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Effect of Preoperative Single-Dose Systemic Dexamethasone (8 mg) on Postoperative Pain and Blood Sugar Levels in Patients Undergoing Percutaneous Nephrolithotomy: A Randomised Controlled Trial

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Abstract

Background & aims

Glucocorticoids, known for their anti-inflammatory and immunomodulatory effects, have shown promise in reducing postoperative pain. We compared the effect of single-dose systemic preoperative dexamethasone (8 mg) with placebo-controlled patients on postoperative analgesia and blood sugar levels in patients undergoing percutaneous nephrolithotomy.

Material & methods

The placebo-controlled randomised, double blind study was carried out on 70 ASA grade I and II patients, aged 18-60 years, of either gender undergoing percutaneous nephrolithotomy under general anaesthesia.

Intravenous (IV) dexamethasone 8 mg/2 ml or normal saline 2 ml is given to patients preoperatively 1 hour before surgery. Patients' haemodynamic data, baseline blood sugar levels, and Visual Analogue Scale (VAS) scores were recorded. Postoperatively, before shifting to the Post Anaesthesia Care Unit (PACU), blood sugar was tested. After shifting to the PACU, haemodynamic data, VAS scores, and the requirement for injection paracetamol were recorded at 0, 6, 12, 24 and 48 hrs.

Results

A two-way repeated-measures ANOVA with Greenhouse-Geisser correction showed a significant difference in VAS scores between the Dexamethasone and Normal Saline groups ($p < 0.001$), but no significant difference between the two groups in random blood glucose levels over time ($p = 0.537$).

Conclusion

Preoperative administration of a single dose intravenous dexamethasone in patients undergoing percutaneous nephrolithotomy significantly reduces the requirement for postoperative rescue analgesia and has no significant effect on blood sugar.

Categories: Anesthesiology
Keywords: analgesia, dexamethasone, nephrolithotomy, percutaneous, postoperative

Introduction

Percutaneous nephrolithotomy (PCNL) is currently regarded as the gold-standard surgical treatment for large and complex renal calculi because of its minimally invasive nature, lower complication rates, and faster postoperative recovery.

Despite being minimally invasive, PCNL can be associated with significant postoperative pain, which may delay mobilisation and hospital discharge. Following the procedure, a nephrostomy tube is commonly placed to ensure adequate urinary drainage, facilitate haemostasis, and provide access for managing potential complications. However, the presence of the nephrostomy tube can contribute substantially to postoperative pain, prolong hospital stay, and adversely affect patient satisfaction [1,2]. The main sources of postoperative pain are visceral pain (T10-L2) due to dilatation of the renal capsule and parenchymal tract, as well as peritubular compression by the nephrostomy tube, and somatic pain (T8-T12) from the access site, which require ongoing management [2,3].

Glucocorticoids are used to reduce inflammation and tissue damage in a variety of conditions, including

inflammatory bowel disease, rheumatoid arthritis and some malignancies. Glucocorticoids have potent immunomodulatory effects and are used in treating acute allograft rejection [4].

Perioperative steroids are also known to increase blood glucose levels due to increased insulin resistance and reduced function of the pancreatic beta-cells [5].

Several recent studies have investigated the potential analgesic benefit of a single preoperative dose of dexamethasone on analgesic requirement in the postoperative period [6].

This study aimed to compare the effect of single-dose (8 mg IV) preoperative dexamethasone with placebo-controlled patients on postoperative pain and rescue analgesia requirement, and to see the effect of dexamethasone on blood sugar levels in patients undergoing percutaneous nephrolithotomy.

Materials And Methods

Following approval by the institutional ethics committee and after obtaining written informed consent, a prospective double-blind randomised placebo-controlled study was conducted in the Department of Anaesthesiology of a tertiary healthcare institute from April 2025 to December 2025. The study was conducted and reported in accordance with the ethical standards of the Declaration of Helsinki (2024) [7]. The study was registered in the Clinical Trial Registry of India (CTRI/2025/04/083893). A total of 75 (100%) patients with American Society of Anesthesiologists (ASA) physical status I and II [8], aged 18-60 years, of either gender, undergoing percutaneous nephrolithotomy under general anaesthesia were assessed for eligibility for the study; out of these, 5 (6.7%) were excluded - 2 (2.7%) were known diabetic and 3 (4.0%) did not give consent (Figure *1*).

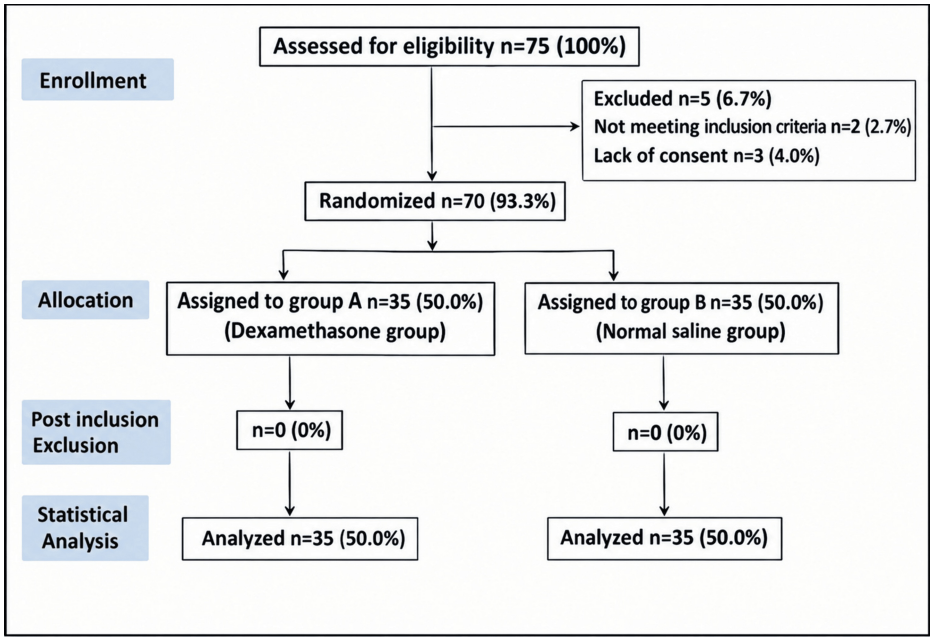


FIGURE 1: Recruitment CONSORT (2010) flow chart

Patients who declined to provide informed consent, required emergency surgery, or had diabetes mellitus, immunocompromised status, long-term steroid therapy, cardiovascular or respiratory disorders, metabolic disorders, or a history of chronic analgesic use were excluded from the study. Patients who were unable to comprehend or appropriately use the Visual Analogue Scale (VAS) were also excluded. Routine preoperative evaluation was performed for all participants.

Pain intensity was assessed using a 10-cm (100-mm) Visual Analogue Scale (VAS), a validated subjective tool for the assessment of pain severity. Before assessment, all patients were instructed regarding the VAS, with a score of 0 representing no pain and 10 representing the worst imaginable pain.

A change of 10 mm on the 100-mm VAS is considered the minimal clinically important difference (MCID), while a VAS score of ⩽33 mm indicates adequate postoperative pain control [9].

The VAS score was recorded preoperatively as a baseline assessment and subsequently at predetermined postoperative time points.

The baseline blood sugar levels were also measured before administering 8 mg dexamethasone IV or normal saline IV in the study group. The following pre-op data were noted: Age, gender, height, weight, type of surgery, NBM status, preoperative or baseline sugar and VAS score. The participants were randomly allotted to one of the following groups by computer-generated simple randomisation, and allocation concealment was achieved using sealed opaque envelopes (Figure *1*). The observer was blinded to the randomisation and the study group.

Group A: This group included patients who received a pre-operative 8 mg (2 ml) single dose of dexamethasone (marketed by Germed, India) intravenously one hour before surgery.

Group B: This group was used as the control group, and the patients received (2 ml) normal saline IV (manufactured and marketed by Lifesciences) one hour before the surgery.

On the day of surgery, after confirming their nil by mouth status and PAC review, patients were shifted to the OR. They were connected to 5-lead ECG, pulse oximetry and NIBP (Non-invasive blood pressure) monitoring. IV access was secured under strict aseptic conditions. All the patients were premedicated with oral alprazolam 0.25 mg the night before surgery and pantoprazole 40 mg on the morning of surgery. Standard monitors - non-invasive blood pressure (5 min intervals), ECG, pulse oximetry, and capnography - were connected on arrival to the operating room. Patients received IV glycopyrrolate 0.1 mg and fentanyl 2 µg/kg prior to induction, induced with IV propofol 1% at 1.5-2.5 mg/kg. After confirming adequate mask ventilation, atracurium 0.5 mg/kg IV was administered. Laryngoscopy was performed, and endotracheal intubation was done with an appropriately sized cuffed endotracheal tube (7.0-7.5 mm for females, 8.0-8.5 mm for males).

Intraoperative anaesthesia and analgesia were maintained with intraoperative infusion of fentanyl (0.5 mcg/kg/hr), O2: air: sevoflurane (age-adjusted MAC of 0.8-1.0) and atracurium (0.3-0.6 mg/kg/hr). After the completion of surgery, neuromuscular blockade was reversed with IV neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg, and patients were shifted to postoperative wards. Postoperative analgesia was managed with IV Tramadol 50 mg 8th hourly. Rescue analgesia with IV 1 gm paracetamol was added to the regular analgesia if the VAS score went above 4. VAS score was assessed in the immediate postoperative period, 6 hrs, 12 hrs, 24 hrs, and 48 hrs postoperatively. Blood sugar was measured after induction, just before incision and at the end of surgery before shifting to PACU. The time of first administration of IV acetaminophen and the total dose of acetaminophen administered to patients were recorded at various time points during the observation period.

In our study, as per the registered CTRI protocol, the effect of preoperative single-dose systemic dexamethasone (8 mg) on postoperative pain is the primary outcome, and the effect on blood sugar levels in patients undergoing percutaneous nephrolithotomy is the secondary outcome [8,9]. Sample size estimation for the primary outcome (postoperative analgesia) was based on the study by Chauhan (2025) [10], which reported a mean postoperative 6-hour VAS score of 3.2 ± 0.8 in the dexamethasone group and 5.4 ± 1.1 in the control group; assuming 80% power and a 5% level of significance, the calculated sample size was five participants per group (total n = 10).

Based on the results reported in Peter et al. (2022) [11], who studied the effect of a single intraoperative dose of dexamethasone on glycaemic profile in the postoperative period, the mean (SD) fasting blood sugar (FBS) in the dexamethasone group on postoperative day 1 was 98.04 (21), and the mean (SD) in the control group, which received normal saline, was 86.96 (10). Assuming the same in our study, with 80% power and a ratio of intervention to control group of 1 and an alpha value of 5%, the sample size was calculated using the difference in two means in OpenEpi v3.01. The expected sample size was 35 in each group, with a total sample size of 70. Therefore, the final sample size for the trial was determined using the secondary outcome, as it required a larger sample to detect a clinically meaningful effect with the predefined level of statistical power and significance. This approach ensured that the study was adequately powered for both primary and secondary outcome assessments and minimized the risk of an underpowered trial.

Statistical analysis was performed using SPSS version 20 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Between-group comparisons at individual time points were initially assessed using independent samples t-tests. Repeated measurements of Visual Analog Scale (VAS) scores and blood glucose values over time were analysed using two-way repeated-measures ANOVA with Greenhouse-Geisser correction. Following a significant omnibus interaction effect, pairwise comparisons across postoperative time points were adjusted using the Holm-Bonferroni method to control for family-wise error due to multiple comparisons. A p-value <0.05 after adjustment was considered statistically significant.

Results

A total of 70 patients who fulfilled the inclusion criteria were recruited and enrolled for the study. The socio-demographic characteristics of the study participants in the Dexamethasone group (n=35) and the Normal Saline group (n=35) were identical (Table *1*).

Variable	Category	(Dexamethasone) Group A, n (%) (n=35)	(Normal Saline) Group B, n (%) (n=35)	p-value
Age (years) - Mean (SD)		40.2 (12.14)	39.54 (12.94)	0.845
Gender	Male	27 (77.14)	27 (77.14)	1.000
	Female	8 (22.86)	8 (22.86)	
ASA Status	I	24 (68.57)	24 (68.57)	1.000
	II	11 (31.43)	11 (31.43)	

TABLE 1: Distribution of Age, Gender and ASA Status

ASA: American Society of Anesthesiologists

The mean age of participants in the Dexamethasone group and Normal Saline group was 40.2 years (SD = 12.14) and 39.54 years (SD = 12.94), respectively, with no significant difference between the groups (p = 0.845). The gender distribution was identical between the groups (p=1.000), with 77.14% (N=27) male and 22.86% (N=8) female.

Amongst the patients studied, in both groups, there were 24 (68.57%) patients with ASA I status and 11 (31.43%) patients with ASA II status (Table *1*). There were no significant differences in ASA status (p=1.000).

Rescue analgesia with injection paracetamol 1 gm intravenous received by the study participants in the Dexamethasone group and the Normal Saline group over different time points during the period of observation is illustrated in Table *2*. After shifting to the Post Anaesthesia Care Unit (PACU), none of the participants in either group received injection paracetamol. At the 6-hour mark, 51.43% of participants in the Dexamethasone group received injection paracetamol, compared to 82.86% in the Normal Saline group (p=0.007). This difference persisted at 12 hours, when the proportion of patients receiving the injection remained lower in the Dexamethasone group (22.86%) compared to the Normal Saline group (57.14%), with p=0.004. At 24 hours, only 2.86% of the Dexamethasone group received injection paracetamol, whereas 31.43% of the Normal Saline group did so (p=0.002). At 48 hours postoperatively, none of the patients in the Dexamethasone group required rescue analgesia with injection paracetamol, compared with 40% in the Normal Saline group (p<0.001).

Time Points of Measurement	(Dexamethasone) Group A, n (%) (n=35)	(Normal Saline) Group B, n (%) (n=35)	p-value*
After shifting to PACU	0 (0)	0 (0)	-
6 hours	18 (51.43)	29 (82.86)	0.007
12 hours	8 (22.86)	20 (57.14)	0.004
24 hours	1 (2.86)	11 (31.43)	0.002
48 hours	0 (0)	14 (40)	<0.001

TABLE 2: Distribution of injection paracetamol received by the study participants between the intervention and control groups over the period of time (N=70)

*p-values calculated using Fisher's Exact test

The distribution of Visual Analogue Scale (VAS) scores among study participants in the dexamethasone and normal saline groups across multiple postoperative time points (N = 70) is presented in Table *3* and Figure *2*. Baseline and immediate postoperative (0-hour) VAS scores were comparable between the two groups, with no statistically significant differences (p = 0.31 and p = 0.09, respectively). The baseline mean (SD) VAS scores were 1.20 (0.41) in the dexamethasone group and 1.11 (0.32) in the normal saline group. At 0 hours, the mean (SD) VAS scores were 1.29 (0.46) and 1.49 (0.51) for the dexamethasone and normal saline groups, respectively.

Time Points of Measurement	(Dexamethasone) Group A, Mean (SD) (n=35)	(Normal Saline) Group B, Mean (SD) (n=35)	Adjusted p-value *
Baseline	1.20 (0.41)	1.11 (0.32)	0.310
0 hours	1.29 (0.46)	1.49 (0.51)	0.090
6 hours	4.69 (1.18)	5.54 (0.85)	0.048 (NS)
12 hours	3.77 (0.88)	4.54 (0.56)	0.003
24 hours	2.83 (0.57)	4.31 (0.47)	< 0.001
48 hours	1.09 (0.28)	3.37 (1.06)	< 0.001

TABLE 3: Distribution of Visual Analog Scale (VAS) score of the study participants between the intervention and control groups over the period of time (N=70)

*p-values adjusted using Holm–Bonferroni correction for multiple comparisons, NS = Not Significant.

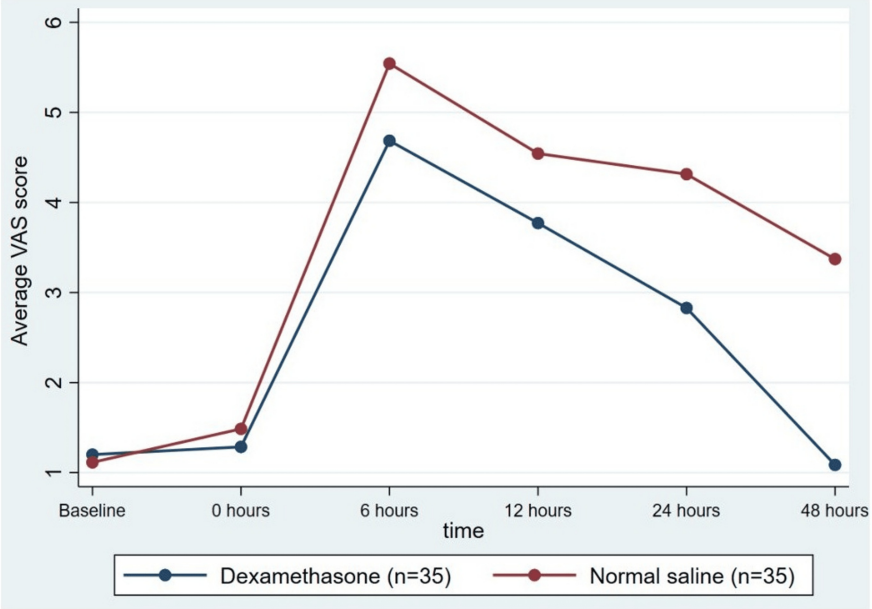


FIGURE 2: Trendline analysis of Visual Analog Scale (VAS) score measured at various time points between the Group A (Dexamethasone, n=35) and Group B (Normal saline, n=35)

At 6 hours postoperatively, mean VAS scores were lower in the Dexamethasone group [4.69 (1.18)] compared with the Normal Saline group [5.54 (0.85)]. Although the unadjusted comparison was nominally significant ($p = 0.048$), this significance was attenuated and did not meet the adjusted threshold for significance after Holm-Bonferroni correction. Statistically significant differences between the two groups were confirmed at 12 hours (adjusted $p = 0.003$), 24 hours (adjusted $p < 0.001$), and 48 hours (adjusted $p < 0.001$).

At 12 hours, the mean (SD) VAS scores were 3.77 (0.88) and 4.54 (0.56), respectively. At 24 hours, the scores further decreased to 2.83 (0.57) in the dexamethasone group and 4.31 (0.47) in the normal saline group. By 48 hours, the mean (SD) VAS scores were 1.09 (0.28) and 3.37 (1.06) for the dexamethasone and normal saline groups, respectively.

After Holm-Bonferroni adjustment for repeated pairwise comparisons, statistically significant differences in VAS scores between the two groups persisted at 12 hours (adjusted $p = 0.003$), 24 hours (adjusted $p < 0.001$), and 48 hours (adjusted $p < 0.001$). Two-way repeated-measures ANOVA with Greenhouse-Geisser correction

demonstrated a significant group-by-time interaction effect ($p < 0.001$), indicating that dexamethasone administration was associated with a significantly greater reduction in postoperative pain over time compared with normal saline.

Table 4 and Figure 3 summarize the distribution of blood glucose levels among study participants in the dexamethasone and normal saline groups across multiple perioperative time points (N = 70). At baseline, the mean (SD) blood glucose was 102.23 (8.93) mg/dL in the dexamethasone group and 102.43 (8.62) mg/dL in the normal saline group, with no statistically significant difference between groups ($p = 0.92$).

Time Points of Measurement	(Dexamethasone) Group A, Mean (SD) (n=35)	(Normal Saline) Group B, Mean (SD) (n=35)	p-value
Baseline	102.23 (8.93)	102.43 (8.62)	0.92
Before Incision	104.54 (6.75)	104.31 (6.69)	0.89
Before Shifting to PACU	118.74 (11.13)	116.63 (10.61)	0.42

TABLE 4: Distribution of blood glucose values of the study participants between the intervention and control groups over the period of time (N=70)

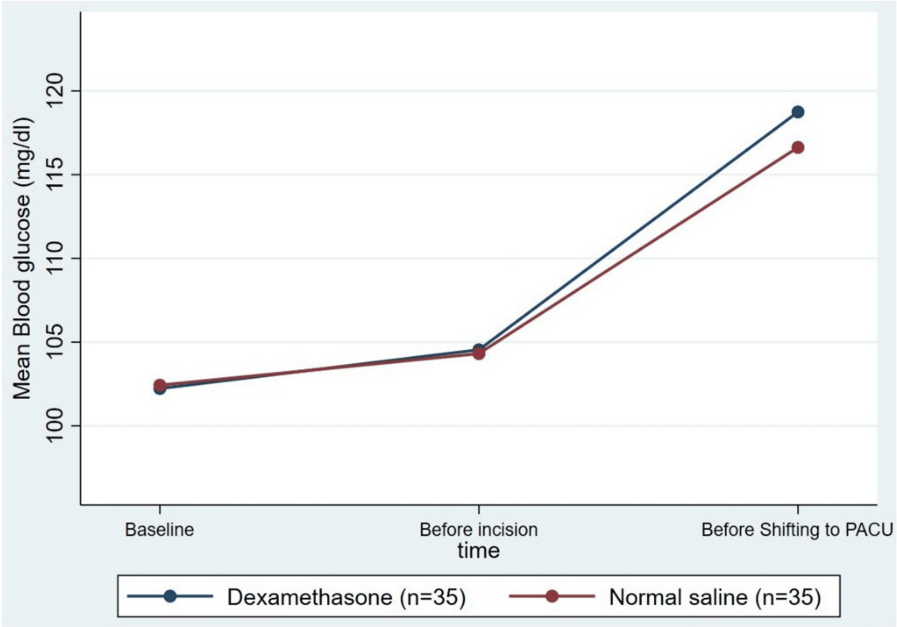


FIGURE 3: Trendline analysis of random blood glucose measured at various time points between the Group A (Dexamethasone, n=35) and Group B (Normal saline, n=35)

Prior to surgical incision, mean (SD) values were 104.54 (6.75) mg/dL for the dexamethasone group and 104.31 (6.69) mg/dL for the normal saline group ($p = 0.89$). Before transfer to the post-anaesthesia care unit (PACU), mean (SD) glucose levels increased to 118.74 (11.13) mg/dL and 116.63 (10.61) mg/dL in the dexamethasone and normal saline groups, respectively ($p = 0.42$).

Across all measured time points, blood glucose levels remained comparable between the two groups, with no statistically significant intergroup differences observed. Two-way repeated-measures ANOVA with Greenhouse-Geisser correction demonstrated no significant effect of group over time on blood glucose levels ($p = 0.537$), indicating that dexamethasone administration did not significantly influence perioperative glycaemic profiles compared with normal saline.

Discussion

The results of the present study indicate that preoperative systemic administration of dexamethasone provides a significant improvement in postoperative analgesia among patients undergoing percutaneous nephrolithotomy.

The socio-demographic characteristics of patients in the Dexamethasone group (mean age: 40.2 years; 77.14% male, N=27) and the Normal Saline group (mean age: 39.54 years; 77.14% male, N=27) were comparable, with no statistically significant differences ($p = 0.845$ for age and $p = 1.000$ for gender). These findings indicate adequate baseline comparability between the groups and are consistent with the observations of Pandey et al. (2018) [12], who evaluated the efficacy of preoperative dexamethasone in preventing postoperative nausea and vomiting following laparoscopic cholecystectomy in an Indian cohort.

A key finding was the significantly lower requirement for rescue analgesia (intravenous paracetamol) in the Dexamethasone group compared with the Normal Saline group at all postoperative time points: 6 hours (51.43% vs. 82.86%), 12 hours (22.86% vs. 57.14%), 24 hours (2.86% vs. 31.43%), and 48 hours (0% vs. 40%). These findings are consistent with Sanders et al. (2023) [13], who reported that a single dose of dexamethasone significantly reduces postoperative pain and analgesic consumption.

Furthermore, the requirement of rescue analgesia was significantly less in patients in the Dexamethasone group at 12 hours postoperatively (22.86%) compared with those in the Normal Saline group (57.14%). This observation is consistent with the findings of Areeruk et al. (2016) [14], who demonstrated reduced postoperative morphine requirements in patients administered dexamethasone after gynaecological laparotomy.

Postoperative pain intensity, assessed using the Visual Analog Scale (VAS), was consistently lower in the Dexamethasone group across multiple time points.

Immediately postoperatively (0 hours), the mean VAS score remained lower in the Dexamethasone group [1.29 (SD = 0.46)] compared with the Normal Saline group [1.49 (SD = 0.51)], corroborating the findings of Szucs et al. (2016) [15], who reported minimal early postoperative pain among patients administered dexamethasone. At 6 hours postoperatively, pain scores increased in both groups; however, they remained lower in the Dexamethasone group [4.69 (SD = 1.18)] than in the Normal Saline group [5.54 (SD = 0.85)]. This contrasts with Areeruk et al. (2016) [14], who observed significantly lower pain scores at this interval, possibly reflecting differences in surgical procedures and perioperative analgesic protocols.

At 12 hours postoperatively, the mean VAS score was 3.77 (SD = 0.88) in the Dexamethasone group compared with 4.54 (SD = 0.56) in the Normal Saline group, findings consistent with those reported by Waldron et al. (2013) [16], who demonstrated significant pain reduction at 12 hours with dexamethasone use. Similarly, at 24 hours, VAS scores in the Dexamethasone group [2.83 (SD = 0.57)] remained significantly lower than in the Normal Saline group [4.31 (SD = 0.47)], in agreement with Bisgaard et al. (2003) [17], who reported reduced postoperative pain at 24 hours following dexamethasone administration. By 48 hours, pain scores further decreased to 1.09 (SD = 0.28) in the Dexamethasone group, compared with 3.37 (SD = 1.06) in the Normal Saline group, consistent with Lim et al. (2011) [18], who observed significantly lower pain scores at 48 hours in patients undergoing laparoscopic cholecystectomy.

With respect to glycaemic control, a predefined threshold for hyperglycaemia was considered to be a blood glucose level greater than 125 mg/dL while fasting and greater than 180 mg/dL 2 hours postprandial [19].

Mean blood glucose levels measured at baseline, before surgical incision, and prior to transfer to the post-anaesthesia care unit (PACU) did not differ significantly between the two groups. These findings are in concordance with Wasfie et al. (2018) [20], who reported no significant differences in baseline glucose levels between dexamethasone and control groups in diabetic patients. Likewise, Joshi et al. (2023) [21] documented comparable pre-incision blood glucose values while evaluating perioperative hyperglycaemic responses to dexamethasone.

Although an increase in blood glucose levels was observed in both groups before transfer to the PACU, this finding contrasts with Peter et al. (2022) [11], who reported significantly higher postoperative glucose levels in non-diabetic patients receiving dexamethasone. Such discrepancies may be attributable to variations in dexamethasone dosage, surgical settings, and patient demographics. Importantly, two-way repeated-measures ANOVA revealed no significant difference in blood glucose levels between the Dexamethasone and Normal Saline groups over time ($p = 0.537$); this supports the safety of dexamethasone for perioperative use without a substantial risk of hyperglycaemia.

A key limitation of this study is the reliance on the Visual Analog Scale (VAS) to guide rescue analgesia, as its subjective nature introduces inter-individual variability and potential assessment bias, potentially affecting both pain reporting and timing of analgesic administration. The analgesic regimen followed the institutional reverse analgesic ladder protocol rather than contemporary ERAS pathways; however, identical analgesia in both groups preserved internal validity.

Additionally, the small sample size and short postoperative follow-up limit the generalizability of the findings. Larger, multicentre studies with longer follow-up are required to better assess the long-term efficacy and safety of the intervention.

Conclusions

In conclusion, a single preoperative intravenous dose of dexamethasone in non-diabetic ASA I-II patients undergoing percutaneous nephrolithotomy (PCNL) significantly attenuates postoperative pain, as demonstrated by lower pain scores and reduced rescue analgesic requirements, while providing an opioid-sparing analgesic effect without significantly affecting perioperative glycaemic levels. The reduction in opioid requirements may potentially minimise opioid-related adverse effects and contribute to enhanced postoperative recovery and patient satisfaction.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Critical review of the manuscript for important intellectual content: Monu Yadav, Shibani Padhy, Akhya Kumar Kar, Prasad Rao, Padmaja Durga, Sudheer K Kumar

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. NIMS Institutional Ethics Committee issued approval EC/NIMS/3254/2023 70th, ESGS No. 1550/2023. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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