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Safety and Efficacy of Spinal Anaesthesia for Ureteroscopy and in Situ Lithotripsy in Proximal Solitary Pelvic Stones

Shumaila Ashfaq[1]*, Sara Sabir[1], Rehan Hassan Khan Niazi[2], Aftab Ahmed Channa[3], Itrat Hussain Kazmi[4] and Hafiz Faheem Asghar[5]

[1]Department of Anesthesia, Islam Medical and Dental College, Sialkot, Pakistan
[2]Department of Anesthesia, Ameer Ud Din Medical College, Lahore, Pakistan
[3]Department of Urology, Islam Medical and Dental College, Sialkot, Pakistan
[4]Department of Anesthesia, Shalamar Medical and Dental College, Lahore, Pakistan
[5]Department of Anesthesia, Muhammad Islam Medical College, Gujranwala, Pakistan

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***Corresponding Author:**
Shumaila Ashfaq
Department of Anesthesia, Islam Medical and Dental College, Sialkot, Pakistan
shumailach2003@yahoo.com

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ABSTRACT

Ureteroscopy and in situ lithotripsy provide an alternative treatment for patients with proximal solitary pelvic stones, but their safety and efficacy using spinal anesthesia are poorly studied. **Objectives:** To evaluate the safety, efficacy and patient satisfaction with spinal anesthesia during these procedures. **Methods:** A single-arm, prospective observational study was conducted at Islam Medical College, Sialkot, from May to October 2024, involving a total of 81 patients aged 20 to 60 years, ASA class I to III, who underwent elective ureteroscopy or lithotripsy. 15 mg of 0.75% bupivacaine was used to perform spinal anesthesia at the L3-L4 interspace. The main endpoints were success, complications, recovery times, and patient satisfaction. Other secondary outcomes were intraoperative hypotension, bradycardia, pain as measured by visual analogue scale (VAS) and post-dural puncture headache (PDPH). SPSS version 26.0 was used for statistical analysis. **Results:** A total of 97.5% patients completed the procedure under spinal anesthesia. The mean procedure time was 37.4 ± 6.2 min. In 53.1% of patients, the maximum sensory blockade level was T6. Hypotension (14.8%), bradycardia (6.2%), and PDPH (2.5%) were the complications. Next, postoperative pain significantly decreased over the 24 hours. In 55.6% of patients, excellent satisfaction was observed. Mean recovery time was 165.3 ± 22.4 minutes. **Conclusions:** Overall, spinal anesthesia for ureteroscopy and in situ lithotripsy in patients with proximal solitary pelvic stones is safe, effective, and has a high patient satisfaction rate.

INTRODUCTION

Endoscopic management of ureteral stones is a commonly encountered urological problem worldwide, and the proximal ureter is a difficult site [1, 2]. Proximal solitary pelvic stones are now routinely treated with an intact URS with in situ lithotripsy using a minimally invasive procedure [3, 4]. There have traditionally been preferred anaesthetic techniques for these procedures, general anesthesia (GA), because it can provide controlled airway, muscle relaxation, and patient immobility [5, 6]. Although regional anesthesia (RA) for ureteroscopy has been largely abandoned due to the risks associated with hypotension and the general enthusiasm for general anesthesia, recent advances in anaesthetic techniques and growing experience with spinal anesthesia have encouraged rethinking the use of RA as a safe and effective alternative [7, 8]. Several advantages of spinal anesthesia are reduced anesthesia-related complications, early postoperative recovery, and shorter hospital stays as well as cost

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effective [9]. However, while spinal anesthesia in urological procedures such as transurethral resection of the prostate (TURP) and percutaneous nephrolithotomy (PCNL) has been extensively utilized, the efficacy in proximal ureteroscopy regarding patient safety, intraoperative events and postoperative outcomes has not been fully explored [10, 11]. Several studies have evaluated the use of spinal anesthesia for distal ureteric stones and other lower urinary tract procedures. Still, there is no clinical evidence regarding the use of spinal anesthesia for proximal solitary pelvic stones treated with ureteroscopy and in situ lithotripsy. Few published studies address the question of the comparison of general anesthesia and spinal anesthesia with respect to perioperative characteristics of patients and patient satisfaction with this anesthesia method used in this setting. This study evaluated spinal anesthesia as an alternative single anesthetic technique for ureteroscopy and in situ lithotripsy in proximal solitary pelvic stones, focusing on intraoperative events and postoperative outcomes.

This study aims to evaluate the safety, efficacy and patient satisfaction with spinal anesthesia during these procedures.

METHODS

This single-arm, prospective observational study was conducted at Islam Medical College, Sialkot, from May 2024 to October 2024. A total of 81 participants were included in the study. The study followed ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of Islam Medical College, Sialkot (900/IMC/ERC/000103). All the participants provided written informed consent after a briefing of the nature, objectives, procedures and possible risks of the study. Throughout the research, patient confidentiality and data protection were at great attention. The sample size for this study was calculated based on the primary outcome of successful completion of ureteroscopy under spinal anaesthesia. Previous studies have reported success rates of spinal anaesthesia in ureteroscopy ranging from 90% [12]. Assuming an expected success rate of 90%, a 95% confidence level (Z = 1.96), and a margin of error of 4%, the minimum required sample size was calculated using the formula for estimating a single proportion: n=Z2·p·(1-p)d2 = 81 [12]. The study used a non-probability purposive sampling technique. Patients aged between 20 and 60 years, with ASA (American Society of Anesthesiologists) class I, II, or III, and scheduled for elective ureterorenoscopy or lithotripsy for upper ureteric or solitary pelvic stones, were included in the criteria. Obesity, spinal deformity, mental disturbance, neurological disorder, and patients with multiple renal calculi or whose calculi involved the pelvic ureteric junction were the exclusion criteria. The night before surgery, each patient received oral diazepam 5 mg and continued on any ongoing medical treatment. One liter of intravenous fluids was preloaded in the patients before the procedure. Blood pressure, pulse rate, oxygen saturation, and ECG were used with a 5-minute recording interval. The patient was sat up and spinal anesthesia was administered at L3-L4 interspace with 25G Whitacre needle. After confirmation of clear cerebrospinal fluid flow, 15 mg of 0.75% bupivacaine was injected intrathecally for all patients, regardless of their individual body weight. Stone size and side: These were obtained from preoperative imaging (ultrasound and non-contrast CT, where available. Ultrasound examinations were performed using a GE Healthcare LOGIQ P9 system with a 3.5–5 MHz convex transducer, while non-contrast CT scans were acquired on a Siemens SOMATOM Definition AS 64-slice scanner. All anaesthetic procedures were undertaken by a single experienced anesthetist. Intraoperative hypotension was defined as SBP less than 90 mmHg or a fall of 50 mmHg from baseline and was managed by IV fluids and plasma expanders. Bradycardia was documented as HR <50 bpm or 20 % drop from baseline, and treated with 0.5mg intravenous atropine. The other adverse events, such as vomiting, were also addressed accordingly. The sensory block level was assessed using the pinprick method on the midclavicular line at 5, 10, 20, and 30 minutes after the anaesthetic injection, at the end of the operation, and 2 hours after the operation. Hip flexion (L2) and knee extension (L3) were used to evaluate motor block. The Visual Analogue Scale (VAS) was used for pain measurement. Postoperative pain was assessed using the Visual Analogue Scale (VAS, 0–10; 0 = no pain, 10 = worst imaginable pain) [13]. The highest sensory block level (ranging from T10 to T4) was determined. The same urologist performed all surgical procedures with an average surgical duration of 30 to 45 minutes. Postoperatively, pain was managed with intravenous nalbuphine 0.1 mg/kilogram at the conclusion of the procedure and intramuscularly every eight hours with ketorolac 100 mg intramuscularly. Safety was evaluated through intraoperative hemodynamic stability (hypotension, bradycardia), intra- and postoperative complications (nausea/vomiting, PDPH, bleeding, urinary retention), and the ability to manage these events conservatively. Efficacy was assessed by procedural success rate (completion of ureteroscopy and lithotripsy under spinal anesthesia without conversion to GA), adequacy of sensory and motor block, procedure time, postoperative analgesia (VAS), and time to recovery and discharge. The statistical analysis was carried out using SPSS version 26.0. Age, stone size, procedure time, time to recovery, and discharge were measured as mean ±

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standard deviation (SD) of quantitative variables. Gender, ASA class, sensory block level, complications and procedural success rate were presented in quantities and percentages of categorical variables. Pearson's correlation test was used to assess the relationship between motor recovery time and time to discharge, with a significant statistical significance of $p \leq 0.05$. The demographic data, in addition to intraoperative efficacy, safety outcomes, postoperative pain scores, recovery times and patient satisfaction, were summarized in tabular form.

RESULTS

This study enrolled a total of 81 patients with a mean age of 42.3 ± 9.5 years. The sample was predominantly of male patients (69.1%), while female patients (30.9%) constituted the rest. Classes I, II, and III, in regard to ASA classification, were 37%, 43.2%, and 19.8%, respectively. The average stone size was 9.2 ± 3.4 mm and was nearly even between the right (53.1%) and left (46.9%) sides (Table 1).

Table 1: Demographics and Baseline Characteristics

Parameters	Value
Age (Years)	
Mean ± SD	42.3 ± 9.5
Gender	
Male	56 (69.1%)
Female	25 (30.9%)
ASA Class	
Class I	30 (37%)
Class II	35 (43.2%)
Class III	16 (19.8%)
Stone Size (mm)	
Mean ± SD	9.2 ± 3.4
Stone Side	
Right	43 (53.1%)
Left	38 (46.9%)

Out of the cases, 97.5 % were completed under spinal anesthesia. The mean procedure time was 37.4 (6.2) minutes. In 53.1% of the patients, the maximum sensory block was achieved at the T6 level, 24.7% at the T8, 14.8% at the T4, and 7.4% at the T10 level. The respective mean time to motor block recovery was 165.3 ± 22.4 minutes; the mean time to discharge from the recovery area was 198.6 ± 30.5 minutes (Table 2).

Table 2: Efficacy Outcomes (n=81)

Outcomes	Value
Procedure Completed Under Spinal, n (%)	79 (97.5%)
Procedure Time (min), Mean ± SD	37.4 ± 6.2
Maximum Sensory Block Level	
T4	12 (14.8%)
T6	43 (53.1%)
T8	20 (24.7%)
T10	6 (7.4%)
Time to Motor Block Recovery (min), Mean ± SD	165.3 ± 22.4
Time to Discharge from Recovery (min), Mean ± SD	198.6 ± 30.5

The Visual Analogue Scale (VAS) postoperative pain did not exceed low levels throughout the first 24 hours. In 2 hours, the mean VAS score was 2.4 ± 1.1, rose slightly to 3.6 ± 1.2 in 8 hours, and dropped to 2.2 ± 1.0 by 24 hours. There was this apparent trend, which was statistically significant ($p<0.001$) (Table 3).

Table 3: Postoperative VAS Pain Scores

Time Point (Hours)	Mean VAS ± SD
2	2.4 ± 1.1
4	2.9 ± 1.3
8	3.6 ± 1.2
12	3.1 ± 1.5
24	2.2 ± 1.0
p-value	<0.001*

It was found that there was a strong positive correlation between motor recovery time and discharge timing ($r=0.72$, $p=0.011$). Quick motor recovery leads to earlier discharge (Table 4).

Table 4: Time to Recovery and Discharge (Reformatted)

Parameters	Value	p-Value
Mean Time to Motor Recovery (minutes)	85.4 ± 10.3	—
Mean Time to Discharge (minutes)	135.2 ± 22.1	—
Correlation between Recovery and Discharge	r=0.72	0.011

Complications intraoperative and postoperative were minimal and managed. 14.8% of patients had hypotension, 6.2% had bradycardia, and 9.9% nausea or vomiting. Out of these, only 2.5% suffered post-dural puncture headache (PDPH); urinary retention was not seen amongst any; and only one (1.2%) sustained bleeding (Figure 1).

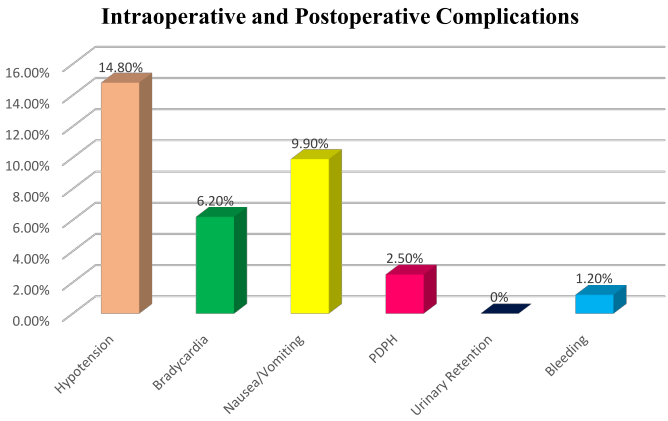

Figure 1: Intraoperative and Postoperative Complications

The high rate of patient satisfaction was reflected in rating results: 55.6% gave the experience excellent, 34.6% good, and 9.9% were fair. Although individuals in this setting did not have a poor experience with spinal anesthesia for

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ureteroscopy and in situ lithotripsy, the overall safety, effectiveness, and patient acceptability of spinal anesthesia in this setting are evident (Figure 2).

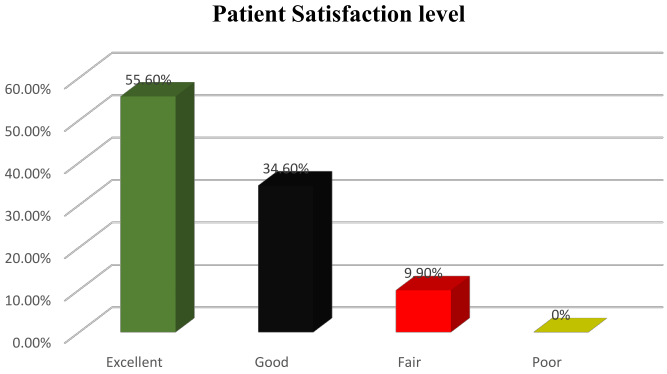

Figure 2: Patient Satisfaction

DISCUSSIONS

This study confirms that spinal anesthesia is a safe and effective means of rendering patients anaesthetized for ureteroscopy and in situ lithotripsy for proximal solitary pelvic stones. In 97.5% of cases, the procedure was performed under spinal anesthesia and was associated with few intraoperative and postoperative complications. These results are consistent with previous studies, which have reported that spinal anesthesia is safe and efficacious for urological surgeries [14]. The procedure time was found to be 37.4 ± 6.2 minutes, consistent with previous reports. For instance, other studies investigating the use of spinal anesthesia in patients undergoing similar urological procedures, Iqbal *et al.* provided an average procedure time of about 40 minutes [15]. The relatively short duration of the procedure decreases the risk of complications and further enhances potential patient outcomes [16]. In our study, the maximum sensory block level was at T6, being 53.1%, with some sensory blocks reaching up to T4. The levels are similar to those reported by Varghese *et al.* who showed most patients received T6 to T8 sensory block during a similar urological intervention [17]. Spinal anesthesia is effective in achieving an adequate sensory block to allow a successful procedure to be completed by means of patient comfort and adequate surgical conditions [18, 19]. Our study demonstrates intraoperative complications of hypotension (14.8%) and bradycardia (6.2%). The rates were relatively low in comparison to the 22% incidence of hypotension reported by Hernandez *et al.* in patients undergoing spinal anesthesia for urological procedures [20]. This lower rate could, however, be explained by closely monitoring the patients' vital signs and being ready to treat patients with hypotension promptly with intravenous fluids and plasma expanders. Moreover, unlike other studies on spinal anesthesia, spinal anesthesia by us did not cause any cases of urinary retention, a complication commonly observed in spinal anesthesia (specifically, in the immediate postoperative period), where other studies, e.g. Mormol *et al.* report urinary retention in patients 5% [21]. Current study showed similar postoperative recovery as in previous studies. Overall, the mean time to motor block recovery was 165.3 ± 22.4 minutes, which is not different from what is typical, reported by Prabhakar *et al.* to be approximately 160 minutes after spinal anesthesia for urological procedures [22]. The mean time to discharge from the recovery area was 198.6 ± 30.5 minutes, which is also in line with Chitnis *et al.* for patients having comparable procedures conducted under spinal anesthesia [23]. Our study showed that the postoperative VAS pain scores in regard to pain management were low, and a significant decline in the pain intensity was observed in the first 24 hours. There was very little difference from Zhou *et al.* who noted moderate pain at the 8-hour mark and then decreasing pain intensity over time. In our study, the intravenous nalbuphine and intramuscular ketorolac allowed for adequate pain control, and are supportive of previous studies in which multimodal analgesia has been deemed the most effective method for relief of post-surgical pain [24]. Regarding patient satisfaction, 55.6% of our participants graded the procedure excellent compared to Neuman *et al.* who reported that 52% of patients graded their experience with spinal anesthesia for urological procedures as excellent [25]. In current study, a high level of satisfaction was found, showing that spinal anesthesia is a safe and effective means of providing anesthesia that patients tolerated well. Given this finding, spinal anesthesia for ureteroscopy and lithotripsy should be a reasonable alternative to general anesthesia because the patients reported better comfort and satisfaction [26].

CONCLUSIONS

Spinal anesthesia for ureteroscopy and in situ lithotripsy in patients with proximal solitary pelvic stones was concluded to be a safe, effective and well-tolerable procedure. The outcomes of this experiment are consistent with prior studies; therefore, spinal anesthesia could still be utilized for these procedures. Considering the good results, further investigation into optimization strategies and large-scale studies would be useful in proving spinal anesthesia as the preferred technique for anesthesia in this setting.

Authors Contribution

Conceptualization: SA
Methodology: SS, RHKN, AAC
Formal analysis: SS, HFA
Writing review and editing: RHKN, AAC, IHK

All authors have read and agreed to the published version of the manuscript

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Conflicts of Interest

All the authors declare no conflict of interest.

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