

A Comparative Study of Ketorolac and Lignocaine for Analgesia and Hemodynamic Stability During Propofol-Induced Pain at Anaesthetic Induction

Zunaira Ayesha Chouhdary¹, Maria Arshad², Shaheer Nayyar³, Roomana Kanwal⁴, Shumaila Ashfaq⁵, Hajra Shuja⁶

¹Department of Urology, Azra Naheed Dental College, The Superior University, Lahore, ²Department of Anesthesia and ICU, Jinnah Burn & Reconstructive Surgery Centre (AIMS), Lahore, ³Department of Anesthesia, Allama Iqbal Medical College/ Jinnah Hospital, Lahore, ⁴Department of Anesthesia, Shaikh Zayed Hospital, Lahore, ⁵Department of Anesthesia, Islam Medical and Dental College, Sialkot, ⁶Department of KEMU/MAYO Hospital, Lahore, Pakistan.

ABSTRACT

Background: Pain on injection of propofol is a common and uncomfortable experience during the induction of general anesthesia, often affecting patient satisfaction and comfort. Various pharmacological agents have been explored to reduce this pain, including lignocaine, a local anesthetic, and ketorolac, a non-steroidal anti-inflammatory drug. This study was designed to assess and compare the analgesic and hemodynamic effects of ketorolac versus lignocaine in minimizing propofol-induced pain during general anesthesia induction.

Methods: This randomized comparative study was conducted at the Department of Anaesthesia, Shaikh Zayed Hospital, Lahore, over six months (July 1 to December 31, 2021). A total of 200 patients meeting the inclusion criteria were enrolled after obtaining ethical approval and informed consent. Participants were randomized into two groups: Group A received ketorolac and Group B received lignocaine before propofol injection. Pain scores and hemodynamic responses were recorded and analyzed using SPSS version 21.

Results: The mean age of patients in Group A (ketorolac) was 37.19 ± 8.39 years, and in Group B (lignocaine) was 37.83 ± 8.85 years. The sample included 33.5% males and 66.5% females. Pre-anesthetic pain scores were 2.37 in the ketorolac group and 2.44 in the lignocaine group ($p = 0.355$). After propofol administration, both groups showed a mean pain score of 0.883 ($p = 1.00$), indicating no statistically significant difference.

Conclusion: Ketorolac and lignocaine were equally effective in reducing pain associated with propofol injection, with no significant difference in their analgesic or hemodynamic effects during anesthesia induction.

Keywords: Propofol, Ketorolac, Lignocaine, Anesthesia Induction, Injection Pain, Hemodynamic Response.

Corresponding Author:

Dr. Zunaira Ayesha Chouhdary,
Department of Urology,
Azra Naheed Dental College,
The Superior University, Lahore, Pakistan.
Email: zchouhdary@msn.com
Doi: <https://doi.org/10.36283/ziun-pjmd14-3/029>.

How to cite: Chouhdary ZA, Arshad M, Nayyar S, Kanwal R, Ashfaq S, Shuja H A Comparative Study of Ketorolac and Lignocaine for Analgesia and Hemodynamic Stability During Propofol-Induced Pain at Anaesthetic Induction. Pak J Med Dent. 2025 July ;14(3): 187-193. Doi: <https://doi.org/10.36283/ziun-pjmd14-3/029>.

Received: Mon, April 07, 2025 **Accepted:** Tue, July 08, 2025 **Published:** Sun, July 21, 2025

INTRODUCTION

Propofol, a derivative of phenol, was first recognized as a potential intravenous anaesthetic in 1980 and approved for clinical use in 1986¹. It has since gained widespread popularity due to its rapid onset and short recovery time, and is now routinely used for induction of general anaesthesia (GA), intensive care unit (ICU) sedation, and in post-anaesthesia care units (PACU)^{1, 2}. Studies have shown that 1% and 2% propofol concentrations have comparable efficacy and safety in paediatric GA induction^{3, 4}.

Despite its benefits, propofol induction is associated with side effects such as pain on injection, hypotension, and, in rare cases, bradycardia⁵. Among these, pain on injection is particularly concerning, ranking seventh out of 33 clinical conditions in terms of incidence and significance⁶.

Propofol is widely used in Total Intravenous Anaesthesia (TIVA) for maintaining sedation and general anaesthesia. Pain on injection occurs in 28% to 90% of patients⁷. Factors influencing this pain include the site of injection, vein size, speed of injection, propofol concentration in the aqueous phase, and the buffering capacity of blood⁸.

Although propofol facilitates smooth induction, rapid recovery, and has antiemetic properties, approximately 70% of patients report experiencing acute, burning pain at the injection site⁹. Several strategies have been employed to mitigate this pain, such as cooling the propofol solution or diluting it with 5% dextrose¹⁰.

Propofol remains the drug of choice for the induction of anaesthesia due to its favorable pharmacokinetic profile. However, being a phenol compound, it can irritate the skin and mucous membranes, contributing to injection site pain in up to 90% of patients¹¹.

The incidence of pain associated with propofol after lidocaine administration ranges from 25.7% to 48.9%¹⁰. Lidocaine is commonly used as a local anaesthetic in dentistry and features on the WHO List of Essential Medicines. Its widespread use is attributed to its rapid onset and moderate duration of action, making it suitable for nerve blocks, infiltration, and topical anaesthesia¹⁰. Additionally,

lidocaine functions as a class 1B anti-arrhythmic agent by blocking voltage-gated sodium channels in cardiac tissues¹¹.

Ketorolac, a nonsteroidal anti-inflammatory drug (NSAID), is used for postoperative analgesia by inhibiting prostaglandin synthesis through cyclooxygenase (COX) inhibition¹². The COX pathway may also play a role in the pain experienced after propofol injection¹³. Ketorolac can be administered via multiple routes, including oral, intramuscular, intravenous, and nasal¹⁴. It may also act as an opioid-sparing adjuvant, enhancing analgesia. Importantly, COX inhibitors like ketorolac have minimal direct cardiovascular effects¹⁵.

Propofol is a commonly used intravenous anaesthetic agent known for its rapid onset and short duration of action; however, pain during injection remains a frequent and distressing side effect, affecting up to 90% of patients. Lignocaine is widely used to reduce this pain due to its local anaesthetic properties, yet it does not fully eliminate the discomfort. Ketorolac, a nonsteroidal anti-inflammatory drug, offers a different mechanism of action by inhibiting prostaglandin synthesis and may provide additional analgesic benefits without significant cardiovascular effects. While both agents have shown effectiveness individually, limited comparative studies exist assessing their relative efficacy and safety in preventing propofol-induced pain and ensuring hemodynamic stability during anaesthetic induction. The present study aimed to compare ketorolac and lignocaine in terms of their analgesic efficacy and impact on hemodynamic parameters during propofol-induced pain at the time of anaesthesia induction.

METHODS

This randomized controlled trial, consisting of 200 patients, was carried out in Shaikh Zayed Hospital Lahore, from 1st July 2021 to 31st December 2021 after getting approval from the ethical committee. This study was approved by the Institutional Review Board/Ethical Committee of Shaikh Zayed Medical Complex, Lahore (Approval No: SZMC/IRB/Internal/0056/2024; Dated: 12th January 2021).

The patients included in the study belonged to the American Society of anesthesiologist (ASA) class I and II between the ages of 15-50 years, both males

and females with a BMI of 18-29.9 Kg/m². Patients with peptic ulcer disease, kidney failure, bleeding disorders, sensitivity to salicylates, NSAIDs, and propofol, pregnant and lactating mothers, asthma, and epilepsy were excluded.

Informed consent was obtained. Using a random number table, patients were randomly split into two groups, A and B. A pre-anesthetic examination was performed the day before surgery to determine the patients' pain tolerance by skin pinch. Pain scoring is through a numerical pain scale, subjective assessment. Routine monitoring of HR, BP, and oxygen saturation was performed upon arrival in the operating room. All patients had an intravenous access placed on the dorsum of the hand with a 20G cannula and were flushed with distilled water.

Over 60 seconds, group A received 15mg ketorolac and group B received 20mg lidocaine. After administering the medication (lidocaine/ketorolac), a 30-second gap was noted before injecting propofol. Propofol was given as a bolus dosage of 1.5mg/kg. Pain was assessed using numerical pain score, as

specified in the operational definition, and vitals variability was observed. The data was gathered using the provided Proforma.

RESULTS

SPSS version 21 was used to enter and analyze all of the data. The patient's age was reported and computed as mean + S.D. By calculating frequency and percentage, categorical variables such as sex and pain grading (no pain, mild, moderate, severe) through numerical pain score were provided. For comparison, the Chi-square test was used in both places. This study included 200 participants aged between 19 and 50 years. The average age was 37.51 years, with a standard deviation of 8.606 years, indicating a moderate spread in ages. Group Comparisons: Group A (Ketorolac): Mean age = 37.19, SD = 8.386, Group B (Lignocaine): Mean age = 37.83, SD = 8.851, and the t-test comparing mean ages showed no statistically significant difference (p = 0.600). Gender Distribution Females made up 66.5% of the sample, males were 33.5%, indicating a female majority **Table 1**.

Table 1: Demographic and Statistical Distribution of Study Participants

Variable	Group	N	Min-Max	Mean	SD	Statistical Test	p-value	Results
Overall Age Distribution								
Age (years)	Participants	200	19-50	37.51	8.606	-	-	Age range = 31 years
Age Distribution by Groups								
Age (years)	Group A: Ketorolac	100	-	37.19	8.386	-	-	
	Group B: Lignocaine	100		37.83	8.851			
Comparison Between Groups								
Age (years)	Group A	-				t= -0.525	0.600	No significant difference in mean ages
	Group B							
Gender Distribution								
Gender	Male	67	-					33.5% Total Sample
	Female	133						66.5%
	Total	200						100%

mean weight of patients in the ketorolac group was 68 kg, while in the lignocaine group it was 70 kg. During anesthetic assessment, 96% of patients in the ketorolac group reported mild pain, and 4% had no pain. In contrast, patients in the lignocaine group reported mild pain. There was no statistically significant difference in preanesthetic pain scores between the two groups (p = 0.353). After propofol injection, 49% of patients in the ketorolac group and 66% in the lignocaine group experienced no pain. Mild pain was reported in 45% of patients in both groups, moderate pain was slightly higher in the lignocaine group (7%) compared to ketorolac (6%). The post-propofol pain scores were identical (1.74 ± 0.88), and statistical analysis showed no significant difference between the two groups (p = 1.000). These findings indicate that both ketorolac and lignocaine are equally effective in reducing propofol-induced pain at induction **Table 2**.

Table 2: Comparison of Pain Scores and Patient Characteristics in Ketorolac and Lignocaine Groups (N = 200)

Parameter	Ketorolac Group (n = 100)	Lignocaine Group (n = 100)	p-value / Test	Interpretation
Mean Weight (kg)	68	70	-	Comparable weight distribution
Preanesthetic Pain				
No Pain	4 (4%)	0 (0%)	-	Slightly more comfort in the Ketorolac group
Mild Pain	96 (96%)	100 (100%)	t = 0.391, p = 0.353	No significant difference
Mean Pain Score (preanesthetic)	2.37 ± 0.56	2.44 ± 0.50		
Post-Propofol				
No Pain	49 (49%)	48 (48%)	-	Similar response
Mild Pain	45 (45%)	45 (45%)	-	-
Moderate Pain	6 (6%)	7 (7%)	-	-
Mean Pain Score (Post-Propofol)	1.74 ± 0.88	1.74 ± 0.88	t = 0.000, p = 1.000	No significant difference

Table 3: Effect on Hemodynamics

Hemodynamics of Participants					
Description	Group of participants	N	Mean	Std. Deviation	T-test & P-values
Heart Rate Baseline	Ketorolac	100	87.86	7.495	t= -2.342 P= .020
	Lignocaine	100	90.86	10.389	
Heart Rate Vital Propofol Injection	Ketorolac	100	93.71	10.729	t= .000 P= 1.000
	Lignocaine	100	93.71	13.186	
Blood Pressure Baseline	Ketorolac	100	99.59	15.474	t= 4.960 P= .000
	Lignocaine	100	89.8	12.256	
Blood Pressure Vital Propofol Injection	Ketorolac	100	89.8	12.256	t= -4.960 P= .000
	Lignocaine	100	99.59	15.474	
SPO Baseline	Ketorolac	100	98.5	0.689	t= -1.933 p= .050
	Lignocaine	100	98.7	0.772	
SPO Vital Propofol Injection	Ketorolac	100	98.75	0.557	t= -5.944 p= .000
	Lignocaine	100	99.2	0.512	

We found no significant difference in the hemodynamics of patients in both groups. Mild changes in blood pressure and heart rate were noted after the injection of propofol. The hemodynamic parameters of participants showed in **Table 3** some significant differences between the Ketorolac and Lignocaine groups. At baseline, heart rate was significantly lower in the Ketorolac group (mean = 87.86 bpm) compared to the Lignocaine group (mean = 90.86 bpm), with a p-value of 0.020. However, following propofol injection, no significant difference in heart rate was observed between the two groups (both means = 93.71 bpm, p = 1.000). Blood pressure readings demonstrated significant differences at both baseline and after propofol injection. The Ketorolac group had a higher mean baseline blood pressure (99.59 mmHg) compared to the Lignocaine group (89.8 mmHg), with p < 0.001. After propofol administration, this trend reversed, with the Lignocaine group showing a higher mean blood pressure (99.59 mmHg) than the Ketorolac group (89.8 mmHg), also statistically significant (p < 0.001). Oxygen saturation (SpO₂) at baseline was slightly lower in the Ketorolac group (98.5%) compared to the Lignocaine group (98.7%), with borderline significance (p = 0.050). After propofol injection, SpO₂ was significantly higher in the Lignocaine group (99.2%) compared to the Ketorolac group (98.75%) with p < 0.001. These findings indicate notable hemodynamic differences between the groups at various time points, particularly regarding blood pressure and oxygen saturation.

DISCUSSION

This study aimed to compare the analgesic efficacy and hemodynamic stability of ketorolac and lignocaine in reducing propofol-induced pain during anaesthesia induction. The results indicate that both ketorolac and lignocaine were equally effective in reducing pain associated with propofol injection. Nearly half of the patients in each group experienced no pain post-injection (49% in the ketorolac group and 48% in the lignocaine group), while mild and moderate pain were similarly distributed between the two groups. The mean post-propofol pain score was identical (1.74 ± 0.88), and no statistically significant difference was observed ($p = 1.000$), suggesting equivalent efficacy of both drugs in managing injection pain.

These findings are consistent with previous studies that demonstrated no significant difference between ketorolac and lignocaine in reducing the incidence and severity of propofol-induced pain¹⁶. Other studies have shown lignocaine to be more effective than ketorolac, particularly when venous occlusion was applied^{17, 18}. However, in our study, venous occlusion was not used, and ketorolac still produced results comparable to lignocaine, suggesting that ketorolac may be effective even without vein occlusion. This supports findings from a study where ketorolac demonstrated analgesic efficacy despite the absence of venous stasis¹⁹.

Our findings contrast with some earlier reports that identified lignocaine as significantly more effective than ketorolac in pain relief, showing higher percentages of pain-free patients and lower incidence of severe pain with lignocaine. However, such studies often involved different doses, administration techniques, or additional interventions like occlusion or premedication, which may account for the observed differences. Notably, one investigation found ketorolac to be ineffective when administered without sufficient vein retention time, highlighting the importance of administration technique¹⁹.

The pre-anesthetic pain assessment also revealed minimal differences between the two groups, with 96% of ketorolac patients and 100% of lignocaine patients reporting mild pain, and a non-significant difference in pre-injection pain scores ($p = 0.353$). These results align with studies that showed only marginal baseline pain variations between different analgesic pretreatments²⁰.

In terms of hemodynamic changes, our results showed statistically significant differences at various time points. Baseline heart rate and blood pressure were higher in the ketorolac group, but these values reversed after propofol injection, with the lignocaine group showing higher post-injection blood pressure. While these changes were statistically significant,

they remained within clinically acceptable ranges. Similar findings have been observed in prior studies where mild hemodynamic fluctuations occurred with both drugs but without clinical instability²¹.

SpO₂ levels also showed significant differences post-propofol injection, with higher oxygen saturation in the lignocaine group (99.2%) compared to ketorolac (98.75%). Though statistically significant ($p < 0.001$), this difference is likely of minimal clinical relevance, as values remained within the normal physiological range. A study assessed propofol's effect on oxygenation and noted such subtle variations that were not considered to impact patient safety²².

Moreover, our findings support the hypothesis that NSAIDs like ketorolac may reduce propofol-induced pain through their inhibition of prostaglandin synthesis, possibly interfering with kinin cascade-mediated vascular irritation²³. While lignocaine acts locally by blocking sodium channels, ketorolac may exert its analgesic effect systemically or via vascular endothelium modulation²⁴.

Several trials have demonstrated that ketorolac, especially when combined with venous occlusion, can reduce pain intensity after propofol injection²⁵. However, the practicality and feasibility of routine occlusion in clinical settings are limited. Our study adds value by showing that a simple intravenous dose of 15 mg ketorolac without occlusion is just as effective as lignocaine, making it a convenient alternative in routine practice.

CONCLUSION

Our findings imply that ketorolac is as effective as lignocaine in minimizing propofol-induced pain, and there is no difference observed in the analgesic and hemodynamic effects of lignocaine and ketorolac in decreasing pain caused by propofol during general anesthesia induction. Our findings imply that ketorolac is as effective as lignocaine in minimizing propofol-induced pain, and there is no difference observed in the analgesic and hemodynamic effects of lignocaine and ketorolac in decreasing pain caused by propofol during general anesthesia induction.

LIST OF ABBREVIATIONS

GA General Anaesthesia
PIP Propofol-Induced Pain
NSAID Nonsteroidal Anti-Inflammatory Drug
IV Intravenous
SO₂ Peripheral Capillary Oxygen Saturation
SD Standard Deviation
bpm Beats Per Minute (Heart Rate)

ACKNOWLEDGMENTS

None

CONFLICT OF INTEREST

None

ETHICAL APPROVAL

This study was approved by the Institutional Review Board/Ethical Committee of Shaikh Zayed Medical Complex, Lahore (Approval No: SZMC/IRB/Internal/0056/2024; Dated: 12th January 2021).

PATIENT CONSENT

Written informed consent was obtained from all patients before their inclusion in the study.

AUTHORS' CONTRIBUTION

All authors equally contributed as per the ICMJE.

REFERENCES

1. Janse van Rensburg E, Indiveri L, Mogane P. The perioperative use of dexmedetomidine in paediatric patients. *Children*. 2025 Jun;12(6):690. <https://doi.org/10.3390/children12060690>
2. Rauch S, Miller C, Bräuer A, Wallner B, Bock M, Paal P. Perioperative hypothermia—a narrative review. *Int J Environ Res Public Health*. 2021 Aug;18(16):8749. <https://doi.org/10.3390/ijerph18168749>
3. Chen Z, Peng T, Zhang S, Yang Q, Qu S, Cao Y, et al. Age-specific plasma concentration, efficacy and safety of ciprofol (cipepopol) for induction and maintenance of general anesthesia in pediatric patients undergoing elective surgery: a single-arm prospective, pragmatic trial. *Clin Drug Investig*. 2025 Mar;45(3):137–50. <https://doi.org/10.1007/s40261-025-01425-y>
4. Zhao Y, Qin F, Liu Y, Dai Y, Cen X. The safety of propofol versus sevoflurane for general anesthesia in children: a meta-analysis of randomized controlled trials. *Front Surg*. 2022 Jul;9:924647. <https://doi.org/10.3389/fsurg.2022.924647>
5. Singh A, Anjankar AP, Anjankar A. Propofol-related infusion syndrome: a clinical review. *Cureus*. 2022 Oct;14(10):e30383. <https://doi.org/10.7759/cureus.30383>
6. Bakhtiari E, Mousavi SH, Gharavi Fard M. Pharmacological control of pain during propofol injection: a systematic review and meta-analysis. *Expert Rev Clin Pharmacol*. 2021 Jul;14(7):889–99.
7. Bajwa SJS, Vinayagam S, Shinde S, Dalal S, Vennel J, Nanda S. Recent advancements in total intravenous anaesthesia and anaesthetic pharmacology. *Indian J Anaesth*. 2023 Jan;67(1):56–62. https://doi.org/10.4103/ija.ija_1022_22
8. Chu Y, Sun T, Xie Z, Sun K, Jiang C. Physicochemical characterization and pharmacological evaluation of novel propofol micelles with low-lipid and low-free propofol. *Pharmaceutics*. 2022 Feb;14(2):414. <https://doi.org/10.3390/pharmaceutics14020414>
9. Hydrate C, Anesthetics—Amides L, Anesthetics—Esters L, Maxwell L, Suresh S, Tobias JD. Sedatives and analgesics: general principles and pharmacology. In: [Book chapter reference incomplete; needs publisher, place, year, and DOI if available]
10. Patel S, Hughes Driscoll C. Peripheral intravenous catheter-associated injuries in neonates: monitoring, diagnosis, management, and complications. *NeoReviews*. 2025 Jan;26(1):e28–40. <https://doi.org/10.1542/neo.26-1-003>
11. Kazi M, Gaskari A, Shahba AA, Ahmad S, Aldughaim MS, Hussain MD. Propofol: current updates, challenges, and strategies for improved self-nanoemulsifying formulation. *ACS Pharmacol Transl Sci*. 2025 Apr;8(4):1013–27. <https://doi.org/10.1021/acspsci.4c00745>
12. Lee GG, Park JS, Kim HS, Yoon DS, Lim JH. Clinical effect of preoperative intravenous non-steroidal anti-inflammatory drugs on relief of postoperative pain in patients after laparoscopic cholecystectomy: intravenous ibuprofen vs. intravenous ketorolac. *Ann Hepatobiliary Pancreat Surg*. 2022 Sep;26(3):251–6.
13. Gu L, Liu J, Machi AT. Perioperative pain management and enhanced recovery protocols. In: *Musculoskeletal Pain*. Springer; 2025. p. 467–512. https://doi.org/10.1007/978-3-031-86057-7_22
14. Gaul E, Barbour T, Nowacki AS, Mace SE. Intranasal ketorolac for acute pain in adult emergency department patients. *West J Nurs Res*. 2022 Nov;44(11):1047–56. <https://doi.org/10.1177/01939459211030336>
15. Lv ZK, Zhang HT, Cai XJ, Su WX, Zhu EJ, Chong H, et al. Ketorolac in the perioperative management of acute type A aortic dissection: a randomized double-blind placebo-controlled trial. *BMC Med*. 2025 Jun;23(1):188. <https://doi.org/10.1186/s12916-025-04021-1>
16. Roshid MHO, Islam MS, Nath RK, Datta PK, Begum SA, Chowdhury GA. A comparative study between intravenous tramadol versus lidocaine pretreatment in reducing pain on propofol injection. *J Chittagong Med Coll Teach Assoc*. 2021 Dec;32(2):90–4. <https://doi.org/10.3329/jcmcta.v32i2.66501>
17. Chobpenthai T, Ingviya T, Thanindratarn P, Jaiwithee R, Sutthivaiyakit K. Ketorolac plus lidocaine vs lidocaine for pain relief following core needle soft tissue biopsy: a CONSORT-compliant double-blind randomized controlled study. *Medicine (Baltimore)*. 2021 Feb;100(7):e24721. <https://doi.org/10.1097/MD.00000000000024721>
18. Niazi ASK, Bajwa MA, Zahra M, Niazi MUK, Zainab I, Anwer A. Efficacy of intra-articular ketorolac and lignocaine on post-operative pain relief after arthroscopic knee surgery. *J Ayub Med Coll Abbotabad*. 2022 Jun;34(2):273–8. <https://doi.org/10.55519/JAMC-02-8647>
19. Eskew J, Kelly T, Ode G. Ketorolac as a local analgesic in orthopaedic conditions: a systematic review of safety and efficacy. *Curr Orthop Pract*. 2023 Jul;34(4):142–59. <https://doi.org/10.1097/BCO.0000000000001215>
20. Feng W, Wang Y, Ran F, Mao Y, Zhang H, Wang Q,

et al. The effectiveness and safety of the rapid titration strategy of background controlled-release oxycodone hydrochloride for patients with moderate-to-severe cancer pain: a retrospective cohort study. *Front Med (Lausanne)*. 2022 Jul;9:918468. <https://doi.org/10.3389/fmed.2022.918468>

21. Gajniak D, Mendrala K, König-Widuch G, Parzonka S, Gierek D, Krzych ŁJ. Effect of lidocaine on intraoperative blood pressure variability in patients undergoing major vascular surgery. *BMC Anesthesiol*. 2024 Jun;24(1):170. <https://doi.org/10.1186/s12871-024-02550-5>

22. Ok E, Barnty B, Eniola J, Enoch O. Adverse effects and safety profiles of propofol and ciprofol: what clinicians should know. [Preprint or journal not specified]; 2024. [DOI and publication details unavailable – please confirm source]

23. Haider SZ, Khoso MA, Ayaz SB, Abbas MA, Rehman HU, Iftikhar H. Pre-treatment with ketorolac alongside venous occlusion can reduce the pain of propofol injection: a quasi-experimental study. *Pak Armed Forces Med J*. 2022 Apr–Jun;72(2). <https://doi.org/10.51253/pafmj.v72i2.7094>

24. Ezell J, Tram J, Furnish T. Mechanisms of action of clinically relevant analgesics (non-opiates). In: *Mechanisms of Pain*. Boca Raton: CRC Press; 2025. p. 230–46.

25. Zahra H, Bary A, Nazeer T, Naseem S, Aziz MA, Hussain R, et al. Comparison of efficacy of ondansetron pre-treatment in alleviating pain due to propofol during general anaesthesia with placebo. *Pak J Med Health Sci*. 2021 Oct;15:2756–8. <https://doi.org/10.53350/pjmhs2115102756>

