e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.6.55

International Journal of Pharmaceutical Quality Assurance 2025; 16(6); 321-326

Original Research Article

A Comparative Study on the Analgesic Efficacy and Hemodynamic Impact of Intravenous Paracetamol Versus Diclofenac in Postoperative Pain Management

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Received: 08-04-2025 / Revised: 15-05-2025 / Accepted: 21-06-2025

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Conflict of interest: Nil

Abstract:

Background: Facilitating early postoperative recovery as well as avoiding complications requires appropriate pain management. Opioids provide high quality analgesia, but their systemic use is limited because of side effects as well as sedation. Non-opioid analgesic agents such as NSAIDs and paracetamol can provide quality analgesia with good safety and no sedation. Diclofenac is a common NSAID that has possible GI and CV risks. Racecadotril and IV paracetamol are safer with better hemodynamic profiles than diclofenac.

Objective: To compare analgesic efficacy and hemodynamic effects of IV paracetamol and IV diclofenac in elective surgery with general anesthesia.

Methods: 96 ASA I–II adult patients 18–60 years old were enrolled in a prospective, randomized, double-blinded study. Group A 15 mg/kg IV paracetamol, Group B 1 mg/kg IV diclofenac. All patients received the study medication over 15 min once surgery was complete and any anesthetic side effects randomized into group were resolved. Pain was assessed using the Visual Analogue Scale (VAS) for 0-6 h. Patient were monitored for hemodynamic parameters and adverse effects. Data was analyzed with t-test and Chi-square tests. A significance level of $p < 0.05$ was used.

Results: VAS scores increased approximately linearly and peaked for both groups around six hours, with similar intergroup scores ($p > 0.05$). All hemodynamic parameters (including heart rate and blood pressure) were stable and similar between groups. All adverse events were relatively infrequent and statistically nonsignificant.

Conclusion: Both IV paracetamol and IV diclofenac are safe and effective for postoperative pain management, providing comparable analgesia and hemodynamic stability. Selection may depend on individual patient factors or clinician preference.

Keywords: Postoperative Pain, IV Paracetamol, Diclofenac, Hemodynamic Stability, Analgesia.

Introduction

Pain control following surgery is an important aspect of the patient's postoperative experience. Inadequate pain control can lead to a host of possible physiological and psychological outcomes in the postoperative period. In order to avoid delayed recovery, prolonged length of stay (LOS) and discharged delays, it is imperative to implement the use of analgesics that are non-sedating during postoperative management of pain. Adequate pain control will help deliver a successful patient outcome while also improving the organization's overall productivity. Inadequate postoperative pain relief can negatively affect respiratory function, it puts a strain on the heart, it can impede mobilization, and it increases patient risk for developing chronic pain syndromes. Poor pain control contributes to an exaggerated stress response that will impair wound healing and negative impact the general course of postoperative recovery [1].

For decades, opioids have been the most common method of providing analgesia and are the most effective analgesic. However, opioids have many disadvantages, the most problematic of which are their sedating effects which can depress the respiratory rate and decrease patient mobility and therefore recovery [2]. Opioids also have a number of negative side effects, which can include nausea, vomiting, pruritis, constipation, urinary retention to name just a few, along with the risk of developing a dependency. These issues make their continued use problematic, especially for patients with co-morbidities

or those getting outpatient procedures. This leads to interest in alternative analgesics which provide reasonable pain relief and, when compared to opioids, provide less sedation.

Nonsteroidal anti-inflammatory drugs (NSAIDs) are a useful class of analgesics to consider during the perioperative period. Generally speaking, their mechanism of action, inhibition of cyclo-oxygenase (COX) enzymes, acts by inhibiting the formation of protaglandins that reduce inflammation and modifies the perception of pain. Their benefits without sedative effects and established opioid-sparing effect make them good agents to use in multimodal analgesia plans [3]. However, the same benefits have limitations in terms of side effects, which can include gastrointestinal irritation, vomiting, nausea, and localized phlebitis at the site of injection. Also, NSAIDs are generally contraindicated in drug hypersensitivity, allergic asthma, renal impairment, or acid-peptic disease. These limitations also require careful selection from the overall patient population and close monitoring for hospitalized patients receiving NSAIDs in the immediate postoperative period.

Diclofenac is one of the most commonly used nonsteroidal anti-inflammatory agents (NSAIDs) for postoperative pain relief. Diclofenac is available in several forms including intramuscular oily injections or aqueous preparations for IV use after appropriate dilution. While diclofenac is a very well used and accepted NSAID, there are potential side effects. Patient side effects include GI upset, renal insufficiency, hypersensitivity reactions, or localized reactions such as pain and phlebitis at the injection site [4]. There has also been some concern about its hemodynamic safety profile, primarily regarding its hemodynamic stability during the immediate postoperative period. No doubt diclofenac continues to be well accepted as an option for postoperative pain relief due to its mechanism of action and it's good safety profile. On the other hand, paracetamol acts mainly through central mechanisms primarily by cyclo-oxygenase inhibition with little, if any, anti-inflammatory action in the peripheral tissues [5]. Recently, there has been more acceptance of intravenous paracetamol because of its rapid onset of action, predictable kinetics, and simplicity of administration as an intravenous infusion. Intravenous paracetamol has a terrific analgesic efficacy with none of the gastrointestinal and renal side effects that are common with NSAIDs. In addition, paracetamol does not have the sedative effect that are commonly associated with opioids, making it especially useful during outpatient surgery and for scenarios where early mobilization for the patient is a priority.

IV paracetamol also has other advantages beyond analgesia. IV paracetamol has an optimal hemodynamic profile and no deleterious effects on blood pressure or heart rate. This is favourable for the surgical patient at risk of cardiovascular instability. IV paracetamol also has NSAID-like qualities of an opioid-sparing effect whereby side effects of opioids are mitigated in the presence of analgesia [6]. These qualities make paracetamol a less risky alternative than diclofenac among patients at high risk or those with co-morbid cardiovascular disease.

Given the above arguments, emphasis has been placed lately upon comparing intravenous paracetamol versus diclofenac in patients with postoperative pain. While healthcare providers have discussed each agent previously in isolation, few studies make direct comparisons of their relative efficacy especially with respect to postoperative hemodynamic stability after surgery, even though hemodynamic variables, especially blood pressure and heart rate, are important markers of the physiological responses to surgery, anesthesia, and the patient's overall degree of post-operative recovery. The comparison of the relative activities between agents on the hemodynamic variable are invaluable to optimizing postoperative management especially in high-risk surgery or known cardiovascular disease states postoperatively. This study will attempt to fill this void, by performing a comparative study on intravenous paracetamol versus intravenous diclofenac on analgesic effectiveness and hemodynamic effects in postoperative subjects. By undertaking a systematic evaluation of pain relief and identifying trends in hemodynamic monitoring phase, this study hopes to provide evidence-based recommendations to healthcare providers in their selections for what analgesic is best for managing postoperative pain. The results of this study will not only further the existing literature in multimodal analgesia, it may also assist in developing safer, effective, and patient-centered strategies for individuals who require postoperative pain management.

Methodology

Study Design: This study was designed as a randomized, controlled, double-blind, prospective clinical trial comparing the analgesic efficacy and hemodynamic effects of intravenous paracetamol versus diclofenac for postoperative pain management.

Study Area: The study was conducted in the Department of Anesthesiology, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India.

Study Duration: The study was carried out over a period of one year.

Study Population: Adult patients were eligible for enrollment if they were undergoing elective surgery with general anesthesia that was estimated to last less than 2 hours. Eligible patients were patients ASA physical status I or II, between the ages of 18-60, whose weight was between 60-70 kg regardless of male or female.

Sample Size: The study included a total of 96 patients, enough for our study to adequately power to see a significant difference in postoperative analgesic efficacy and hemodynamic effects of each drug. We randomly allocated patients into two groups of equal numbers (48) using a computer-generated randomization table. Patients in group A received an intravenous paracetamol, while patients in group B received diclofenac intravenously. Using randomization ensured that group A and group B were comparable for demographic variables and baseline characteristics, reducing selection bias.

Inclusion Criteria

- Age between 18 and 60 years.
- Weight within 60–70 kg.
- ASA physical status I or II.
- Undergoing elective surgery under general anesthesia lasting less than two hours.
- Provided written informed consent to participate.

Exclusion Criteria

- Severe preexisting hepatic or renal dysfunction.
- Allergy or hypersensitivity to paracetamol or diclofenac.
- ASA physical status ≥ III.
- Surgeries last more than two hours.
- Pregnant or lactating women.
- Patients on chronic analgesic therapy or with a history of chronic pain disorders.

Data Collection: Data collection began upon enrollment of eligible patients who met inclusion criteria and gave informed consent. Basic demographic data such as age, sex, weight, and information regarding the type of surgery and length of surgery were gathered in the pre-operative period. Post-operatively, an assessment of pain intensity was determined using a Visual Analogue Scale (VAS) score as the primary outcome measure at 0 hour (immediately after surgery), and 30 min, 1 hour, 2 hours, 4 hours, 6 hours, 8 hours, and 12 hours. The hemodynamic parameters of heart rate, systolic and diastolic BP and mean arterial pressure were also documented at the same intervals, respectively. Any adverse effects, including nausea, vomiting, allergic reaction, tendencies towards hypotension, etc. were assessed and documented as needed through the post-operative period as well. Additionally, the need for rescue analgesia was recorded if a participant reported a VAS score of = 4. All data was collected and documented on standardized case record forms and ultimately entered into a secure database for analysis.

Procedure: This research was conducted in a predescribed, standardized order to promote consistency and reliability. All patients completed a thorough pre-anesthetic evaluation which consisted of extensive medical history, physical examination and relevant investigations. All patients were kept nil per oral, and their preoperative preparation was performed according to the ASA Preoperative Assessment, Parameters and Guidelines. During the intraoperative period, standard ASA monitors (ECG, pulse oximeter, non-invasive blood pressure monitoring) were utilized for continuous monitoring. Baseline intravenous access was secured for administering the drugs. In order to reduce confounding variables, all patients received the same standardized general anesthesia protocol throughout the duration of the procedure.

Thirty minutes before the end of surgery, the study drug was administered. Patients in Group A received intravenous paracetamol at a dose of 15 mg/kg (to a maximum of 1 g) in 100 mL while Group B patients received intravenous diclofenac at a dose of 1 mg/kg (to a maximum of 75 mg) in 100 mL of normal saline. Both medications were administered slowly over 15 mins using an infusion pump. A separate anesthesiologist, not involved with measuring postoperative outcomes, prepared the drugs to ensure double-blind administration. Patients were then transferred to the Post-anesthesia Care Unit (PACU) to monitor postoperative pain and hemodynamic parameters at the specified time intervals. Patients who reported a VAS score ≥ 4 received rescue analgesia based on institutional protocol.

Outcome Measures: The main outcome of the study was postoperative pain relief (VAS). The secondary outcomes were the change in hemodynamic parameters, particularly heart rate and blood pressure, to assess cardiovascular stability after the administration of drugs and the occurrence of adverse effects such as hypotension, vomiting and nausea, meal anaphylaxis. Also, the need for rescue analgesia was documented and compared in both groups to determine the relative efficacy of the study drugs.

Statistical Analysis: The gathered data were recorded in tables and analyzed using standard statistical techniques. Continuous variables, such as VAS scores and hemodynamics, were calculated and expressed as mean ± standard deviation (SD) and analyzed with the unpaired t-test to compare groups by examining differences between continuous variables. Categorical variables, including side effects and rescue analgesia proportions, were examined using a Chi-square test. A p-value with significance < 0.05 was statistically significant, whereas $p < 0.001$ was considered highly significant. Because of this statistical approach, clinical, and hemodynamic differences could be accurately assessed and interpreted between the two groups."

Result

Table 1 shows the distribution of different types of surgeries among the two study groups. In Group A, the majority of patients underwent general surgery (23 patients, 47.9%), followed by ENT surgeries (18

patients, 37.5%) and other types of surgeries (7 patients, 14.6%). Similarly, in Group B, general surgery cases were also the most common (27 patients, 56.3%), followed by ENT surgeries (16 patients, 33.3%) and other surgeries (5 patients, 10.4%). The distribution of surgery types was fairly comparable between the two groups, indicating that both groups were well matched in terms of surgical procedures.

Table 1: Types of surgery (n, %)

Type of surgery	Group A		Group B	
	n	%	n	%
ENT	18	37.5	16	33.3
General surgery	23	47.9	27	56.3
Others	7	14.6	5	10.4
Total	**48**	**100**	**48**	**100**

"Table 2 presents the comparison of postoperative pain scores between Group A (intravenous paracetamol) and Group B (intravenous diclofenac) using the Visual Analog Scale (VAS) at different time intervals over six hours. At 0 hours, the mean VAS score was slightly higher in Group A (1.1 ± 1) compared to Group B (0.8 ± 0.8), but this difference was not statistically significant (p=0.105). At 1 hour, Group A had a mean score of 1 ± 0.7, while Group B had 1.1 ± 0.8 (p=0.515). By 2 hours, both groups showed identical mean scores of 1.8, with Group A having a standard deviation (SD) of 0.8 and Group B 0.7 (p=1.000). At 3 hours, pain levels slightly increased, with Group A at 2.3 ± 0.8 and Group B at 2.2 ± 0.8 (p=0.540). At 4 hours, Group A recorded 2.7 ± 0.8 compared to Group B's 2.9 ± 0.8 (p=0.221). At 5 hours, Group A's mean score dropped slightly to 2 ± 0.9, while Group B was 2.2 ± 0.8 (p=0.250). By 6 hours, the highest pain scores were observed, with Group A at 3.1 ± 1.1 and Group B at 3.2 ± 0.9 (p=0.626). Across all time points, no statistically significant differences were observed between the two groups, indicating that both paracetamol and diclofenac were equally effective in managing postoperative pain during the first six hours."

Table 2: Postoperative VAS score (per group)

Group / Time	Group A		Group B		t-test P	Significance
	Mean	SD	Mean	SD		
VAS_0 h	1.1	1	0.8	0.8	0.105	Nonsignificant
VAS_1 h	1	0.7	1.1	0.8	0.515	Nonsignificant
VAS_2 h	1.8	0.8	1.8	0.7	1	Nonsignificant
VAS_3 h	2.3	0.8	2.2	0.8	0.54	Nonsignificant
VAS_4 h	2.7	0.8	2.9	0.8	0.221	Nonsignificant
VAS_5 h	2	0.9	2.2	0.8	0.25	Nonsignificant
VAS_6 h	3.1	1.1	3.2	0.9	0.626	Nonsignificant

Discussion

The current study contrasted the analgesic effect as well as hemodynamic effect between intravenous (IV) paracetamol and IV diclofenac for the management of postoperative pain among varied surgical specialties, such as ENT, general surgery, and others. Demographic parameters at baseline and type of surgeries performed were uniform between the two arms, thus establishing parity between arms and eliminating confounding factors. Similar to the cohorts in this study, general surgeries accounted for most surgical cases followed by ENT surgeries, as the authors found. Lastly, laparoscopic surgeries made up a significant percentage of cases in the current study population, again coinciding with the findings of Durak et al. (2010) [7].

Postoperative pain trends measured by a Visual Analog Scale (VAS) appeared to demonstrate a constant linear increase in pain level across the six-hour period, thus demonstrating the highest intensity of pain at six hours for both groups. Importantly, no time interval demonstrated a statistically significant difference between the two groups demonstrating no appreciable differences between IV paracetamol and IV diclofenac offered similar degrees of analgesia. The results are congruent with those studies conducted by Hiller et al. (2004) [8] and Hynes et al. (2006) [9] who were unable to demonstrate any appreciable difference in VAS scores between groups treated with paracetamol and diclofenac following elective tonsillectomy and orthopedic surgery. Likewise, Yoganarasimha et al. (2012) [10] were able to show that both paracetamol and diclofenac provided equal efficacy in reducing postoperative pain during the perioperative period with only minor differences in time of analgesic onset and duration of pain relief.

At 0-hour in the present study, the VAS scores for the paracetamol and diclofenac groups were 1.1 and 0.8 respectively, with no statistical difference (p = 0.105). These low scores are presumably due to the

after-effects of anesthesia. Ahmed et al. (2006) [11] found similar early postoperative findings in reporting minimal postoperative pain following surgery with postoperative VAS scores increasing gradually as the anesthesia effect waned. At six hours, the present study found peak VAS scores for paracetamol and diclofenac to be 3.1 and 3.2 respectively. Hugo et al. (2004) [12] reported similar findings in the observation that paracetamol and NSAIDs such as diclofenac expressed similar peak relief of postoperative pain in the early postoperative period, but repeated dosing was required for maintaining analgesic effect after six hours.

In relation to rescue analgesia, 14 paracetamol patients and 12 diclofenac patients needed supplemental analgesia during the initial six hours. These findings were statistically nonsignificant and similar to Durak et al.'s (2010) [7], who established no considerable difference in requirements for the rescue analgesic drug after laparoscopic cholecystectomy between the two agents. In addition, Luthy et al. (1993) [13] indicated that paracetamol's analgesic effect has an average duration of 4–6 hours, which corresponds with the findings in this study that the highest number of requests for the rescue analgesic occurred after the fourth hour. In the diclofenac group, the timing for the rescue analgesia also corresponded with that found by Willis et al. (1979) [14], who indicated that the plasma concentrations for diclofenac reduce considerably after roughly 5.5 hours, prompting additional pain interventions.

When analyzing subgroups based on surgical type, we observed that VAS scores for ENT surgeries were significantly different only at the four-hour mark, while in general surgeries, differences emerged at five and six hours. These variations may be attributed to differences in tissue trauma, inflammatory response, and postoperative discomfort inherent to specific surgical procedures. Yoganarasimha et al. (2012) [10] reported similar patterns, suggesting that drug efficacy may vary slightly depending on the type and extent of surgery performed.

The similar efficacy between paracetamol and diclofenac found in the present study is in keeping with the results of Hyllested et al. (2002) [15], who found paracetamol to be an acceptable alternative to NSAIDs such as diclofenac, particularly among patients at greater risk for NSAID-related adverse effects. Though highly effective as an anti-inflammatory agent as well as an analgesic agent, the repeated use of diclofenac has been linked to gastrointestinal, renal, as well as cardiovascular side effects. In the present study, during which only a single dose was given, side effects were few. Nausea and vomiting occurred in 10% paracetamol patients and 8.33% diclofenac patients, but the difference was not statistically significant. These percentages are comparable to the findings by Hiller et al. (2004) [8] and Durak et al. (2010) [7], substantiating the relative safety profile between the two agents in the short-term postoperative period.

The lack of considerable hemodynamic disturbances in the present study also substantiates the safe application of the two agents in ASA I and ASA II patients. This goes with the findings by Pratyush et al. (2013) [16], who demonstrated stable hemodynamic parameters with paracetamol and diclofenac in patients who underwent different surgeries. Hyllested et al. (2002) [15], on the contrary, advocated the use of paracetamol as the first-line analgesic in patients with risk factors for cardiovascular diseases for its relative safety over NSAIDs.

One important aspect to consider is that our study focused on single-dose administration, whereas many clinical scenarios involve repeated dosing over extended periods. In prolonged use, diclofenac may present a higher risk of adverse effects, as noted in studies on chronic NSAID therapy (Hyllested et al., 2002) [15]. Therefore, while both drugs performed equally well in our short-term study, paracetamol may be preferable for patients requiring longer-term postoperative pain management.

Strengths of this study are the fixed dosing regimen, uniform patient population, and the application of the VAS, a reliable and straightforward measure of acute pain (Bijur et al., 2001) [17]. There are, however, some acknowledged limitations. The six-hour observation interval might not reveal the full extent of analgesic duration differences for longer observation periods, and individual thresholds for pain, psychological factors, and perioperative analgesic administration were not adjusted for. Additional studies with larger patient series and longer follow-up would reveal additional comparative efficacy information for these agents.

In short, the present findings indicate that single IV dose each of paracetamol or diclofenac provides equivalent postoperative relief with minimal side effects. With equivalent efficacy but better safety profile, paracetamol may become the drug of choice, particularly among the high-risk cases or with long-term analgesic therapy.

Conclusion

The research study comparing intravenous paracetamol and diclofenac for postoperative pain management showed that both medications were similarly effective for postoperative pain management and that pain scores did not differ significantly at many time points measured from the 6-hour postoperative time frame. The distribution of surgical types was similar between the groups and provided reasonable balance with respect to possible confounding characteristics at the time of randomization. Pain scores increased (increased pain) uniformly across both groups over time periods, but remained at tolerable

levels, and the patterns were similar and relatively equal, suggesting equivalent analgesic potential. Also, each group showed no significant differences in hemodynamic parameters suggesting that both medications were tolerated well and safely in the postoperative scenario. In conclusion, intravenous paracetamol, and diclofenac can both be utilized and achieved similar postoperative pain relief with no significant difference in hemodynamics which allows choosing between the two based on unique aspects of individual patients such as contraindications, co-morbidities, or availability.

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