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Comparison of Ketorolac and Lidocaine for Post-Digestive Surgery Pain Management

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ABSTRACT

Background: Postoperative pain is a significant issue in digestive surgery patients, impacting recovery and satisfaction. Effective pain management through a multimodal approach that includes various analgesics is essential to reduce discomfort and prevent complications. Ketorolac, a potent NSAID, and lidocaine, a local anesthetic, have proven effective in alleviating postoperative pain. However, challenges such as variability in pain perception and concerns about opioid dependence persist. Accurate pain assessment using the Numeric Rating Scale (NRS) is crucial for tailoring treatment. No studies have compared these two drugs in multimodal analgesia for postoperative digestive surgery patients, necessitating further research. Objective: Comparing NRS in post-digestive surgery patients between ketorolac and lidocaine groups. Research Method: This study was a randomized clinical trial at Dr. Soetomo General Hospital, involving 30 patients. Data were analyzed using SPSS with the Friedman test and the Mann–Whitney test. Results: Initial NRS median scores showed ketorolac at 6 (1-10) and lidocaine at 5 (2-10), decreasing to medians of 2 (1-6) and 3 (1-6), respectively. The Friedman test indicated a significant decrease ($p < 0.001$), while the Mann-Whitney test revealed no significant difference ($p > 0.05$). Conclusion: Both ketorolac and lidocaine provide rapid and stable analgesic effects without significant differences, demonstrating their effectiveness in managing postoperative pain.

KEYWORDS: Digestive Surgery, NRS, Intravenous Lidocaine, Ketorolac

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INTRODUCTION

Postoperative pain is a significant clinical problem in patients undergoing digestive surgery, with implications for patient recovery, long-term outcomes, and overall patient satisfaction. Effective pain control is crucial not only to reduce patient discomfort but also to facilitate early mobilisation, reduce the risk of complications, and shorten hospital stays [1].

Digestive surgery often involves large incisions, manipulation of visceral organs, and sometimes the use of laparoscopic techniques. These interventions can cause somatic and visceral pain, making pain management particularly challenging [2]. Inadequate pain control has been associated with an increased risk of pulmonary complications, delayed return of bowel function, and progression to chronic post-operative pain.

Over the past two decades, there has been a paradigm shift from conventional opioid-based analgesia to a multimodal approach to pain management. Multimodal analgesia involves the use of various classes of analgesics and techniques that target different pain pathways, thereby potentially reducing the need for opioids and their side effects [3]. Techniques such as epidural analgesia, transversus abdominis plane (TAP) blocks, and the use of nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, and gabapentinoids are now commonly used in enhanced recovery after surgery (ERAS) protocols [4].

Despite these advances, challenges remain. Individual variability in pain perception and response to analgesics, as well as concerns about opioid dependence and side effects, necessitate ongoing research into personalised pain management strategies [5].

Postoperative pain management in digestive surgery remains an important component of perioperative care [6], directly affecting patient outcomes, recovery time, and the risk of complications [7]. In recent years, increasing emphasis has been placed on minimising opioid use due to concerns about side effects such as sedation, respiratory depression, ileus, and potential dependence [5]. As a result, non-opioid analgesics, particularly non-steroidal anti-inflammatory drugs (NSAIDs), have become the primary choice in multimodal analgesia protocols.

Effective postoperative pain management in gastrointestinal surgery is crucial for reducing complications, improving patient comfort, and supporting mobilisation and early recovery. Traditionally, opioids have been the mainstay of postoperative analgesia. However, their use is associated with various side effects, including respiratory depression, nausea, vomiting, ileus, and the risk of dependence. This has led to increased interest in opioid-sparing strategies, including the use of local anaesthetics such as intravenous

lidocaine infusion as part of a multimodal analgesia protocol [8].

Of these drugs, two are particularly noteworthy: ketorolac, an NSAID that is currently in widespread use, and lidocaine, which has recently begun to be used as an alternative in the multimodal analgesia of patients.

Ketorolac is a commonly used NSAID; it is a potent NSAID with analgesic and anti-inflammatory properties. Ketorolac has been extensively studied and is used for the short-term management of moderate to severe post-operative pain. This drug works by inhibiting the cyclooxygenase (COX) enzyme, thereby reducing prostaglandin synthesis, which is central to the pain and inflammation cascade [9]. Unlike opioids, ketorolac does not cause sedation or respiratory depression, making it a valuable addition or alternative during the perioperative period.

In digestive surgery, ketorolac has been shown to be effective in reducing pain scores and opioid consumption immediately after surgery. A randomised controlled trial by Ahmed et al. showed that ketorolac resulted in lower pain scores compared to tramadol in patients undergoing inguinal hernia surgery [10]. Another study by Ljungqvist et al. also demonstrated that ketorolac's opioid-sparing effect contributes to enhanced recovery after surgery (ERAS) protocols, which aim to accelerate recovery and reduce hospital stays. Its use in the ERAS pathway for colorectal surgery has been associated with improved gastrointestinal function and reduced opioid-related ileus [4].

Lidocaine is an amide-type local anaesthetic that, when administered systemically at low doses, exhibits analgesic, anti-inflammatory, and antihyperalgesic properties. Its mechanisms of action include sodium channel blockade, inhibition of ectopic neuron activation, and modulation of inflammatory mediators [11]. These properties make it particularly useful in managing the somatic and visceral pain commonly experienced after digestive surgery.

There is growing evidence supporting the use of perioperative intravenous lidocaine infusion in digestive surgery. A systematic review and meta-analysis showed that lidocaine infusion significantly reduced postoperative pain scores, opioid requirements, and bowel function recovery time in patients undergoing colorectal surgery [12]. Additionally, lidocaine has been shown to reduce postoperative nausea and vomiting (PONV), improve gastrointestinal recovery, and shorten hospital stay as primary goals in the Enhanced Recovery After Surgery (ERAS) protocol [11,13].

To monitor patients' pain levels, accurate pain assessment is essential to guide analgesic administration and improve patient outcomes. Of the various tools available, the Numeric Rating Scale (NRS) is the most widely used subjective instrument for measuring pain intensity and is routinely used in most hospitals, including Dr. Soetomo General Hospital in Surabaya.

Postoperative pain is a complex and multifaceted phenomenon that can vary significantly between individuals, depending on the type and extent of surgery, patient psychology, and comorbid conditions. In digestive surgery, poorly controlled pain can lead to complications such as ileus, delayed ambulation, and prolonged hospitalisation [1]. Therefore, consistent and validated pain assessment tools are essential for optimising post-operative care.

The NRS is a commonly used tool, where patients are asked to rate their pain on a scale of 0 (no pain) to 10 (worst pain imaginable). The NRS is easy to use and does not require the use of paper or visual aids, making it more practical in the postoperative setting [14].

In the context of digestive surgery, NRS has been integrated into ERAS protocols to monitor post-operative pain and adjust analgesic regimens. A study by Beaussier et al. demonstrated the benefits of NRS in assessing the effectiveness of pain control in colorectal surgery patients, highlighting its role in multimodal analgesia strategies [15].

To date, there has been no research comparing intravenous ketorolac and intravenous lidocaine as postoperative analgesics in digestive surgery to assess their adequacy in managing pain in patients. Based on this background, the researchers believe that it is necessary to conduct research on the use of these two drugs as part of multimodal analgesia in patients, with the hope of providing alternative options for administering post-operative analgesia to patients, thereby enabling them to recover more quickly and effectively.

CONCEPTUAL FRAMEWORK

One of the most common clinical problems faced by patients after digestive surgery is post-operative pain. Digestive surgery, whether laparotomy or laparoscopy, uses various techniques such as incisions, retraction, and dissection. All of these actions have the potential to cause tissue trauma [16]. The acute inflammatory process is triggered by the release of chemical mediators such as prostaglandins, bradykinin, serotonin, histamine, and other proinflammatory cytokines. These chemical mediators are responsible for various physiological reactions, one of which is nociceptors, sensory nerve endings responsible for pain surges [16].

Transduction occurs when nociceptors are activated. This process converts chemical, mechanical, or thermal stimulation into electrical impulses. Ion flow through sodium channels and other ion channels in the sensory neuron membrane controls this process. Local anaesthetics such as lidocaine and bupivacaine can reduce pain transmission by blocking sodium channels. Conversely, NSAIDs such as ketorolac and ibuprofen work by inhibiting the COX enzyme to produce fewer prostaglandins [17,18]. Research also shows that the use of selective COX-2 agents such as celecoxib can provide similar analgesic effects at this stage [17].

After the transduction process, electrical impulses travel through sensory nerve pathways to the spinal cord, where transmission occurs, i.e., pain signals move from peripheral neurons to the central nervous system. This transmission represents the journey through Aδ and C nerve fibres to the dorsal horn of the spinal cord before being transmitted to the thalamus and somatosensory

cortex [16]. This is followed by the modulation process, which is the amplification or inhibition of pain signals by the central nervous system that occurs after pain impulses reach the spinal cord. The inhibitory pathway descends from the brainstem to the dorsal horn using neurotransmitters such as serotonin and norepinephrine to control this phenomenon [16]. Finally, there is the process of pain perception. This is the interpretation of pain sensations by the brain through the primary sensory cortex and limbic system [16,19]. Furthermore, the physiological and psychological responses resulting from pain perception can exacerbate the problem, such as an increase in heart rate, blood pressure, and respiratory rate, as well as the potential for anxiety and depression [16,20]. Therefore, mapping pain experiences often uses the Numeric Rating Scale (NRS) to evaluate the effectiveness of pain control experienced by post-operative patients [21].

Research Hypothesis

1. Intravenous ketorolac can relieve post-operative pain following digestive surgery, as measured by the NRS.
2. Intravenous lidocaine can relieve post-operative pain following digestive surgery, as measured by the NRS.

METHOD

Research Population

The population in this study consisted of all patients who had undergone digestive surgery in the recovery room at Dr. Soetomo General Hospital.

Research Sample

The sample population is the population that meets the inclusion and exclusion criteria with a minimum sample size calculated based on the minimum sample formula. The research sample consists of all patients who have undergone digestive surgery in the recovery room at Dr. Soetomo General Hospital who meet the inclusion criteria.

Inclusion Criteria

1. Patients aged 18 to 60 years.
2. Patients who have undergone digestive surgery and are being treated in the recovery room.
3. Patients who are cooperative and able to communicate well.
4. The patient's family or the patient signs an informed consent form.

Exclusion Criteria

1. Patients allergic to the medications to be administered, namely amide-type local anaesthetics, ketorolac, paracetamol, and tramadol.
2. Use of other local anaesthetics in large quantities.
3. Patients in shock.
4. Patients with acute tachyarrhythmia (rapid AF) or undergoing treatment with amiodarone.
5. Patients with bradycardia.
6. Patients with renal impairment, Blood Urea Nitrogen 50mg/dL and serum Creatinine greater than 5mg/dL.
7. Patients with liver impairment, Serum Glutamic Oxaloacetic Transaminase and Serum Glutamic Pyruvic Transaminase above 500 IU/L.

Sampling Techniques

The sample size for this study was determined using a P1 value of 0.2, taken from patients experiencing moderate pain with an NRS score of 4-6 at 120 minutes, amounting to 4 out of 24 samples in the intravenous lidocaine treatment group, and a P2 value of 0.6, taken from patients experiencing moderate pain with an NRS score of 4-6 at minute 120, which amounted to 14 out of 24 samples in the control treatment group. These figures were taken from a previous study conducted by Sipahutar et al. (2013), which was quite similar to this study [22]. With a significance level of 5% and a statistical test power of 90%, the minimum sample size required for the two groups in this study was 30 patients.

Operational Definition of Variables

Table 1. Operational definitions of variables

No	Variable	Definition	Unit	Data Scale
1.	Treatment	Administration of intravenous lidocaine or ketorolac to patients	Patient Treatment	Nominal
2.	NRS value	Numerical assessment of pain experienced by patients	NRS Score (0-10)	Ordinal

Data Analysis

The research results consist of trends from NRS every 15 minutes during 120 minutes of observation in the recovery room, frequency and percentage of mean values, minimum values, and maximum values, which will be presented descriptively using numbers and percentages for categorical variables. Statistical analysis was performed using the SPSS 26 program. The Wilcoxon-Mann-Whitney test was performed. To examine differences before and after the intervention, the Wilcoxon signed-rank test was used. Results were considered statistically significant if the p-value was <0.05 with a 95% confidence level.

RESULT

Characteristics of Research Subjects

A total of 30 post-operative digestive surgery patients who met the inclusion criteria were divided into two groups: the Ketorolac group (n = 15) and the Lidocaine group (n = 15). The basic characteristics of the subjects included gender, age, and body mass index (BMI).

Table 2: Characteristics of research subjects

Variable	Ketorolac (n=15)	Lidocaine (n=15)	p-value
Gender			0,456[a]
Male	10 (66,7)	8 (53,3)	
Female	5 (33,3)	7 (47,7)	
Age (years)	42,73 ± 9,01	41,53 ± 7,92	0,701[b]
BMI (kg/m²)	22,58 ± 2,94	24,53 ± 7,60	0,361[b]
Rescue fentanyl administration	6 (40)	5 (33,3)	
Median administration	0 (0 – 8)	0 (0 – 8)	0,791[c]
Mean ± SD (µg)	1,53 ± 2,39	1,40 ± 2,41	
[a]chi-square test; [b]independent t-test; [c]Mann-Whitney test			

Based on Table 2, the gender distribution between the two groups shows that the Ketorolac group consisted of 66.7% males and 33.3% females, while the Lidocaine group consisted of 53.3% males and 46.7% females. The Chi-Square test showed no significant difference (p = 0.456).

The mean age of patients in the Ketorolak group was 42.73 ± 9.01 years, while in the Lidocaine group it was 41.53 ± 7.92 years (p = 0.701). The mean BMI was also not significantly different between the Ketorolac group (22.58 ± 2.94 kg/m²) and the Lidocaine group (24.53 ± 7.60 kg/m², p = 0.361).

Most patients did not require additional fentanyl in the first 120 minutes. Nine patients (60%) in the Ketorolac group and 10 patients (66.7%) in the Lidocaine group did not require rescue analgesia. The median number of rescue fentanyl administrations in both groups was the same, i.e. 0 (0–8), with a mean ± SD of 1.53 ± 2.39 µg and 1.40 ± 2.41 µg, respectively, indicating that the need for additional analgesia in both groups was very low and not significantly different. Thus, both groups were homogeneous in terms of baseline characteristics and could be validly compared in subsequent analyses.

Numerical Rating Scale on the administration of Ketorolac and Lidocaine

The Shapiro–Wilk normality test showed that NRS data at most measurement times were not normally distributed (p < 0.05 at several points in time), so the data were presented as the median (min–max).

Table 3: Results of numerical rating scale measurements

Time	Ketorolac	Lidocaine	p-value
NRS 0 minutes	6 (1 – 10)	5 (2 – 10)	0,950
NRS 15 minutes	5 (1 – 9)	5 (2 – 9)	0,946
NRS 30 minutes	5 (1 – 9)	5 (2 – 8)	0,950
NRS 45 minutes	5 (1 – 8)	5 (2 – 8)	0,930
NRS 60 minutes	4 (1 – 8)	4 (1 – 8)	0,800
NRS 75 minutes	4 (1 – 8)	4 (1 – 7)	0,790
NRS 90 minutes	3 (1 – 7)	3 (1 – 7)	0,924
NRS 105 minutes	3 (1 – 7)	3 (1 – 7)	1,000
NRS 120 minutes	2 (1 – 6)	3 (1 – 6)	0,843

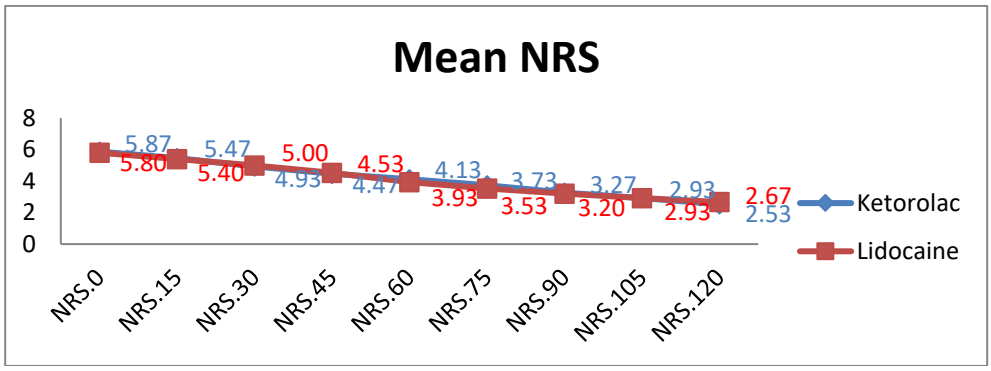

Figure 1: Average NRS trend every 15 minutes for the Ketorolac and Lidocaine groups

The median initial NRS score in the Ketorolac group was 6 (1–10) and in the Lidocaine group was 5 (2–10). There was a gradual decrease in pain scores up to 120 minutes, with a final median of 2 (1–6) in Ketorolac and 3 (1–6) in Lidocaine. The Friedman test showed a significant decrease over time in both groups ($p < 0.001$), indicating meaningful intra-group analgesic efficacy. However, the Mann–Whitney test between groups showed no significant differences at any measurement point ($p > 0.05$).

Declining Trend Analysis

The Friedman test of NRS scores showed significant results ($p < 0.001$) for both groups, indicating a consistent reduction in pain throughout the observation period.

Table 4: Friedman test analysis

Group	NRS χ^2 (df = 8)	p-value
Ketorolac	102,24	<0,001
Lidocaine	109,09	<0,001

The Friedman test results showed a highly significant decrease in pain scores ($p < 0.001$) at all observation points. This indicates that both ketorolac and lidocaine provide rapid and stable analgesic effects without any significant differences between the two.

DISCUSSION

Characteristics of Research Subjects

From the basic characteristics table (Table 2), it can be seen that the proportion of males and females in the Ketorolac group was 66.7% males and 33.3% females, while in the Lidocaine group it was 53.3% males and 46.7% females. The Chi-Square test showed no significant difference between the groups ($p = 0.456$), indicating that the gender distribution was relatively balanced between the two groups. This balance in baseline characteristics is important to avoid confounding that may arise from demographic variables such as gender, which are known to affect patients' pain perception and analgesic response [23].

The mean age of patients in the Ketorolac group was 42.73 ± 9.01 years, while in the Lidocaine group it was 41.53 ± 7.92 years ($p = 0.701$). A p-value > 0.05 indicates no significant difference in age between the groups. Age homogeneity between groups is an important prerequisite in comparative analgesia studies because age can affect drug metabolism, pharmacodynamic and pharmacokinetic changes with age, and pain response variability [24]. Therefore, age equivalence between groups confirms the internal validity of the results of this study.

Furthermore, the mean Body Mass Index (BMI) in the Ketorolac group was 22.58 ± 2.94 kg/m², while in the Lidocaine group it was 24.53 ± 7.60 kg/m² ($p = 0.361$). A p-value greater than 0.05 indicates that there was no significant difference between groups for the BMI variable. BMI is often an important factor in post-operative pain analysis because obesity or excess weight can increase the risk of more severe post-operative pain, increased inflammation, and impact analgesic response [2]. Thus, the stability of BMI values between groups in this study helps to ensure that BMI variability does not systematically affect the results of analgesic comparisons.

Comparison of Numeric Rating Scale Measurements in the Administration of Intravenous Lidocaine and Ketorolac

This study analysed the analgesic efficacy of two intravenous regimens of Ketorolac and Lidocaine in patients after digestive surgery, with the primary evaluation being pain intensity scores using the Numeric Rating Scale (NRS) instrument. This scale was chosen because it is the standard at Dr. Soetomo General Hospital and in post-operative pain studies, providing a quantitative measure that allows for comparison between groups when the study design meets the criteria for homogeneity of baseline characteristics, as in this study. In this case, the Ketorolac and Lidocaine groups were found to be not significantly different in demographic variables (age, gender, BMI), allowing for NRS analysis between groups to be conducted under the assumption that differences in analgesic efficacy were not due to differences in baseline characteristics.

Based on the research data, NRS scores showing a significant decrease over time in both groups indicate that both ketorolac and

lidocaine provide analgesic effects within 120 minutes postoperatively. However, intergroup analysis showed that there were no significant differences at any time point between the Ketorolac and Lidocaine groups (Mann–Whitney test for NRS data; all $p > 0.05$). This means that in the context of the observation period up to 120 minutes, the pain response reported through NRS was equivalent between the two interventions.

Research and systematic reviews indicate that intravenous Ketorolac provides significant postoperative analgesia [25]. A Cochrane review states that intravenous administration of Ketorolac can offer substantial pain reduction for most patients after surgery [8]. A study by Amini et al. [26] comparing Ketorolac + Lidocaine in Bier blocks showed that the analgesic combination significantly reduced morphine consumption compared to the control group. Conversely, for intravenous Lidocaine, several studies indicate that intraoperative or postoperative Lidocaine infusion significantly reduced pain scores and opioid consumption compared to the control group. For example, a study in laparoscopic colon patients found that Lidocaine infusion reduced pain scores in the first 24 hours ($p < 0.05$) compared to the control group [24,25,27,28].

Direct comparisons between Ketorolac and intravenous Lidocaine are relatively rare. However, one RCT showed that patients receiving Ketorolac plus Nasocalcin reported an average VAS score of 4.5 at 24 hours, compared to 5.1 in the Lidocaine plus Nasocalcin group ($p < 0.001$) after abdominal surgery [29]. This study demonstrated the superiority of Ketorolac over Lidocaine in combination with Nasocalcin (nasal spray) and over a longer observation period (24 hours). This differs slightly from the results of this study, which showed equivalent efficacy over a 120-minute period.

In intravenous lidocaine studies, long-term infusion or up to 24 hours had a greater effect on outcomes such as pain reduction, opioid consumption, and gastrointestinal function recovery. For example, a BMC review states that intraoperative Lidocaine infusion reduces opioid consumption and pain intensity with a median cumulative morphine of 0 (0–1) mg vs 4 [1–8] mg ($p < 0.001$) in 24 hours [27]. This indicates that lidocaine also has good analgesic efficacy, but the results are highly dependent on infusion duration, type of surgery, and multimodal analgesia regimen.

From the above literature, it was found that: (1) Intravenous ketorolac is an effective NSAID analgesic postoperatively, (2) Intravenous lidocaine is also effective, especially in multimodal regimens and longer observation periods, and (3) Direct comparative studies of intravenous ketorolac versus lidocaine are still limited. The results of this study, which showed no difference up to 120 minutes, are reasonable given the limitations of the time interval and design.

Postoperative pain is the result of the activation of a complex nociceptive system. This process includes the stages of transduction, transmission, perception, and modulation. Both ketorolac and lidocaine act on several different stages but ultimately converge on a reduction in the activity of nociceptive neurons in the spinal cord and central nervous system, resulting in similar analgesic effects at the level of patient perception.

Ketorolac is a non-selective non-steroidal anti-inflammatory drug (NSAID) that inhibits cyclooxygenase enzymes (COX-1 and COX-2), thereby reducing prostaglandin synthesis in peripheral tissues and the central nervous system. Prostaglandins, particularly PGE_2 are important mediators that lower the activation threshold of nociceptors and enhance pain transmission in the dorsal horn of the spinal cord [2,30]. By suppressing prostaglandin formation, Ketorolac reduces peripheral and partial central hyperalgesia, producing a rapid analgesic effect within 30-60 minutes after intravenous injection [31].

In contrast, lidocaine is an amide-class local anaesthetic that works by blocking voltage-gated sodium channels (VGSCs) in the membrane of afferent neurons. This blockage of sodium channels prevents depolarisation, thereby inhibiting the transmission of pain impulses from the periphery to the spinal cord. In addition to its conduction effects, intravenous lidocaine has systemic effects as it reduces the activity of central sensitisation neurons, inhibits the release of excitatory neurotransmitters such as glutamate, and suppresses NMDA receptor activation [31,32]. Lidocaine also has anti-inflammatory effects through the reduction of pro-inflammatory cytokine release (IL-1β, IL-6, TNF-α) from neutrophils and macrophages [32,33].

Intravenous lidocaine has been shown to reduce IL-6 and TNF-α concentrations in patients after major abdominal surgery [27,31]. Similarly, ketorolac inhibits COX-2 induction, which also plays a role in regulating IL-6 cytokine release, resulting in a reduction in systemic cytokine levels postoperatively [9]. In other words, although the initial molecular targets are different, both drugs suppress the same inflammatory pathway through inhibition of NF-κB signal transduction and reduction of inflammatory mediators. These parallel anti-inflammatory effects may explain why the differences in pain intensity perceived by patients are not significant.

Another important factor that may explain the absence of significant differences is the ceiling effect phenomenon in multimodal analgesia. In this study, all patients received standard general anaesthesia, with the possibility of intraoperative opioid administration or other agents such as paracetamol or inhalation anaesthetics that have residual analgesic effects. This combination produced a cumulative analgesic effect in the early postoperative phase. Once the combined analgesic effect had reached the maximum threshold that patients could perceive, the additional effects of ketorolac or lidocaine may not have increased the clinically measurable difference as assessed by the NRS.

A similar phenomenon is described by O'Neill & Lirk [34], that after achieving a ≥ 50% reduction in pain from baseline, the patient's subjective sensitivity to distinguish additional levels of pain is greatly reduced, so that small differences between drugs become statistically undetectable. Thus, in the first 120 minutes postoperatively, a period in which the effects of intraoperative anaesthesia and opioids are still significant, the additional effects of ketorolac or lidocaine will be below the patient's perception threshold.

In addition to pharmacological factors, individual variability also influences pain perception and response to analgesics. Genetic, psychological, and hormonal factors play an important role. Research shows that cortisol levels, preoperative anxiety levels, and

differences in COX and VGSC receptor sensitivity can modulate pain perception [35]. With a sample size of 15 patients per group, these individual variations can result in large fluctuations in NRS scores, masking small differences between interventions.

In addition to comparable reductions in NRS scores, the number of rescue fentanyl administrations was also not significantly different between the Ketorolac and Lidocaine groups ($p = 0.791$). The low average fentanyl administration in both groups indicates that pain control was adequate with each primary analgesic regimen, resulting in minimal need for additional opioids. This supports the finding that, physiologically, both drugs have equivalent analgesic efficacy in the acute postoperative phase.

Research Limitations

This study was designed with consideration given to the principles of homogeneity of basic characteristics and good internal validity, but there are several limitations that need to be considered in interpreting the results. First, due to the limitations of the equipment, namely the post-operative monitor in the inpatient ward, patient observation could only be carried out in the recovery room, as the administration of intravenous lidocaine required monitoring, meaning that observation could only be carried out for 120 minutes.

Second, the short observation period (120 minutes) may not have been sufficient to capture the different analgesic dynamics between the two drugs, which have different pharmacokinetic profiles and durations of action. The analgesic effect of intravenous lidocaine tends to be more beneficial in the later postoperative phase (6–24 hours), while ketorolac has an earlier peak effect and may decline after a few hours. Thus, a longer observation period would offer a more comprehensive picture of the efficacy profiles of both agents.

Third, other clinical variables that could potentially influence pain perception, such as perioperative anxiety levels, the duration and type of surgery, and the use of opioids or intraoperative anaesthetics, were not analysed in this study. These factors may play a role in reducing the sensitivity of the results to differences between groups. In addition, pain assessment using the subjective NRS instrument still has inter-individual variation that can affect the precision of the results.

Finally, this study was conducted in a single clinical setting (Dr. Soetomo General Hospital), so generalisation of the results to different populations should be done with caution. A multicentre study with a larger sample size and longer observation period will be required to validate these findings and determine whether the equivalent efficacy between Ketorolac and Lidocaine also applies broadly to other post-operative patient populations.

CONCLUSION

Based on the results of data analysis and discussion, several conclusions can be drawn as follows:

1. Intravenous ketorolac and intravenous lidocaine can relieve post-operative pain following digestive surgery, as indicated by low NRS scores when patients leave the recovery room.
2. Intravenous ketorolac and intravenous lidocaine have similar analgesic effects up to 120 minutes, as indicated by NRS scores that are not significantly different.

Based on the research results and limitations described above, the following recommendations can be made:

1. As there is no difference between the two agents, the choice between them can be adjusted according to the patient's clinical condition, drug contraindications, and hospital facility availability.
2. It is recommended that studies with longer observation periods (minimum 6–24 hours post-operatively) be conducted to evaluate the differences in efficacy and duration of analgesia between lidocaine and ketorolac more comprehensively. Measuring additional parameters such as inflammatory cytokine levels (IL-6, TNF-α), additional opioid requirements, gastrointestinal function recovery time, and systemic side effects will enrich our understanding of the physiological and clinical analgesic mechanisms of both agents.

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