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Original Research Article

INTRAVENOUS DICLOFENAC, KETOROLAC OR TRAMADOL FOR ACUTE RENAL COLIC: A RANDOMISED STUDY

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ABSTRACT

Background: Acute renal colic is among the most severe pain presentations to the emergency department (ED). Although non-steroidal anti-inflammatory drugs (NSAIDs) are recommended as first-line analgesia, head-to-head comparisons of intravenous agents are limited. **Objectives:** To compare the analgesic efficacy and safety of intravenous diclofenac, ketorolac and tramadol in acute renal and ureteric colic.

Material and Methods: In this single-center, prospective, double-blind study, 135 adults (18–60 years) with acute renal or ureteric colic and a Visual Analogue Scale (VAS) score ≥4 were randomized equally to intravenous diclofenac 75 mg, ketorolac 30 mg or tramadol 100 mg, all diluted identically in 100 mL saline. VAS was recorded at baseline and at 10, 30, 60 and 90 minutes; secondary outcomes included time to ≥50% pain reduction, rescue analgesia, adverse effects and revisit/admission. Analysis: Kruskal–Wallis, Mann–Whitney U, chi-square and ANOVA tests.

Results: Baseline characteristics were comparable. VAS scores differed significantly among the groups at 30, 60 and 90 minutes ($P<0.001$, $P<0.001$ and $P=0.010$), with both NSAIDs outperforming tramadol. At 90 minutes, mean VAS scores were 0.51±0.89 (ketorolac), 0.87±1.78 (diclofenac) and 1.42±1.66 (tramadol). More ketorolac (68.9%) and diclofenac (64.4%) patients achieved ≥50% pain reduction by 30 minutes than tramadol patients (20.0%) ($P<0.001$). Nausea/vomiting was most frequent with tramadol (46.7% vs 17.8% vs 6.7%; $P<0.001$); rescue analgesia was required by 22.2%, 11.1% and 4.4%, respectively ($P=0.037$). Revisit and admission rates did not differ significantly ($P=0.259$).

Conclusions: Intravenous diclofenac and ketorolac provided faster and better-tolerated analgesia than tramadol in acute renal colic, with less rescue analgesia.

Keywords: Renal colic; ketorolac; diclofenac; tramadol; analgesia.

INTRODUCTION

Few presentations in emergency practice are as painful as acute renal colic, and few demand such prompt diagnosis and effective analgesia. The usual culprit is a calculus causing acute partial or complete ureteric obstruction; the resulting rise in intraluminal pressure, ureteral smooth-muscle spasm and prostaglandin-mediated local inflammation generate the characteristic severe flank pain radiating to the groin.[1] Roughly one in ten people develop urolithiasis, with marked geographic variation linked to diet, climate and comorbidities such as obesity, diabetes and hypertension.[1,2] Although the global age-standardised incidence of urolithiasis declined modestly between 1990 and 2019, the absolute number of cases and the associated disability burden have risen with population growth and ageing; India,

China and the Russian Federation together account for almost half of global incident cases.[2]

In busy emergency departments, the choice of initial analgesic has consequences that extend beyond pain scores: it influences the need for additional medication, the incidence of adverse effects, the duration of ED stays and the likelihood of unscheduled return visits. Stone disease also tends to recur, so many patients with renal colic are repeat visitors to the ED, and the cumulative effect of suboptimal initial analgesia is considerable. [1,2] An agent that controls pain rapidly and cleanly therefore benefits both the patient and the emergency department as a whole.

The first priority in managing acute renal colic is rapid, sustained pain relief. Urological association guidelines recommend NSAIDs as first-line agents, because cyclooxygenase inhibition reduces prostaglandin synthesis and thereby targets the underlying mechanisms of ureteric obstruction — intraluminal hypertension, spasm and inflammation — in addition to relieving pain.[3,4] Opioids, including tramadol, are generally reserved for patients in whom NSAIDs are contraindicated or ineffective.[3,4] A Cochrane review and subsequent meta-analyses have shown that NSAIDs provide analgesia at least equivalent to opioids at 30 minutes, with less vomiting and a reduced need for rescue analgesia.[5-7]

The intravenous route is preferred in the ED because it provides rapid and predictable plasma concentrations in patients who are frequently vomiting or unable to tolerate oral medication. Diclofenac and ketorolac are the two parenteral NSAIDs most widely stocked in Indian emergency departments; both are inexpensive, familiar to clinicians and recommended by urological guidelines, [3,4] yet they differ in potency, dosing schedules and cost. Tramadol, a centrally acting synthetic opioid with additional serotonergic and noradrenergic activity, remains popular as initial analgesia in many centres because it is perceived as safe and non-sedating.[13] How these three agents compare when given by the same route, under blinded conditions and with a standardised assessment schedule, is therefore a question of direct practical value to emergency clinicians.

Despite guideline recommendations, opioids are still frequently the first drug given in emergency practice, and studies comparing intravenous diclofenac, ketorolac and tramadol head-to-head under standardised conditions remain scarce.[6,7] Existing studies vary considerably in design, dosage, route of administration and outcome measurement, which limits firm conclusions about the relative onset of action, duration of relief and safety of these three agents.[6,7] We therefore set out to compare the analgesic efficacy, onset of action, requirement for rescue analgesia and adverse-effect profile of these three intravenous agents in adults presenting to the ED with acute renal and ureteric colic.

MATERIALS AND METHODS

Study design and setting

This was a single-center, prospective, double-blind, randomized comparative study conducted in the emergency department of a tertiary care teaching hospital in Greater Noida, Uttar Pradesh, India, between May 2023 and November 2024. The emergency department serves a mixed urban and rural population and manages a high daily volume of acute pain presentations, including renal and ureteric colic. The study protocol was approved by the Institutional Ethics Committee before enrolment began [SU/SMS&R/76-A/2023/122], and the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Declaration of Helsinki. Written informed consent was obtained from all participants prior to inclusion; signed consent forms were received from every participant and are archived by the authors.

Participants

Patients aged 18–60 years were eligible if they presented with acute-onset renal or ureteric colic of less than 6 hours' duration, had clinical and radiological confirmation of renal or ureteric colic due to urinary stones, and reported moderate-to-severe pain defined as a Visual Analogue Scale (VAS) score of 4 or higher on a 0–10 scale. Patients were excluded if they were younger than 18 or older than 60 years, had a known allergy or previous adverse reaction to NSAIDs or opioids, had a history of gastric ulcer, or had renal failure.

Sample size

Based on prevalence data reported by Liu et al.[8] (prevalence rate P=0.20), with a precision (d) of 0.12 and a 95% confidence level (z=1.96), the minimum required sample size was calculated as 43 patients per group. A total of 135 patients were enrolled, with 45 patients allocated to each group.

Randomization and blinding

Participants were randomly allocated in a 1:1:1 ratio to one of the three study groups using a sequentially numbered, opaque, sealed envelope technique. Envelopes were prepared in advance by a member of the research team who was not involved in patient care or data analysis, were identical in appearance and were opened only after enrolment. Both patients and the healthcare providers assessing outcomes remained blinded to group allocation throughout the study. Drug preparation, drug administration and outcome recording were performed by different healthcare professionals who had no interaction during the study. In the event of an adverse event or a significant clinical change, the allocated treatment was disclosed to the care team to ensure patient safety.

Study protocol

After allocation, each patient received the assigned analgesic intravenously: Group A received diclofenac 75 mg, Group B received ketorolac 30 mg,

and Group C received tramadol 100 mg. All study drugs were diluted to an identical volume of 100 mL normal saline and administered as an intravenous infusion, so that the solutions were indistinguishable in appearance and volume to the treating team and the outcome assessors. As all enrolled patients weighed more than 50 kg, a uniform 30 mg dose of ketorolac was used. If there was little or no reduction in pain after administration of the initial analgesic, rescue analgesia with intravenous fentanyl 50 µg was administered according to patient demand.

Parameters assessed

Pain intensity was measured on a 10-cm VAS at baseline (0 minutes) and at 10, 30, 60 and 90 minutes after drug administration; the change in VAS score over this 90-minute observation period was the primary outcome. Patients marked their pain on a standard 10-cm horizontal line anchored by "no pain" (0) and "worst possible pain" (10), and all assessments were performed at the bedside by personnel blinded to group allocation. Secondary outcomes were the time to achieve a ≥50% reduction in pain intensity from baseline (chosen as a patient-centered marker of meaningful analgesic response), the requirement for rescue analgesia, the incidence of adverse effects, and ED revisit and hospital admission rates. Nausea and vomiting were recorded as present or absent at any point during the observation period. Data on demographics, comorbidities, systemic examination findings and investigations (ultrasonography of the whole abdomen/kidney–ureter–bladder, urine routine microscopy, complete blood counts, renal function tests and abdominal radiography) were systematically collected.

Statistical analysis

Statistical analysis was performed using SPSS version 29.0 (IBM Corp., Armonk, NY, USA) and Microsoft Excel. Continuous variables are summarized as mean ± standard deviation (SD) and range, and categorical variables as counts and percentages. Normality of continuous data was assessed with the Shapiro–Wilk test and graphical methods. Age was compared across groups using one-way analysis of variance (ANOVA). Because normality assumptions were violated for VAS scores, scores across the three groups were compared using the Kruskal–Wallis test at each time point; post hoc pairwise comparisons were performed with the Mann–Whitney U test with Bonferroni correction for multiple comparisons. Categorical variables were compared using the chi-square test. A P value of <0.05 was considered statistically significant.

RESULTS

A total of 135 patients were enrolled and randomly allocated to the three groups (45 each); all patients received their assigned drug, completed the 90-minute assessment period and were included in the analysis (Figure 1). Baseline demographic and clinical characteristics were similar across the groups (Table 1). Mean ages were 33.89±14.53 years (Group A), 35.09±12.73 years (Group B) and 33.36±12.53 years (Group C) (P=0.819), and gender distribution did not differ significantly (P=0.813). Hypertension was the most common comorbidity in all groups, and the distribution of comorbidities did not differ significantly between groups (P=0.669).

Mean VAS scores were comparable at baseline (P=0.512) (Table 2, Figure 2). From 10 minutes onwards, the groups began to separate significantly. At 10 minutes, mean VAS scores were 5.64±1.17 (Group A), 5.69±1.10 (Group B) and 6.40±1.47 (Group C) (P=0.003). The separation widened at 30 minutes (3.42±1.34, 3.33±1.15 and 4.71±1.71, respectively; P<0.001) and at 60 minutes (1.56±1.53, 1.60±1.44 and 3.04±1.87; P<0.001). At 90 minutes, Group B had the lowest mean VAS score (0.51±0.89), followed by Group A (0.87±1.78) and Group C (1.42±1.66) (P=0.010).

Pairwise comparisons with Bonferroni correction showed that both diclofenac (Group A) and ketorolac (Group B) produced significantly lower VAS scores than tramadol (Group C) at 10, 30 and 60 minutes (adjusted P<0.05 for all comparisons), whereas no significant difference was observed between the two NSAID groups at any time point (Table 2). At 90 minutes, ketorolac remained significantly superior to tramadol (adjusted P=0.017), while the difference between diclofenac and tramadol did not reach statistical significance (adjusted P=0.062).

The time to achieve ≥50% pain reduction differed significantly among the groups (P=0.000078) (Table 3). Most patients receiving ketorolac (31/45, 68.9%) or diclofenac (29/45, 64.4%) achieved ≥50% pain reduction within 30 minutes, whereas most tramadol-treated patients required 60 minutes or longer.

Adverse effects and follow-up outcomes are summarized in Table 4 and Figure 3. Nausea and vomiting were significantly more frequent with tramadol (21/45, 46.7%) than with diclofenac (8/45, 17.8%) or ketorolac (3/45, 6.7%) (P=0.000025). Rescue analgesia was required by ten patients (22.2%) in the tramadol group, five (11.1%) in the diclofenac group and two (4.4%) in the ketorolac group (P=0.037). ED revisit and admission rates were numerically highest with tramadol (11.1% and 8.9%, respectively) and lowest with ketorolac (2.2% each), but these differences did not reach statistical significance (P=0.259); 95.6% of ketorolac-treated patients required neither revisit nor admission.

Table 1: Baseline demographic and clinical characteristics of the study groups

Characteristic	Group A: Diclofenac 75 mg IV (n=45)	Group B: Ketorolac 30 mg IV (n=45)	Group C: Tramadol 100 mg IV (n=45)	*P* value
Age (years), mean ± SD (range)	33.89±14.53 (19–60)	35.09±12.73 (18–60)	33.36±12.53 (18–60)	0.819[a]
Male, n (%)	20 (44.4)	23 (51.1)	22 (48.9)	0.813[b]
Female, n (%)	25 (55.6)	22 (48.9)	23 (51.1)	–
Hypertension, n (%)	7 (15.6)	12 (26.7)	8 (17.8)	0.669[b]
Type 2 diabetes mellitus, n (%)	9 (20.0)	6 (13.3)	8 (17.8)	0.669[b]
Recurrent urinary tract infection, n (%)	2 (4.4)	4 (8.9)	3 (6.7)	0.669[b]

SD: standard deviation; IV: intravenous. [a]One-way ANOVA; [b]chi-square test (overall comorbidity distribution; categories not mutually exclusive).

Table 2: Visual Analogue Scale (VAS) scores over time by study group

Time point	Group A (Diclofenac), mean ± SD	Group B (Ketorolac), mean ± SD	Group C (Tramadol), mean ± SD	*P* value (overall)[a]
Baseline (0 min)[b]	7.04±1.07	7.29±0.94	7.13±1.10	0.512
10 min[b]	5.64±1.17	5.69±1.10	6.40±1.47	0.003
30 min[b]	3.42±1.34	3.33±1.15	4.71±1.71	<0.001
60 min[b]	1.56±1.53	1.60±1.44	3.04±1.87	<0.001
90 min[b]	0.87±1.78	0.51±0.89	1.42±1.66	0.010

VAS: Visual Analogue Scale (0–10); SD: standard deviation. [a]Kruskal–Wallis test. [b]Pairwise post hoc comparisons (Mann–Whitney U test with Bonferroni correction; values given as A vs C, A vs B, B vs C; Group A: diclofenac, Group B: ketorolac, Group C: tramadol): baseline P=1.000, 0.711, 1.000; 10 min P=0.007, 1.000, 0.012; 30 min P<0.001, 1.000, <0.001; 60 min P<0.001, 1.000, <0.001; 90 min P=0.062, 1.000, 0.017.

Table 3: Time to achieve ≥50% reduction in pain intensity, n (%)

Time to ≥50% pain reduction	Group A: Diclofenac (n=45)	Group B: Ketorolac (n=45)	Group C: Tramadol (n=45)
10 min	0 (0.0)	2 (4.4)	1 (2.2)
30 min	29 (64.4)	31 (68.9)	9 (20.0)
60 min	13 (28.9)	9 (20.0)	22 (48.9)
90 min	3 (6.7)	3 (6.7)	11 (24.4)
>90 min	0 (0.0)	0 (0.0)	2 (4.4)

Chi-square test for distribution across groups: *P*=0.000078.

Table 4: Adverse effects, rescue analgesia and follow-up outcomes, n (%)

Outcome	Group A: Diclofenac (n=45)	Group B: Ketorolac (n=45)	Group C: Tramadol (n=45)	*P* value[a]
Nausea/vomiting	8 (17.8)	3 (6.7)	21 (46.7)	0.000025
Rescue analgesia required	5 (11.1)	2 (4.4)	10 (22.2)	0.037
ED revisit	3 (6.7)	1 (2.2)	5 (11.1)	0.259
Hospital admission	2 (4.4)	1 (2.2)	4 (8.9)	0.259
Neither revisit nor admission	40 (88.9)	43 (95.6)	36 (80.0)	0.259

ED: emergency department. [a]Chi-square test; revisit/admission analyzed as a single three-category outcome (revisit / admission / neither).

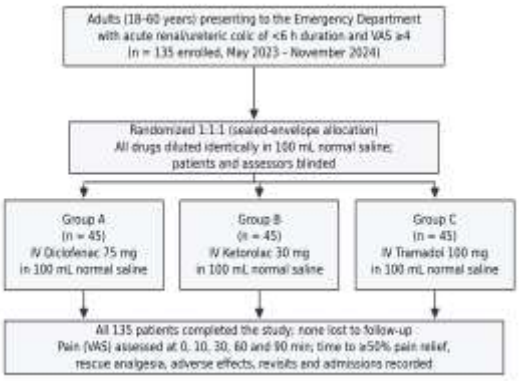


Figure 1: Study flow diagram showing patient enrolment, random allocation to the three study groups, and assessment schedule

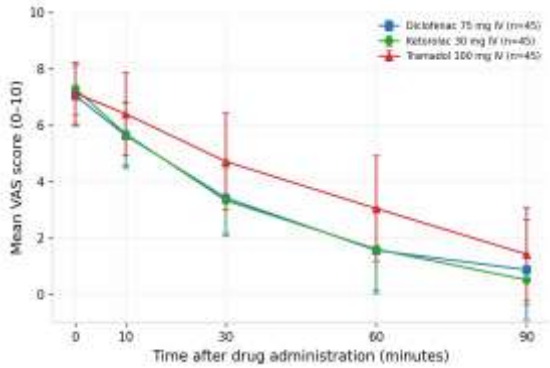


Figure 2: Mean Visual Analogue Scale (VAS) scores over time in the three study groups. Error bars represent standard deviations. VAS was recorded at baseline and at 10, 30, 60 and 90 minutes after intravenous drug administration.

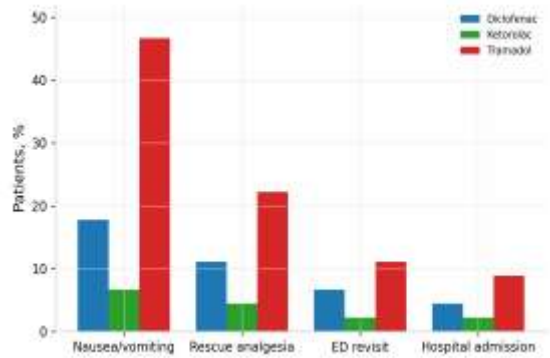


Figure 3: Adverse events and follow-up outcomes by study group: incidence of nausea/vomiting, requirement for rescue analgesia, emergency department revisit and hospital admission (percentage of patients in each group).

DISCUSSION

In this double-blind comparison of 135 adults with acute renal and ureteric colic, intravenous diclofenac and ketorolac both relieved pain faster and more completely than intravenous tramadol over the first 90 minutes after administration. The two NSAIDs were statistically indistinguishable from each other at every time point, although ketorolac achieved the lowest absolute VAS score at 90 minutes and was the only agent that remained significantly superior to tramadol at that time point. The NSAIDs were also better tolerated: nausea and vomiting occurred in almost half of the tramadol-treated patients, and the requirement for rescue analgesia was significantly highest in the tramadol group and lowest in the ketorolac group.

These results sit comfortably within the wider literature. A systematic review and meta-analysis of 36 randomized studies found NSAIDs to be at least equivalent to opioids for initial pain reduction at 30 minutes, with less vomiting (number needed to treat 5) and fewer requirements for rescue analgesia (number needed to treat 11).[6] A Cochrane review similarly concluded that NSAIDs are superior to placebo and antispasmodics for pain control in renal colic,5 and a more recent meta-analysis of 18 studies confirmed that patients treated with NSAIDs experience fewer side effects even where analgesic efficacy is comparable.[7] In a randomized comparison of intramuscular diclofenac and tramadol, Salameh et al. reported a >50% pain reduction within 30 minutes in 64% of diclofenac-treated patients versus 49% with tramadol, broadly mirroring the proportions achieving ≥50% reduction by 30 minutes in the present study (64.4% and 20.0%, respectively), and likewise found a higher rescue-analgesia requirement with tramadol (51% vs 21%).[9] An earlier systematic review by Holdgate and Pollock demonstrated greater pain-score reductions and less need for rescue medication with NSAIDs than with opioids.[10]

Head-to-head trials of the individual agents support these findings. Cohen et al., in a double-blind comparison of intramuscular ketorolac 30 mg and diclofenac 75 mg in 57 patients with renal colic, found the two NSAIDs equally effective in terms of pain relief, requirement for rescue medication and adverse effects,[15] consistent with the absence of any significant difference between our two NSAID groups at any time point. Larkin et al. reported that intramuscular ketorolac provided significantly greater pain relief than the opioid meperidine at 40, 60 and 90 minutes after administration,[16] a time-course that closely parallels the widening separation between ketorolac and tramadol observed in the present study. The combination of an NSAID with an opioid has also been shown to outperform either agent alone, [11,12] which raises the question of whether combination therapy might further improve outcomes; however, our data suggest that an intravenous NSAID alone provides adequate analgesia for most patients, since more than 95% of ketorolac-treated patients required neither ED revisit nor hospital admission.

The efficacy gradient we observed is pharmacologically plausible. Ureteric obstruction stimulates prostaglandin E2 release, which increases renal blood flow, intrapelvic pressure and ureteral contractility and thereby perpetuates pain; NSAIDs

interrupt this cycle by inhibiting cyclooxygenase, reducing ureteral pressure, spasm and inflammation.[5,10] Both diclofenac and ketorolac are potent non-selective cyclooxygenase inhibitors with rapid onset after parenteral administration, and parenteral ketorolac has previously shown analgesic efficacy comparable to, or synergistic with, opioids in renal colic.[11,12] Tramadol, by contrast, is a weak μ-opioid receptor agonist whose analgesia depends partly on its active O-desmethyl metabolite and on serotonin and noradrenaline reuptake inhibition; this dual mechanism does not address prostaglandin-mediated inflammation, and its serotonergic activity is consistent with the high incidence of nausea and vomiting observed in the tramadol group.[13] The mean between-group differences in VAS scores at 30 and 60 minutes (approximately 1.3–1.5 points) also approach or exceed the threshold generally accepted as a clinically important change in acute pain,[14] suggesting that the differences are clinically as well as statistically meaningful.

The rapid onset of both NSAIDs was notable: separation from tramadol was evident by 10 minutes and maximal by 30–60 minutes. This is consistent with the pharmacology of parenteral non-selective cyclooxygenase inhibitors and with previous reports of significant pain relief within 30–60 minutes of parenteral ketorolac or diclofenac. [9,15] For the emergency clinician, this means that the response to an intravenous NSAID can be judged within about 30 minutes, allowing early escalation to rescue analgesia or alternative strategies where necessary.

The nausea and vomiting burden with tramadol (46.7% of patients) warrants particular emphasis. In the ED setting, emesis is not merely a tolerability issue: it delays disposition, may require additional antiemetic treatment and can compound the dehydration frequently present in patients with renal colic. Although NSAIDs carry recognized risks — gastric irritation, renal impairment and bleeding — these are largely confined to prolonged use or to patients with pre-existing disease, whom we excluded; short-course parenteral NSAID use in otherwise healthy adults with renal colic has an established safety record.[5,6] Revisit and admission rates followed the same direction — numerically lowest with ketorolac (2.2% each) and highest with tramadol (11.1% and 8.9%) — but did not reach statistical significance (P=0.259). This may reflect a genuine but small effect that our sample size could not detect, or simply chance variation; we therefore regard it as hypothesis-generating rather than as evidence that first-dose NSAID analgesia reduces downstream resource use. It is also worth noting that opioid-sparing analgesia has value beyond tolerability: tramadol's serotonergic and opioid activity carries recognized risks of sedation, dizziness, serotonin syndrome with interacting medicines and dependence with repeated use,[13] all of which argue for reserving it for patients with genuine NSAID contraindications.

These findings have practical implications for emergency practice. An intravenous NSAID should be the default first-line analgesic for adults with acute renal colic who have no contraindication, with tramadol reserved for patients in whom NSAIDs are unsuitable or ineffective. The uniform 30 mg intravenous ketorolac dose used in this study was effective across the adult weight range represented (all patients weighed more than 50 kg), which simplifies stocking and dosing protocols. Where NSAID analgesia proves insufficient, combination with an opioid remains a reasonable next step supported by previous work, [11,12] but our data indicate that most patients will not require it.

That tramadol nevertheless performed worst on nearly every measure — onset, magnitude of pain relief, tolerability and rescue-analgesia requirement — highlights a persistent gap between guideline recommendations and everyday practice.[3,4] Its continued popularity as first-line analgesia probably reflects familiarity, a perceived safety advantage over NSAIDs in patients with renal or gastric risk factors, and its dual mechanism being marketed as "balanced" analgesia.[13] Our findings suggest that, in patients without contraindications, this rationale does not translate into better outcomes, and that protocol-level changes favoring intravenous NSAIDs as the default first-line agent could improve both pain control and ED throughput.

Future research should build on these findings in several directions. Multi-center studies with larger samples would provide adequate power to clarify whether the numerical differences in revisit and admission rates are real. Longer follow-up would capture pain recurrence after discharge, delayed adverse effects and patient-reported satisfaction. Direct comparison of intravenous NSAIDs with newer agents and routes — and of NSAID–opioid combinations against NSAID monotherapy — would help refine escalation strategies for the minority of patients with inadequate response, and a formal cost-effectiveness analysis would be valuable in resource-limited settings where all three of these inexpensive drugs compete for formulary space.

Limitations

- The study was conducted at a single center with a modest sample size, which may limit the generalizability of the findings and the power to detect differences in infrequent outcomes such as revisits and admissions.
- Follow-up was restricted to 90 minutes; longer-term outcomes such as pain recurrence after discharge and delayed adverse effects were not captured.
- The sample size was estimated from prevalence data rather than from an expected treatment-effect size.
- Patients with renal impairment, gastric ulcer disease and those older than 60 years were excluded, so the findings cannot be extrapolated to these clinically important subgroups.

- Pain was assessed with a subjective self-reported scale, although the double-blind design and standardized assessment schedule mitigate this limitation.
- A uniform 30 mg ketorolac dose was used because all enrolled patients weighed more than 50 kg; the findings may not directly apply to lower-weight patients, in whom weight-adjusted dosing would be considered.

CONCLUSION

Within the limitations of a single-center study with short follow-up, intravenous diclofenac and ketorolac provided faster, more sustained and better-tolerated analgesia than intravenous tramadol in patients with acute renal and ureteric colic, with a significantly lower requirement for rescue analgesia. Revisit and admission rates, while numerically lower with the NSAIDs, did not differ significantly between groups. Ketorolac offered a modest additional advantage in late pain scores and tolerability, with diclofenac performing comparably. Tramadol's slower onset, high rate of nausea and vomiting and greater reliance on rescue analgesia make it a poor choice for initial analgesia in this setting. These findings are in keeping with current guideline recommendations favoring NSAIDs as first-line analgesia for renal colic. On the balance of efficacy, speed of onset and tolerability, intravenous ketorolac emerged as the preferred agent in this study.

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Author Contributions

S.M. conceived and designed the study, collected and analyzed the data and drafted the manuscript. S.L. contributed substantially to patient recruitment, clinical supervision of data collection in the emergency department, interpretation of the data and critical revision of the manuscript for important intellectual content. S.D. supervised the study, contributed to the conception and design and critically revised the manuscript. J.S. contributed to data acquisition, patient follow-up assessments and drafting of the manuscript. All authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethics Approval and Consent

The study was approved by the Institutional Ethics Committee of the participating institution prior to enrolment [SU/SMS&R/76-A/2023/122 dated 03/05/2023] and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants, and evidence of ethics committee approval will be supplied on demand.

Data Availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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