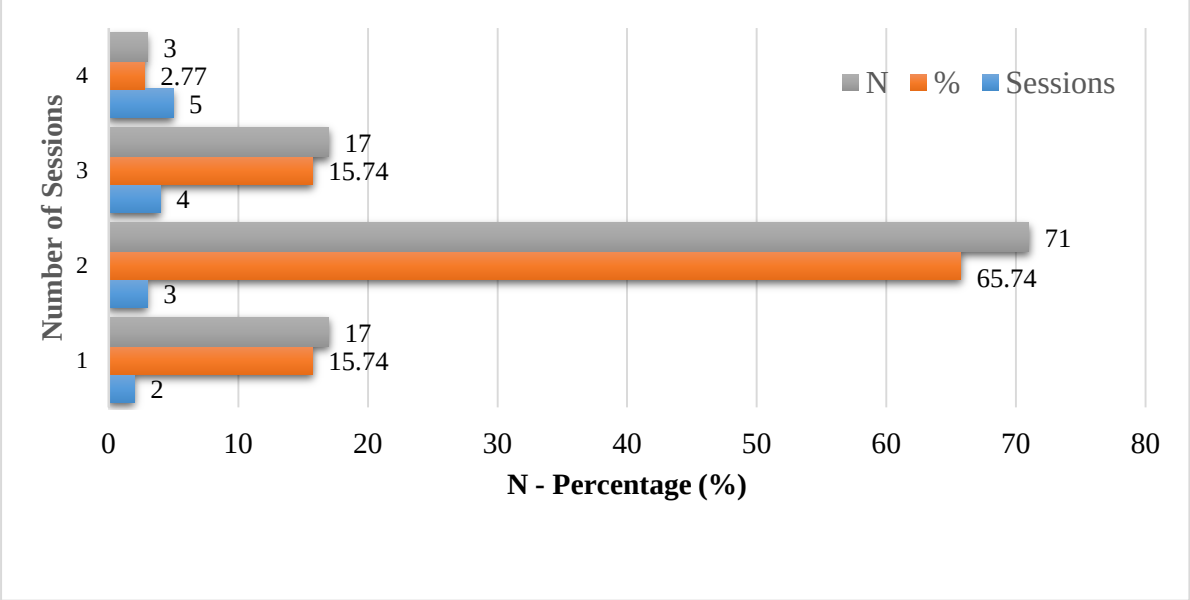

Figure 4: Deciding on selection of ESWL as treatment modality

The most commonly used number of shockwaves was 3000, reported by 45.4% of respondents, followed by 2000 shockwaves (19.4%) and 1000 shockwaves (10.2%). Treatment modality decisions were primarily guided by EUA guidelines (78.07%), and RIRS (45.69%) was the most preferred alternative when not opting for ESWL as shown in **table 3 and figure 4**.

TABLE 3: IMPLEMENTATION TECHNIQUES AND OUTCOME ASSESSMENT IN ESWL

Techniques and outcome		n	%	Response rate
What policy for ESWL has impacted the upper ureteral calculi?	As the first option, if unsuccessful then URS	38	31.93	72.56
	Ureteroscopy as the first option	81	68.07	
Do you have ESWL facility at your hospital?	No	14	11.76	72.56
	Yes	105	88.24	
Do you perform ESWL by yourself?	No	104	87.39	72.56
	Yes	15	12.61	
If not, then who performs it at your setup?	Medical officer	21	20.19	
	Not available	2	1.92	
	Registrar	8	7.69	
	Resident	6	5.77	
	Specialist doctor	2	1.92	
	Trained technician	65	62.5	
Which position do you use in ESWL in lower ureteral stones?	Prone	54	50.94	64.63
	Supine	52	49.06	
How do you adjust the level of energy during treatment?	I begin with a lower level of energy and increase gradually.	96	85.71	68.29
	I change the level of energy depending on the disintegration level of the stone(s)	16	14.29	
Do you use any specific maneuvers for coupling?	No	80	67.23	65.85
	Yes	28	23.53	
If yes, then specify those maneuvers	Gel	28	7.56	17.07
	Any lubricant	6	21.43	17.07
What kind of gel do you use for coupling?	Hydrogel	3	10.71	
	KY- Jelly	8	28.57	
	Litho clear gel	2	7.14	
	Ultrasound Gel	3	10.71	
	Volatile hydrogel	2	7.14	
	Water based with no air bubbles	4	14.29	
When do you evaluate the patient after ESWL?	>1week	42	36.21	70.73
	>2weeks	53	45.69	
	5-7days	21	18.10	
Which radiologic method do you use to evaluate your patient after ESWL?	Ultrasound KUB	11	9.24	70.73
	Xray KUB	105	88.24	
What is your definition of "SUCCESS" after ESWL?	Clinically insignificant residual fragments	83	71.55	70.73
	Completely stone-free status without any fragment	33	28.45	
What is the meaning of clinically insignificant residual fragments?	<2mm	52	44.83	70.73
	<3mm	64	55.17	
What is the period in months for you to define the status of success after ESWL?	1	62	53.45	70.73
	3- 6	2	1.72	
	3	52	44.83	
Which radiologic method do you prefer to perform in children before ESWL?	Low dose CT scan	23	19.33	68.90
	Regular CT scan	14	11.76	
	Ultrasound	76	63.87	
Maximum number of sessions for the same stone	2.0	17	15.74	65.85
	3.0	71	65.74	
	4.0	17	15.74	
	5.0	3	2.78	
How do you decide on giving ESWL as treatment modality?	AUA Guidelines	3	2.63	69.51
	EUA Guidelines	89	78.07	
	Personal experience	22	19.30	
If not ESWL, What other modality if your preference	PCNL	50	43.10	70.73
	PCNL or RIRS	2	1.72	
	RIRS	53	45.69	
	URS	11	9.48	

DISCUSSION

Despite the widespread use of SWL, there remains a significant gap in the literature regarding its practical implementation, particularly in our region. A review of current studies highlights a lack of research on treatment trends and technical aspects of SWL. Understanding these trends and technical details is crucial for improving patient outcomes and ensuring

adherence to best practices. While earlier survey-based studies have assessed general management strategies for urinary tract stones globally, our study specifically examines the trends and practices of ESWL for upper urinary tract stones. Similar investigations have been conducted elsewhere: for example, Lantz et al. studied ESWL practices among endourologists in the United States and Canada[13]. Sharma et al. conducted a phone-based survey across 21 centers in the United Kingdom, highlighting discrepancies in SWL practices[14]; and Yenigürbüz et al. used a web-based survey to evaluate treatment trends and technical aspects of ESWL among 97 academic endourologists[11].

Most respondents (62%) avoid using ESWL in obese patients with appropriately sized stones, and 55.17% prefer it as the primary option in abnormal kidneys. According to EAU guidelines, ureteroscopy is safer and more effective for renal stones in obese patients[15]. Obese patients and those with skeletal deformities, such as horseshoe kidneys, are prioritized for ureteroscopy due to the poor fragment clearance associated with ESWL. With an 84.48% rate, our survey stressed the importance of a single working kidney for ESWL treatment. In our survey, 37.82% of participants inserted a JJ stent in all situations and 26.66% in patients with big stones in single kidneys. Lantz et al.[13] found that 51% of Canadian urologists frequently stent patients with single kidneys, while 66% of American urologists did so, suggesting that Canadian and American urologists are more conservative than European urologists. This method may also be due to medico-legal issues in North America. We found that 89% of individuals stopped anticoagulants before ESWL. Our inquiry did not specify low-dose acetylsalicylic acid, so anticoagulant medication may have covered it. On this subject, American urologists stopped acetylsalicylic acid for renal and ureteral stones at a higher rate (96% and 90%, respectively) than Canadian urologists (88% and 62%, respectively) [16]. The 2018 EAU and AUA Guidelines on the temporary withdrawal or bridging of antithrombotic treatment in high-risk patients should be discussed with the internist [15, 17]. The occurrence of perinephric hematoma in patients having ESWL for renal and proximal ureteric stones was linked to anticoagulant/antiplatelet medicines and intraoperative hypertension [18]. Razvi et al. [18] found 0.34% perirenal hematoma, lower than other series. Our study found that warfarin, heparin, dipyridamole, clopidogrel, and ticlopidine were withdrawn before ESWL, while low-dose acetylsalicylic acid (81 mg) and NSAIDs were continued. Anticoagulant/antiplatelet medicines increased perinephric hematoma risk (hazard ratio: 4.198). Another study found 0.53% of patients had perirenal hematoma, with 0.23% clinically symptomatic. All patients with perirenal hematoma used cardiovascular medication, although low-dose (100 mg) acetylsalicylic acid did not affect it [19]. Another recent study found similar ESWL perirenal hematoma rates [20]. Razvi and colleagues [18] revealed the ESWL machine model. Unfortunately, our study did not assess the different ESWL models.

We found that 57.76% of urologists do not take antibiotic prophylaxis. Canadian urologists used prophylactic antibiotics in 2% of cases, compared to 78% for American urologists. Interestingly, both groups of urologists reported identical routine urine culture rates [13]. The EAU and AUA do not suggest routine antibiotic usage before ESWL[12, 21]. Our investigation found that 42.24% routinely used antibiotics, inconsistent to Sharma et al. [14] and 25% from the UK. Both guidelines urge preventive antibiotics for suspected UTIs. Our survey suggested intravenous prophylactic antibiotics before ESWL in individuals with elevated bacterial burden [10, 12] but did not examine ESWL for nephrostomy tube patients.

As Sharma et al. [14] found, NSAIDs (58%) and diclofenac were the most commonly utilized analgesics before ESWL. EAU guidelines advocate managing pain during ESWL to limit pain-related movements for accurate targeting [12]. American urologists used general anesthesia for ESWL 8% of the time, compared to 5% in Canada [13]. General anesthesia had higher ESWL treatment success rates than intravenous sedation, although our institute only uses it for minors[22]. Recent research found that mild analgesics, NSAIDs, and opioids can reduce ESWL pain to a manageable level. Analgesia was more often described as adequate for opioids than NSAIDs [23], but there were no significant differences in safety or efficacy. Our survey found 12.15% opioid use.

A meta-analysis found that slower SW application rates enhanced ESWL efficacy and lowered expenses by 50% [24, 25]. In Canada, 76% of urologists used a high SW delivery rate (120/min), and in the US, 45% used 60 SW/min and 41% used 90 SW/min [13]. Our analysis found that 3% use 120 SW/min, per EAU standards. The EAU recommendations noted that SW rate enhanced tissue damage [12]. Our survey allowed 3000 SW per adult session, equivalent to Canadian and American urologists [13].

The EAU standards propose proper acoustic coupling because air bubbles were not eliminated, which greatly reduces SW energy delivery and deflects 99% of SW [12, 26]. We found that 23.53% utilized special gels and 28.57% used KY gel.

The prone posture was preferred by 51% of respondents for distal ureteral stones. Kamel et al. [27] found that supine trans-gluteal had a greater stone-free rate than prone. ESWL for distal ureteral stones in supine trans-gluteal position was successful in several studies [28, 29].

This first-of-its-kind study highlights ESWL practices in Pakistan. While valuable, its tool length may have lowered response rates. A single follow-up was sent, but more reminders or social media use could help. Despite limitations, it offers key insights into Asian endourologists' perspectives and treatment trends in ESWL.

This study reveals that most urologists have direct access to ESWL devices, typically operated by trained technicians. Clinical decisions are mainly influenced by stone characteristics, especially density, with <1000 Hounsfield units as a common threshold. NSAIDs are preferred for analgesia, while antibiotic prophylaxis is limited, favoring cephalosporins when used. Ureteroscopy is the main approach for managing steinstrasse, and post-treatment assessment commonly involves X-ray KUB. Adherence to EAU guidelines reflects efforts toward standardized care. Overall, the findings indicate general alignment with international practices, while highlighting opportunities to improve consistency, training, and protocol adherence in ESWL practice across Pakistan.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

FUNDING: The work was not financially supported by any organization. The entire expense was taken by the authors.

ACKNOWLEDGEMENTS: We are thankful to all who were involved in our study.

AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

CONFLICT OF INTEREST: No competing interest declared

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