Original Article

Effect of Postoperative Methylprednisolone on Swelling and Pain After Mandibular Third Molar Surgery: A Randomized Controlled Trial

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ABSTRACT

Background: Pain and swelling are common inflammatory complications following mandibular third molar surgery. Corticosteroids are widely used to control postoperative inflammation and improve patient comfort. However, evidence regarding the effectiveness of low-dose postoperative methylprednisolone, particularly at an 8 mg dose, remains limited, especially in low- and middle-income countries (LMICs). This study aimed to evaluate the effectiveness of an 8 mg dose of methylprednisolone on postoperative pain intensity and facial swelling following surgery.

Methods: This study employed a parallel-group, two-arm randomized controlled trial design conducted in accordance with the CONSORT guidelines. A total of 30 patients who met the inclusion criteria were randomly assigned to either the intervention group (8 mg methylprednisolone) or the control group (standard care), with 15 participants in each group. The independent variable was methylprednisolone administration, while the dependent variables included pain intensity measured using the Visual Analog Scale (VAS) and facial swelling. Outcome assessments were performed on postoperative days 1, 3, and 7. Statistical analyses were used for independent t-tests.

Results: Pain intensity was lower in the methylprednisolone group than in the control group at all postoperative time points, with large between-group effect sizes observed on day 1 ($p = 0.003$; Cohen's $d = 1.42$), day 3 ($p = 0.020$; Cohen's $d = 1.36$), and day 7 ($p = 0.007$; Cohen's $d = 1.18$). Facial swelling also differed between groups, showing a lower degree of swelling in the methylprednisolone group during postoperative days 1–3 ($p = 0.029$; Cohen's $d = 0.98$) and days 3–7 ($p = 0.002$; Cohen's $d = 0.87$), indicating consistently large effects across outcomes.

Conclusion: Low-dose methylprednisolone is statistically and clinically effective in reducing postoperative pain and swelling following surgery and may be integrated as a safe and cost-effective adjuvant therapy in postoperative dental care.

Keywords: Methylprednisolone; Mandibular Third Molar Surgery; Postoperative Pain; Facial Swelling; Corticosteroids.

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Implications for Practice:

- Post-odontectomy therapeutic protocol recommending methylprednisolone 8 mg as part of standard postoperative therapy to minimize inflammation, accelerate recovery, and support clinical decision-making.
- Integrated pain management by combining methylprednisolone with nonsteroidal analgesics such as meloxicam to enhance control of pain and swelling through a synergistic anti-inflammatory effect.
- Clinical safety and quality-of-care improvement through careful monitoring of dosage, treatment duration, and potential side effects—particularly in patients with systemic conditions or long-term corticosteroid exposure—while updating clinical guidelines and educating patients about the benefits and safe use of corticosteroids to improve treatment effectiveness and patient comfort during recovery.

Introduction

The procedure of tooth extraction of the mandibular third molar (M3M) is the removal of a tooth in a state of inability to grow or partially grow through surgery (Albanese et al., 2023; Frasseck, 2023; Hamad, 2024). The global prevalence of dental impaction cases varies widely. Studies have reported prevalence rates ranging from 3% to 68.6%. This high variability is thought to be associated with heterogeneity among populations worldwide. Age distribution indicates that dental impaction most commonly occurs between 17 and 25 years, a period when third molars begin to erupt (Alamri et al., 2020; da Silva Menezes et al., 2024; Mushtaq Bhat & Mir, 2019). In Indonesia, the prevalence of dental impaction has been reported at Brawijaya University Education Hospital revealing that 60.6% of patients experienced M3M impaction (Septina et al., 2021). Another report from Bali showed that out of a total of 233 subjects, the prevalence of partially impacted third molars was 61.37% (Sumadi et al., 2025).

Post M3M surgery, pain and swelling are the main manifestations of the tissue inflammatory response resulting from surgical trauma to both soft and hard tissues (Al Khaq et al., 2022; Tammama et al., 2024). Complications that often occur include iatrogenic (e.g., nerve injury, fracture, *dry socket*, pain after surgery, infection, swelling, *trismus* and others which affect the patient's quality of life after the procedure (Ginanjar et al., 2022). Clinically, these complaints typically arise within 6–12 hours after the effects of local anesthesia subside and reach their peak at 24–72 hours postoperatively (Deliverska & Petkova, 2016). In the context of healthcare services, including perioperative nursing and dental nursing practice, this condition requires pain and inflammation management that is effective, safe, and easy to apply, particularly in healthcare facilities with limited resources. Uncontrolled pain and swelling not only increase patient discomfort but may also interfere with nutritional intake, communication, daily activities, and the wound-healing process.

Theoretically, the postoperative inflammatory response involves activation of the arachidonic acid pathway, increased levels of inflammatory mediators such as prostaglandins, leukotrienes, and proinflammatory cytokines (e.g., IL-6), as well as increased vascular permeability leading to swelling and nociceptor sensitization (Abdulkhaleq et al., 2018). The pharmacological framework commonly used to explain this phenomenon is the acute inflammatory response model, in which anti-inflammatory interventions aim to suppress the early phase of inflammation, thereby reducing the severity of pain and swelling. The swelling that occurs can be reduced, one of which is by taking corticosteroid drugs (Stone et al., 2021). The most commonly used corticosteroid

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drug is *methylprednisolone*. Methylprednisolone works by inhibiting the enzyme phospholipase A2, thereby reducing the formation of arachidonic acid and its downstream inflammatory mediators. *Methylprednisolone* has the advantage, namely, it has an effective glucocorticoid effect to suppress inflammatory reactions, so that it does not cause fluids and salts to be retained in the body and can reduce swelling (Reichardt et al., 2021).

A previous study by Libório et al. (2024) demonstrated that methylprednisolone is effective and safe in patients after third molar extraction, reducing pain, swelling, and trismus. Other studies on corticosteroids have also been reported. A study by Miroshnychenko et al. (2023) showed that there were only very small differences in postoperative pain intensity and side effects of corticosteroids administered orally, submucosally, or intramuscularly. Another study by Antonelli et al. (2023) on corticosteroid use found that preoperative administration of low-dose prednisone could reduce postoperative sequelae by improving patient comfort after M3M surgery and decreasing facial swelling two days and one week after the surgical procedure. However, evidence regarding the effectiveness of low-dose postoperative methylprednisolone, particularly at an 8 mg dose, remains limited, especially in low- and middle-income countries

From a nursing and healthcare practice perspective, postoperative pain and inflammation control is an integral part of holistic patient care. Nurses play a crucial role in monitoring patient responses to pharmacological therapy, early detection of corticosteroid side effects, and patient education regarding medication adherence and postoperative warning signs. Therefore, scientific evidence regarding the effectiveness and safety of methylprednisolone after M3M surgery is relevant not only for dentists but also for nursing professionals and policymakers in developing evidence-based postoperative care protocols.

This study aims to quantitatively assess the effect of administering 8 mg methylprednisolone on the degree of facial swelling and pain intensity in patients after M3M surgery compared with patients who do not receive methylprednisolone at Clinic X. This study is expected to provide an evidence-based foundation for healthcare professionals, particularly dentists and nurses, in determining the effective and safe use of methylprednisolone as part of postoperative pain and swelling management following M3M surgery in healthcare facilities.

Methods

Study Design

This parallel-group randomized controlled trial (CONSORT-compliant) included 30 patients recruited through consecutive sampling and randomly allocated using simple randomization. Pain intensity (VAS) and facial swelling were assessed on postoperative days 1, 3, and 7. Data were analyzed using independent t-tests with a significance level of $p < 0.05$.

Participants

The study was conducted in Indonesia at Clinic X during the period from December 2021 to January 2022. The study population consisted of patients undergoing M3M surgery. Sampling was performed using consecutive sampling, in which all patients who met the inclusion criteria during the study period were recruited until the required sample size was achieved. Eligible subjects were then randomly assigned to the intervention group or the control group using simple randomization.

The inclusion criteria were: (1) patients aged 18–40 years; (2) undergoing impacted

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M3M surgery; (3) in good general health; and (4) willing to participate in the entire study by signing informed consent.

The exclusion criteria were: (1) a history of allergy to corticosteroids or nonsteroidal anti-inflammatory drugs; (2) the presence of systemic diseases that could affect the wound-healing process; (3) prior use of corticosteroids before the procedure; and (4) the occurrence of severe intraoperative complications.

A total sample of 30 respondents (15 respondents per group) was determined based on subject availability during the study period. The sample size of 30 participants was determined based on recruitment feasibility in a single clinic during a limited study period. Formal power analysis was not conducted; therefore, the sample size is acknowledged as one of the study's limitations. All respondents completed the study until the end, and no participants were lost to follow-up (dropouts).

Instruments

Pain intensity assessment was conducted using the Visual Analog Scale (VAS) by providing a 10-cm paper scale divided according to pain levels: 0–10 mm indicating no pain, 11–30 mm mild pain, 31–70 mm moderate pain, 71–90 mm severe pain, and 91–100 mm very severe pain (Modarresi et al., 2022). Subjects were asked to mark the pain scale that best represented the pain they experienced on that day. To ensure uniformity in VAS perception, calibration was performed through direct communication with the subjects as well as direct observation of nonverbal behaviors (grimacing, crying, gait changes, abnormal posture) and verbal expressions. These observations were conducted during control visits to achieve a shared understanding of pain perception between the subjects and the researcher.

Facial swelling was measured by assessing the anatomical distance from the pogonion to the mandibular angle using a cloth measuring tape (Antonelli et al., 2023). This measurement approach has been commonly used in oral and maxillofacial surgery research and has demonstrated acceptable validity and reliability for evaluating postoperative facial swelling when performed consistently. To ensure measurement accuracy, all swelling assessments were conducted using the same measuring tape and performed by a single trained researcher following a standardized protocol. VAS sheets and data recording forms were prepared as supplementary materials.

No formal pilot testing was conducted before the main study because the instruments used (VAS and linear facial measurement) are standardized tools that have been widely applied in similar clinical contexts.

To minimize measurement error, pain intensity and facial swelling were measured repeatedly at predefined postoperative time points (days 1, 3, and 7). The same assessor performed all measurements, and participants received standardized instructions before completing the VAS to ensure consistent interpretation of the scale. These procedures were implemented to reduce inter-observer variability and enhance the reliability of the collected data.

Intervention

Participants in the intervention group received standard postoperative therapy consisting of amoxicillin 500 mg three times daily and meloxicam 7.5 mg once daily, in addition to methylprednisolone administered orally at a dose of 8 mg three times daily for three consecutive days following M3M surgery. The control group received the same standard therapy without methylprednisolone.

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The selection of an 8 mg dose of methylprednisolone was based on pharmacological considerations, indicating that low-dose corticosteroids are effective in suppressing acute inflammatory responses with minimal risk of side effects during short-term use (Belletti et al., 2025). Patient adherence to medication was monitored through direct confirmation at each follow-up visit. Safety monitoring was conducted by recording any potential side effects, such as nausea, dizziness, or gastrointestinal disturbances.

To ensure intervention fidelity, all participants received standardized written and verbal instructions regarding medication dosage, frequency, and duration at discharge. Medication adherence was assessed through direct confirmation during follow-up visits on postoperative days 1, 3, and 7, including patient self-report and verification of remaining medication. Any deviations from the prescribed regimen or potential adverse effects were recorded and monitored throughout the intervention period.

Data Collection

The study stages included: (1) subject recruitment and screening; (2) randomization into intervention and control groups; (3) performance of M3M surgery by the same operator; (4) administration of interventions according to group allocation; and (5) measurement of swelling and pain intensity on postoperative days 1, 3, and 7.

Enumerators involved in data collection underwent a one-day training session (approximately 4 hours) prior to the study. The training covered study objectives, ethical considerations, standardized administration of the Visual Analog Scale (VAS), facial swelling measurement techniques using fixed anatomical landmarks, and data recording procedures. Training materials included a written measurement protocol, demonstration sessions, and supervised practice to ensure procedural consistency.

Data collectors received brief training on measurement and data recording procedures to ensure consistency. Data were recorded on specific forms and securely stored in anonymized form. No data loss occurred during the study; therefore, all subjects were analyzed using a complete-case analysis approach (**Figure 1**).

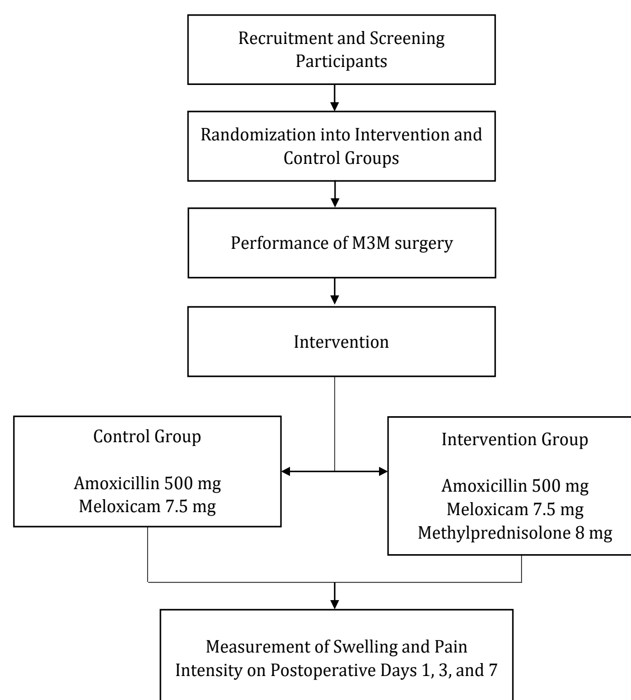

Figure 1. Workflow Diagram

Data Analysis

Data analysis was performed using IBM SPSS software version 24. Data normality was assessed using the Shapiro–Wilk test, while homogeneity of variance was evaluated using Levene's test. When data met the assumptions of normality and homogeneity ($p > 0.05$), parametric tests were applied; specifically, paired *t*-tests were used for within-group comparisons and independent *t*-tests for between-group comparisons. If one or both assumptions were violated ($p \leq 0.05$), nonparametric

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alternatives were employed, namely the Wilcoxon signed-rank test for within-group analysis and the Mann–Whitney U test for between-group comparisons.

Regarding missing data, all participants completed the study through the final follow-up, and no data were missing at any measurement point. Therefore, a complete-case analysis approach was applied. This procedure has been explicitly stated to clarify that no imputation or data replacement methods were required.

In addition to statistical significance testing, effect sizes were calculated using Cohen's *d* to provide a measure of the magnitude of the intervention effect. Interpretation of effect sizes followed standard guidelines, where values of approximately 0.2 indicate small effects, 0.5 moderate effects, and ≥0.8 large effects. Reporting both *p*-values and effect sizes was intended to enhance the clinical interpretability of the findings beyond statistical significance alone.

Ethical Considerations

This study received approval from the Health Research Ethics Committee under approval number 195/KEP/XII/2021 and was conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent after receiving a full explanation of the study's objectives, procedures, benefits, and potential risks. Data confidentiality was maintained through the use of anonymized codes, and the data were used solely for scientific purposes.

Results

Table 1. Demographic Characteristics of Respondents (n = 30)

Characteristic	Category	n	%
Gender	Male	17	56.7
	Female	13	43.3
Age (years)	18–25	19	63.3
	26–33	5	16.7
	34–40	6	20.0
Occupation	Student	14	46.7
	Private employee	9	30.0
	Self-employed	5	16.6
	Others	2	6.7
Education Level	Senior high school/equivalent	16	53.3
	Diploma	5	16.7
	Bachelor's degree	9	30.0

Table 1 shows that the majority of respondents were male (56.7%), with the largest age group being 18–25 years (63.3%). Most respondents were students, and the highest proportion had a final education level of senior high school or equivalent. All respondents completed the study to the end, with no loss to follow-up (dropouts).

Table 2. Normality and Homogenity Test Results

Variable	Group	Normality	Homogenity
Pain Intensity	Control	0.278	0.356
	Intervention	0.312	
Facial Swelling	Control	0.263	0.319
	Intervention	0.314	

Table 2 shows that all pain intensity and facial swelling data at all measurement time points had p-values greater than 0.05, confirming a normal data distribution. In addition, Levene's test showed p-values greater than 0.05 for all variables, indicating homogeneity of variance between groups. As both normality and homogeneity assumptions were satisfied, parametric statistical tests were applied for between-group comparisons.

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Table 3. Comparison of Pain Intensity (VAS) between the Methylprednisolone and Control Groups on Postoperative Days 1, 3, and 7

Measurement Day	Group	Mean ± SD (mm)	95% CI	Cohen's d	p-value
Day 1	Methylprednisolone (n = 15)	17.0 ± 6.8	13.2–20.8	1.42	0.003
	Control (n = 15)	66.0 ± 12.5	59.1–72.9		
Day 3	Methylprednisolone (n = 15)	6.0 ± 3.2	4.2–7.8	1.36	0.020
	Control (n = 15)	45.0 ± 10.4	39.3–50.7		
Day 7	Methylprednisolone (n = 15)	2.0 ± 1.5	1.2–2.8	1.18	0.007
	Control (n = 15)	25.0 ± 8.7	20.2–29.8		

Table 3 shows that the group receiving methylprednisolone consistently experienced lower pain intensity than the control group at all measurement time points—postoperative days 1, 3, and 7. Differences in mean pain scores between groups were evident from the first day and remained statistically significant through day seven, with p-values < 0.05 at each time point. The large effect sizes (Cohen's d > 1.0) indicate a strong effect, demonstrating that pain reduction was not only statistically significant but also clinically meaningful. These findings confirm that methylprednisolone administration is effective in suppressing postoperative pain by inhibiting inflammatory mediators from the early phase of inflammation.

Table 4. Comparison of Facial Swelling between the Methylprednisolone and Control Groups

Time Interval	Group	Mean ± SD (cm)	95% CI	Cohen's d	p-value
Days 1–3	Methylprednisolone	1.10 ± 0.32	0.93–1.27	0.98	0.029
	Control	1.60 ± 0.41	1.38–1.82		
Days 3–7	Methylprednisolone	1.00 ± 0.29	0.84–1.16	0.87	0.002
	Control	0.50 ± 0.25	0.36–0.64		

Table 4 shows that the degree of facial swelling in the methylprednisolone group was lower than in the control group during both the day 1–3 and day 3–7 postoperative intervals. These differences indicate that methylprednisolone is able to suppress the increase in swelling during the early inflammatory phase and accelerate the reduction of swelling during the subsequent healing phase. The large effect sizes (Cohen's d ≥ 0.8) and statistically meaningful 95% confidence intervals support the presence of a strong clinical effect of this intervention. These findings suggest that the use of methylprednisolone plays an important role in controlling the postoperative tissue inflammatory response following M3M surgery.

Discussion

This study demonstrates that postoperative administration of 8 mg methylprednisolone has a significant effect in reducing pain intensity and facial swelling in patients following M3M surgery. Statistically significant differences between the intervention and control groups were evident as early as the first postoperative day and persisted through day seven, with large effect sizes. These findings confirm that methylprednisolone is not only statistically effective but also provides clinically meaningful benefits in controlling the postoperative inflammatory response.

Regarding pain intensity, the results indicate that the group receiving

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methylprednisolone experienced a faster and more consistent reduction in pain compared with the control group at all measurement time points. Physiologically, postoperative pain after M3M surgery is a consequence of tissue trauma that triggers the release of inflammatory mediators such as prostaglandins, bradykinin, and proinflammatory cytokines. Methylprednisolone acts by inhibiting the enzyme phospholipase A2, thereby suppressing the formation of arachidonic acid and reducing prostaglandin production, which plays a key role in nociceptor sensitization. This mechanism explains why the intervention group exhibited lower pain intensity, even though both groups received nonsteroidal analgesics.

These findings are consistent with previous studies reporting that the use of corticosteroids in third molar surgery significantly reduces postoperative pain compared with therapy without corticosteroids. Libório et al. (2024) and Miroshnychenko et al. (2023) reported that corticosteroids are effective in suppressing pain and accelerating functional recovery. However, those studies were generally conducted in high-income countries with variations in dosage and timing of administration. Therefore, the present study makes an important contribution by demonstrating that a low dose of methylprednisolone (8 mg) is also effective within the context of healthcare services in low- and middle-income countries (LMICs).

In terms of facial swelling, this study found that the methylprednisolone group experienced a lower increase in swelling during the early inflammatory phase (postoperative days 1–3) and a faster reduction in swelling during the subsequent phase (postoperative days 3–7). Post M3M surgery swelling is associated with increased capillary permeability and accumulation of interstitial fluid due to acute inflammatory processes (Muhajir et al., 2020). Corticosteroids reduce vascular permeability and inhibit the migration of inflammatory cells to traumatized tissues, thereby more effectively limiting swelling volume (Saim et al., 2025).

These results are consistent with the acute inflammatory response theory and support the findings of Saim et al. (2025), who stated that corticosteroids play an important role in controlling postoperative swelling following oral surgery. The large effect sizes observed in this study indicate that differences in swelling between groups represent not merely clinical variation but a practically meaningful intervention effect. This is particularly relevant for young adult patients, for whom facial swelling may affect speech, eating, and social activities.

Another previous study by Antonelli et al. (2023) reported that preoperative administration of a low dose of prednisone (25 mg) was effective in reducing pain and facial swelling in patients after M3M surgery. This effect was attributed to the ability of corticosteroids to suppress the inflammatory response from the early phase of surgery by inhibiting inflammatory mediators, thereby reducing the severity of postoperative sequelae. These findings indicate that preoperative corticosteroid administration can improve patient comfort during the early recovery period. Meanwhile, the present study demonstrates that postoperative administration of methylprednisolone at a dose of 8 mg also results in clinically meaningful reductions in pain and facial swelling up to postoperative day seven. This suggests that effective control of postoperative inflammatory responses can be achieved through low-dose corticosteroid administration.

In low- and middle-income countries, including Indonesia, access to postoperative care is often constrained by limited resources, variability in follow-up

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compliance, and cost considerations. Cultural preferences for rapid symptom relief, early return to daily activities, and minimization of medication burden may influence both prescribing practices and patient adherence. In this context, the observed effectiveness of a low-dose methylprednisolone regimen is clinically relevant, as it aligns with the need for affordable, practical, and easily implementable postoperative interventions within resource-limited healthcare settings. Moreover, the availability and relatively low cost of methylprednisolone support its feasibility for wider implementation in primary and secondary healthcare facilities. Nevertheless, corticosteroid use requires careful clinical consideration, particularly in patients with comorbid conditions, and appropriate monitoring by healthcare professionals remains essential.

Implications and limitations

Conceptually, this study reinforces the framework of the acute postoperative inflammatory response by demonstrating that suppression of inflammatory pathways through low-dose corticosteroid administration is sufficient to produce meaningful clinical improvement. These findings contribute theoretically by validating that effective control of pain and swelling after M3M surgery does not necessarily depend on high doses or complex interventions, but rather on precise pharmacological targeting of key inflammatory mediators. Accordingly, this study expands understanding of the role of methylprednisolone in evidence-based inflammatory management models and supports the integration of rational pharmacological approaches into postoperative care practices, including within clinical nursing contexts.

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size and the single-center design limit the generalizability of the findings to broader populations. Second, no formal power analysis was conducted, and short-term or long-term side effects of methylprednisolone were not systematically evaluated. In addition, individual factors such as anxiety levels, pain thresholds, and social characteristics of respondents were not analyzed in depth. Therefore, future studies are recommended to employ multicenter designs with larger sample sizes and to include additional clinical and psychosocial variables to strengthen the external validity of the findings.

Relevance to Practice

The findings of this study indicate that low-dose methylprednisolone (8 mg), as part of postoperative therapy following M3M surgery, can be practically integrated into routine clinical practice to reduce pain and swelling effectively. For dental practitioners, methylprednisolone may be considered as an adjuvant therapy alongside standard analgesics in patients without contraindications, with brief monitoring for side effects and patient education regarding medication adherence. From a nursing perspective, these findings support the role of nurses in monitoring inflammatory responses, providing postoperative patient education, and detecting early corticosteroid-related side effects. For policymakers and healthcare administrators, the results provide a foundation for developing or updating evidence-based, low-cost, and easily implementable postoperative care protocols, particularly in healthcare facilities with limited resources.

Conclusion

This study demonstrates that short-term postoperative administration of low-dose methylprednisolone can effectively

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reduce pain intensity and facial swelling following mandibular third molar surgery. The findings highlight the potential clinical benefit of incorporating low-dose corticosteroids as an adjunct to standard postoperative care to improve patient comfort during the early recovery period. However, the results should be interpreted with caution. Although no adverse effects were observed during the study period, this research did not include a systematic assessment of corticosteroid-related side effects. Therefore, methylprednisolone should be considered for short-term postoperative use only and prescribed to patients without contraindications, with appropriate clinical monitoring.

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CrediT Authorship Contributions Statement

Gabriella Debora Alvionita Situmorang: Conceptualization, Methodology, Writing - Original Draft, Project Administration

Borman Sumaji: Writing - Original Draft, Supervision

Dian Lesmana: Writing - Original Draft, Supervision

Leonardo Jaya Setiadi Tanumiharja: Review & Editing, Translation to English, Submission of Draft until Publication

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper"

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