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Original Article

Dexamethasone-Enhanced Lignocaine for Mandibular Third Molar Surgery: A Randomized Split-Mouth Clinical Trial

Samuel K. Otieno[1]*, Hana T. Desta[1], Yusuf A. Saleem[1]

[1]Department of Oral and Maxillofacial Surgery, School of Dentistry, University of Nairobi, Nairobi, Kenya.

***E-mail** ✉ samuel.otieno@gmail.com

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ABSTRACT

Surgical management of impacted mandibular third molars affects a region rich in blood supply and loose connective tissues, which commonly results in postoperative inflammatory reactions manifested as pain, edema, trismus, and temporary impairment of oral function. Within minor oral surgery, a comprehensive strategy to prolong anaesthetic action and lessen these unavoidable postoperative effects has not yet been thoroughly established. To assess whether incorporating dexamethasone into local anaesthetic solutions enhances the depth and duration of anaesthesia and decreases post-surgical complications following the extraction of impacted third molars. A controlled, randomized, split-mouth, double-blind prospective investigation was undertaken in 35 participants undergoing lower third molar removal. The experimental side (Group I) was administered 8 mg dexamethasone combined with 2 ml of 2% lignocaine with epinephrine, while the comparison side (Group II) received 2 ml sterile water added to 2 ml of 2% lignocaine with epinephrine. Measurements included onset and duration of anaesthesia, followed by assessments of pain, swelling, and mouth opening limitations across 7 postoperative days. Data were analyzed using independent t-tests and repeated-measures ANOVA. The dexamethasone group demonstrated a reduction in anaesthetic onset time by 69 s and an extension of duration by 128.4 min ($p < 0.001$). Pain levels during the initial 24 h (Visual Analogue Scale) were 4.9 versus 7.5 in the test and control groups, respectively ($p < 0.001$). Mean analgesic consumption through day 7 was 12.6 doses in Group I and 18.4 in Group II ($p < 0.001$). Postoperative swelling was markedly reduced in the dexamethasone group, and trismus was also diminished by 1 cm on days 1 and 2 and by 0.2 cm on day 7. Supplementing lignocaine with dexamethasone during nerve blockade accelerates the onset, prolongs anaesthetic duration, and significantly reduces pain, edema, and trismus. Direct incorporation of steroids into the local anaesthetic solution may substantially limit postoperative complications in third molar surgeries while requiring only a single injection.

Keywords: Dexamethasone, Lignocaine, Third Molar, Mandibular, Split-Mouth

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Introduction

Removal of impacted third molars is a common minor oral surgical task carried out with local anaesthesia. Numerous pharmacologic and non-pharmacologic strategies have been proposed to improve postoperative comfort after such procedures [1]. Inadequate depth and short duration of local anaesthesia may result in unnecessary discomfort during minor surgeries [2].

Extraction of third molars frequently leads to pain, swelling, bleeding, infection, trismus, and transient or lasting paraesthesia [3–5]. These postoperative reactions originate from inflammatory pathways, including vasodilation and the release of mediators such as histamine, bradykinin, and prostaglandins [6–8].

Evidence from other surgical fields [9–12] and in vivo experiments has shown that corticosteroids used

alongside local anaesthetics can extend their duration. Perineural dexamethasone as a supplement to peripheral nerve blocks has been linked to faster onset, prolonged anaesthesia/analgesia, reduced postoperative pain, and lower analgesic consumption relative to anaesthetic alone [13–16].

The prolonged analgesia associated with dexamethasone may stem from several mechanisms:

(a) activation of glucocorticoid receptors resulting in vasoconstriction and reduced systemic uptake of the anaesthetic [16];

(b) suppression of C-fibre pain transmission and a direct reduction in neuronal firing [17, 18].

Research specifically addressing the combination of dexamethasone with local anaesthetics in Oral and Maxillofacial Surgery remains limited [19–22]. Lignocaine, an amide-based anaesthetic, allows comfortable execution of minor surgeries without general anaesthesia. When paired with dexamethasone, it creates a formulation worthy of evaluation [23]. Prior work indicates that a lignocaine–dexamethasone mixture remains chemically stable, exhibits a higher pH, enhances comfort during injection, shortens onset time, and prolongs anaesthetic duration [24].

Dexamethasone, a synthetic glucocorticoid without mineralocorticoid activity [25], inhibits vascular dilation, fluid extravasation, and modestly reduces leukocyte migration, accounting for diminished swelling and trismus [26]. It is 25–50 times stronger than hydrocortisone, with a plasma half-life of 100–300 min and a biological half-life of 36–72 h, and is regarded as a highly potent anti-inflammatory agent [27].

At anti-inflammatory doses, it lacks hydrocortisone's sodium-retaining effects and also regulates transcription of anti-inflammatory genes [28–30]. A 4 mg dose produces roughly five times the normal endogenous cortisol output [31]. Its onset is around 1–2 h, allowing adequate time for membrane diffusion [32]. Corticosteroids are most effective within the first 24 h post-procedure, with activity extending up to three days [26].

The primary objective of this investigation was to determine how effectively dexamethasone, when combined with lignocaine and adrenaline, enhances the depth and prolongs the duration of local anaesthesia compared with the use of lignocaine and adrenaline alone. The secondary objective was to assess whether this steroid–anaesthetic formulation lessens postoperative outcomes, including pain, edema, and trismus, as well as to document any adverse reactions associated with administering the dual-agent mixture.

Materials and Methods

A prospective, randomized, split-mouth, double-blind clinical study was conducted at the Department of Oral and Maxillofacial Surgery, Manipal College of Dental Sciences, Mangalore. Individuals reporting to the outpatient clinic for surgical extraction of impacted mandibular third molars between December 2020 and November 2022 were enrolled. Using the specified formula, the required sample size was determined to be 70.

$$n = \frac{2[Z_{1-\frac{a}{2}} + Z_{1} - \beta]^{2}\sigma^{2}}{d^{2}} \quad (1)$$

$Z_{1-\frac{a}{2}}$=1.96 is a standard normal value at 5% level of significance.

$Z_{1}-\beta$=0.84 is a standard normal value at 80% power

σ = combined standard deviation = 2.195

d = clinically significant difference = 1.5

With a 95% confidence interval, the sample size in each bilateral was 35, and the total sample size was 70. After securing approval from the Institutional Ethics Committee (IEC), individuals presenting to the Oral and Maxillofacial Surgery outpatient clinic for management of impacted mandibular third molars were evaluated for study eligibility. Once written informed consent was obtained, 35 ASA II patients aged 18–45 years who required bilateral mandibular third-molar removal in class II position B and showed no evidence of acute inflammation, marked decay, pain, or pathology adjacent to the third molars were recruited. Exclusion criteria included: active infection, a history of peptic ulcer disease, diabetes mellitus, endocrine disturbances, hypertension, renal disorders, bleeding tendencies, obesity, hypersensitivity to any study-related materials, antibiotic use within the previous 2 weeks, NSAID use in the previous 1 week, pregnancy, lactation, or unwillingness to participate.

Screening

Individuals arriving at the Manipal College of Dental Sciences, Mangalore, for the extraction of impacted third molars underwent screening. During the initial consultation, bilateral impactions and adequate gingival coverage permitting flap closure without tension were confirmed clinically. Radiographic evaluation—using either an Orthopantomogram or intraoral periapical view—verified the tooth's position relative to surrounding structures. The medical and dental history, combined with imaging, was reviewed to identify any basis for exclusion. All potential participants were briefed on the surgery and the nature

of the clinical investigation. None displayed pain, trismus, or swelling at the time of extraction.

Randomization and blinding procedure

Upon confirming eligibility and obtaining written consent, demographic details (name, age, sex) and clinical variables (contraceptive use in the past month, psychotropic medication use, and smoking quantified as cigarettes per day) were documented. Each participant was assigned a unique identifier, and allocation of the surgical side was determined via simple randomization. Using Microsoft EXCEL, odd numbers were designated on the left side and even numbers on the right. The selected side received 2 ml of 2% lignocaine with 1:200,000 adrenaline plus 2 ml of 8 mg dexamethasone, whereas the alternate side was given 2% lignocaine with 1:200,000 adrenaline plus 2 ml of sterile water.

The opaque envelope technique was used for allocation concealment: each participant's materials were placed inside an opaque container labeled with the injection side and marked with their unique code. Blinding was maintained by having the operator administer injections using syringes prepared beforehand by a co-investigator who handled randomization and envelope management. The 5 ml syringes containing 2 ml of 2% lignocaine with 1:200,000 adrenaline plus 2 ml dexamethasone (8 mg) formed the test mixture, while control syringes contained 2 ml of 2% lignocaine with 1:200,000 adrenaline with 2 ml water. Each surgical side was assigned to one of the two formulations according to the randomization chart.

A single clinician performed all procedures, reducing variability. Prior to surgery, all participants rinsed with 0.12% chlorhexidine for 20 s. The allocated anaesthetic (test or control) was loaded into a 5 ml syringe, and inferior alveolar, lingual, and long buccal nerve blocks were delivered using a 26-gauge, 45 × 38 mm, 1.5-inch needle.

Microsoft EXCEL-generated numbers provided simple randomization for 35 impaction sites in each group, with each patient acting as their own control. Opaque envelopes ensured concealment throughout. Syringes were handed to the operator by the co-investigator, maintaining the allocation system.

The same surgical approach—buccal guttering combined with sectioning—was used for every patient. On the day of treatment, each participant received 1 g of amoxicillin prior to surgery. A single prophylactic dose was considered adequate for perioperative coverage while reducing the potential for adverse reactions and antibiotic resistance. Because extraction procedures did not exceed 3 h, no additional dosing was required. The 1 g dosage was selected since its plasma concentration comfortably exceeds the minimum inhibitory concentration for bacteria commonly implicated in surgical infections [33–36].

Facial measurements were obtained with 2–0 nylon and a millimeter ruler before the procedure and again at 24 h, 48 h, and 1 week post-operatively. Permanent markers were used to designate anatomical landmarks, including the angle of the mandible, tragus, labial commissure, nasal border, lateral canthus, and soft pogonion. The recorded distances were:

D1 – Angle of mandible to tragus
D2 – Angle of mandible to lateral canthus
D3 – Angle of mandible to nasal border
D4 – Angle of mandible to labial commissure
D5 – Angle of mandible to soft-tissue pogonion

Because postoperative edema involves irregular three-dimensional tissue expansion, exact quantification is challenging. The swelling that follows surgical trauma can intensify trismus, which itself arises from multiple contributing mechanisms.

Mouth opening was evaluated by determining the inter-incisal distance with a divider before surgery, and again at 24 h, 48 h, and 1 week after the intervention. All findings were documented on a standardized Proforma. Participants returned after 4 weeks for the extraction of the third molar on the opposite side using the identical workflow.

A total of 4 ml of local anaesthetic—combined with either dexamethasone or sterile injectable water—was delivered to anesthetize the inferior alveolar, lingual, and long buccal nerves, adhering to randomization and blinding procedures. The onset of numbness was noted as the interval from the injection to the point when the patient reported complete absence of pain to a gentle probe in the canine and molar areas, verified every 20 seconds. Removal of the impacted lower third molar was completed under local anaesthesia in an aseptic setting. Anaesthesia duration was defined from the first sensation of mild–moderate discomfort until the individual no longer felt pain to an atraumatic stimulus. All participants were given Paracetamol 650 mg orally as needed and instructed to use Chlorhexidine mouthwash three times daily.

Patients rated their discomfort using a 0–10 VAS scale, where 0 indicated no pain, and 10 represented maximal pain. The effective analgesic period of the nerve block was defined as the interval between the onset of numbness and the point when pain rose to a mild–moderate level.

Pain scores (VAS) and the number of analgesics consumed were recorded every 24 h for 1 week.

Postoperative swelling was assessed from facial linear measurements at 24 h (POD1), 48 h (POD2), and 1 week (POD7).

Trismus was documented by maximal inter-incisal opening at 24 h, 48 h, and 1 week. Subjects were seen again after 4 weeks for treatment of the contralateral side following the same protocol.

Data assessment was performed using IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY: IBM Corp.).

Quantitative variables—including anaesthetic onset and duration, facial swelling, pain scores, and mouth-opening values—were summarized as means with standard deviations for comparison between experimental and control arms.

Independent t-tests were used to compare the onset and duration of anaesthesia, swelling, pain intensity, and mouth opening between groups. Repeated-measures ANOVA examined changes in swelling and inter-incisal distance from baseline to 24 h, 48 h, and 1 week. A p-value <0.05 was considered statistically meaningful.

Normality testing confirmed that the variables followed a normal distribution, validating the use of t-tests.

The methodology was reported according to CONSORT guidelines [11]. The clinical trial was registered with CTRI (registration number: CTRI/2021/08/035560).

Results and Discussion

Enrolment and random allocation of participants are illustrated in **Figure 1.**

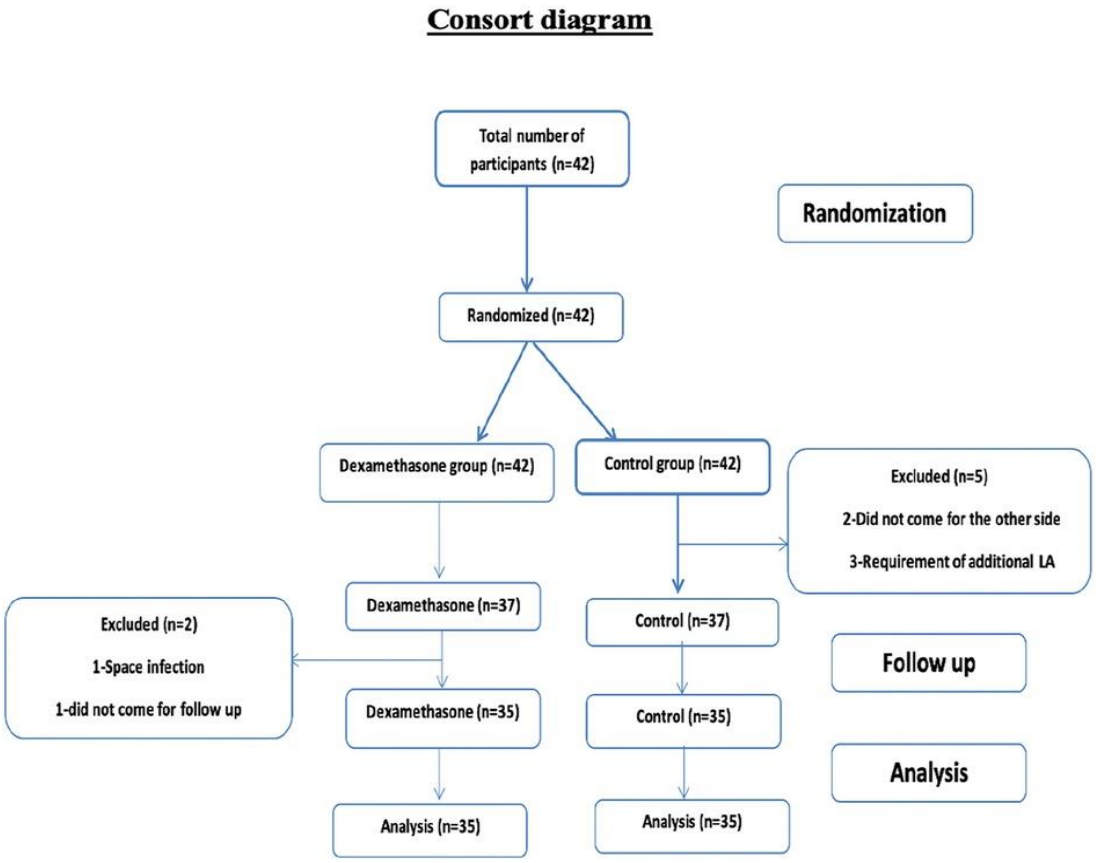

Figure 1. CONSORT diagram illustrating participant flow.

The values for anaesthetic onset and duration in the test versus control conditions are displayed in **Table 1**.

Table 1. Onset and duration of anaesthesia in test and control groups.

Parameter	Test Group Mean	Test Group SD	Control Group Mean	Control Group SD	p-value
Onset (seconds)	118.7	34.7	187.7	52.5	<0.001
Duration (minutes)	240.3	44.3	111.9	24.3	<0.001

Facial swelling, calculated using distances between fixed anatomical landmarks (D1–D5) **(Figures 2–5)**, was significantly lower in the test group ($p < 0.001$) compared with the control arm **(Tables 2–6)**.

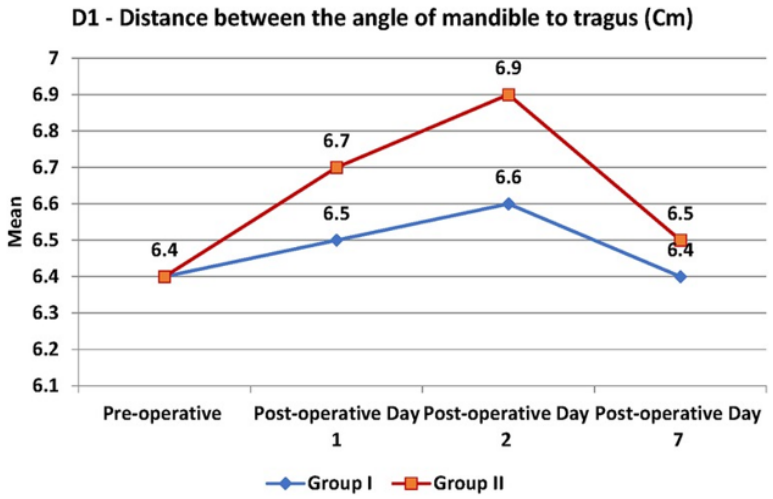

Figure 2. D1—distance from mandibular angle to ear tragus.

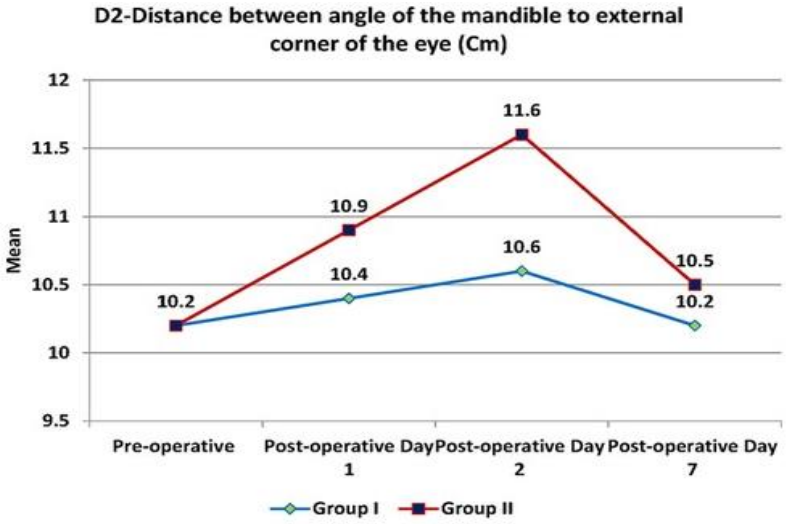

Figure 3. D2—distance from mandibular angle to external canthus.

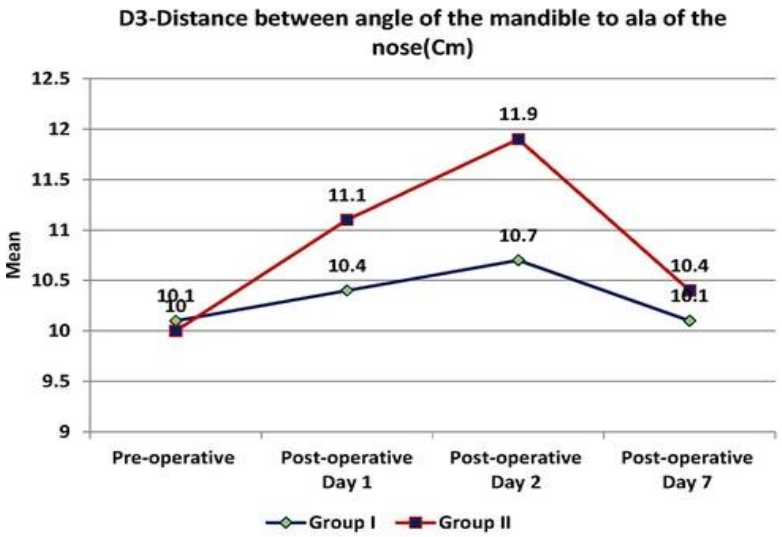

Figure 4. D3—distance from mandibular angle to nasal ala.

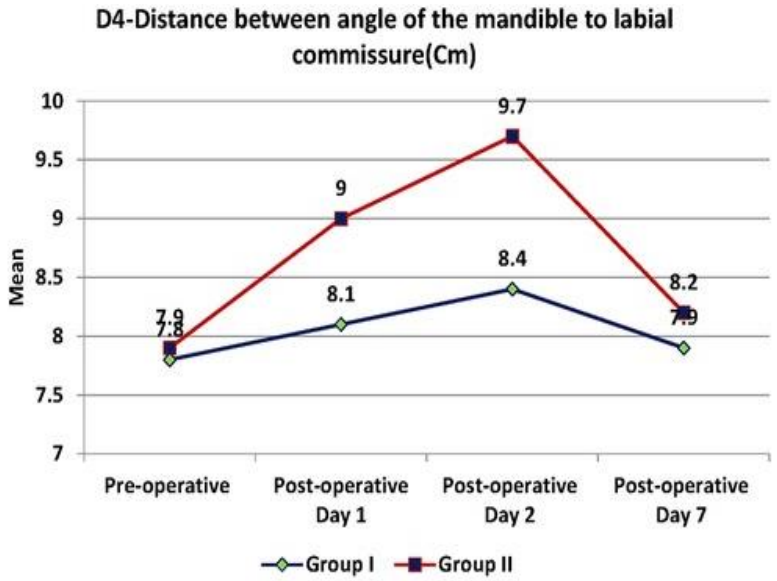

Figure 5. D4—distance from mandibular angle to oral commissure.

Table 2. D1—Mandibular angle to tragus distance.

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	6.4	0.9	6.4	0.9	0.999
First day after surgery	6.5	0.9	6.7	1.0	0.408
Second day after surgery	6.6	1.0	6.9	1.1	0.135
Seventh day after surgery	6.4	0.9	6.5	1.0	0.766
Between-group comparison					0.500
Within-subject change over time					<0.001

Baseline distance was 6.4 cm in both groups. In group I, values were 6.5 cm on POD1, 6.6 cm on POD2, and returned to 6.4 cm by POD7. In group II, the corresponding measurements were 6.7 cm on POD1, 6.9 cm on POD2, and 6.5 cm on POD7. No intergroup differences reached significance ($p > 0.05$), though a significant within-subject change over time was observed ($p < 0.001$).

Table 3. D2—Mandibular angle to external canthus distance.

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	10.2	1.1	10.2	1.1	0.933
First day after surgery	10.4	1.2	10.9	1.2	0.120
Second day after surgery	10.6	1.2	11.6	1.4	0.004
Seventh day after surgery	10.2	1.1	10.5	1.2	0.362
Between-group comparison					0.149
Within-subject change over time					<0.001

Initial measurement was 10.2 cm in both arms. In the test group, swelling measured 10.4 cm on POD1, 10.6 cm on POD2, and 10.2 cm on POD7. In the control arm, values were 10.9 cm, 11.6 cm, and 10.5 cm for POD1, POD2, and POD7, respectively. There was a statistically significant 1 cm difference on POD2 ($p = 0.004$), favouring the test group. At all other time points, differences were nonsignificant ($p > 0.05$). Significant temporal changes occurred within subjects ($p < 0.001$).

Table 4. D3—Distance from mandibular angle to nasal ala

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	10.1	1.0	10.0	1.0	0.952
First day after surgery	10.4	0.9	11.1	1.0	0.003
Second day after surgery	10.7	0.9	11.9	0.9	<0.001
Seventh day after surgery	10.1	1.0	10.4	1.0	0.247
Between-group comparison					0.016
Within-subject change over time					<0.001

At baseline, the mandibular angle–to–ala measurement was 10.1 cm in group I and 10 cm in group II. In the test arm, values increased to 10.4 cm on POD1, 10.7 cm on POD2, and returned to 10.1 cm by POD7. The control arm recorded 11.1 cm on POD1, 11.9 cm on POD2, and 10.4 cm on POD7 **(Table 4)**. Intergroup differences of 0.7 cm and 1.2 cm on POD1 and POD2 were statistically meaningful ($p = 0.003$ and $p < 0.001$), favouring the test group. Significant temporal and between-group changes were also detected ($p < 0.001$ and $p = 0.016$).

Table 5. D4—Distance from mandibular angle to oral commissure

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	7.8	0.9	7.9	0.9	0.939
First day after surgery	8.1	0.9	9.0	1.0	<0.001
Second day after surgery	8.4	1.0	9.7	1.1	<0.001
Seventh day after surgery	7.9	0.9	8.2	0.9	0.184
Between-group comparison					0.007
Within-subject change over time					<0.001

Initial values were 7.8 cm for group I and 7.9 cm for group II. Group I showed postoperative distances of 8.1 cm (POD1), 8.4 cm (POD2), and 7.9 cm (POD7). Group II recorded 9.0 cm on POD1, 9.7 cm on POD2, and 8.2 cm on POD7 **(Table 5).** Differences of 0.9 cm and 1.3 cm on POD1 and POD2 were significant ($p < 0.001$), again indicating lower swelling in the test arm. Both within-subject and between-group effects were significant ($p < 0.001$ and $p = 0.007$).

Table 6. D5—Distance from mandibular angle to soft-tissue pogonion

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	11.4	0.9	11.4	0.9	0.979
First day after surgery	11.6	0.9	11.9	1.1	0.176
Second day after surgery	11.7	0.9	12.2	1.0	0.046
Seventh day after surgery	11.4	0.9	11.6	1.0	0.524
Between-group comparison					0.290
Within-subject change over time					<0.001

The baseline measurement for both groups was 11.4 cm. In group I, distances were 11.6 cm at POD1, 11.7 cm at POD2, and 11.4 cm at POD7. Group II showed 11.9 cm on POD1, 12.2 cm on POD2, and 11.6 cm on POD7 **(Table 6)**. A significant 0.5 cm difference on POD2 was seen ($p = 0.046$). Temporal variation within subjects was also significant ($p < 0.001$).

Trismus assessment used the maximum inter-incisal distance (MID). The test group demonstrated significantly greater mouth opening than the control group ($p < 0.001$) **(Figure 6)**. MID in the test arm was 4 cm on POD1, 4.1 cm on POD2, and 4.4 cm on POD7

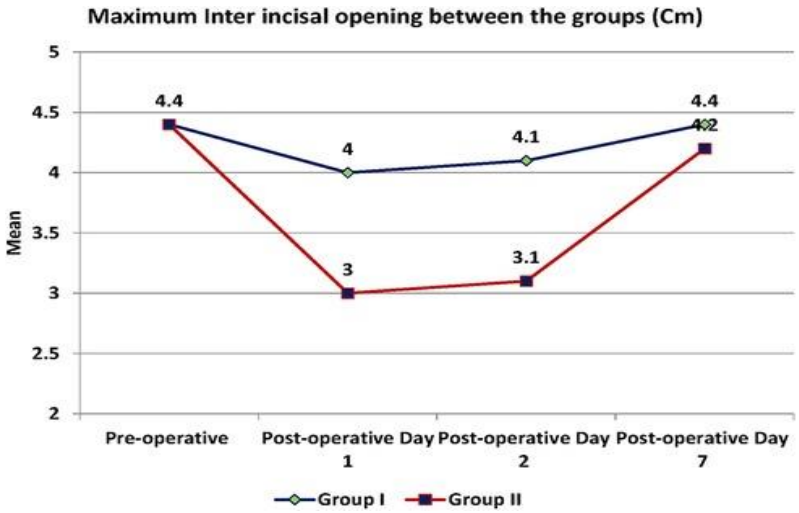

Figure 6. Maximum inter-incisal distance.

The control arm showed 3 cm on POD1, 3.1 cm on POD2, and 4.2 cm on POD7 **(Table 7)**. Pre- and postoperative photographs are shown in **Figure 7.**

Table 7. Maximum inter-incisal distance

Measurement Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
Before surgery	4.4	0.4	4.4	0.4	0.976
First day after surgery	4.0	0.4	3.0	0.4	<0.001
Second day after surgery	4.1	0.4	3.1	0.4	<0.001
Seventh day after surgery	4.4	0.4	4.2	0.4	0.013
Between-group comparison					<0.001
Within-subject change over time					<0.001

Baseline MID was 4.4 cm in both groups. Group I had postoperative values of 4 cm (POD1), 4.1 cm (POD2), and 4.4 cm (POD7). Group II recorded 3 cm on POD1, 3.1 cm on POD2, and 4.2 cm on POD7. Significant differences on POD1, POD2, and POD7 were found ($p < 0.05$), with better postoperative opening in the test arm. Between-group and within-subject differences over time were both significant ($p < 0.001$).

Figure 7. Clinical views before and after surgery.

Pain outcomes were evaluated using VAS scores **(Table 8)** and the total analgesic intake recorded each 24-h period during the first postoperative week **(Figure 8).** The mean number of analgesics taken by each group is illustrated in **Figure 9**. Both metrics showed markedly lower pain in the test arm ($p < 0.001$).

Table 8. VAS pain ratings.

Time Point	Test Group		Control Group		p-value
	Mean	SD	Mean	SD	
First 24 hours after surgery	4.9	0.7	7.6	0.5	<0.001
Post-operative Day 1	4.5	0.7	7.5	0.6	<0.001
Post-operative Day 2	3.9	0.6	6.6	0.9	<0.001
Post-operative Day 3	2.9	0.8	5.9	0.9	<0.001
Post-operative Day 4	1.9	0.8	4.6	1.2	<0.001
Post-operative Day 5	0.7	0.6	3.3	1.2	<0.001
Post-operative Day 6	0.1	0.3	2.3	1.1	<0.001
Post-operative Day 7	0.0	0.2	1.5	1.1	<0.001
Between-group comparison					<0.001
Within-subject change over time					<0.001

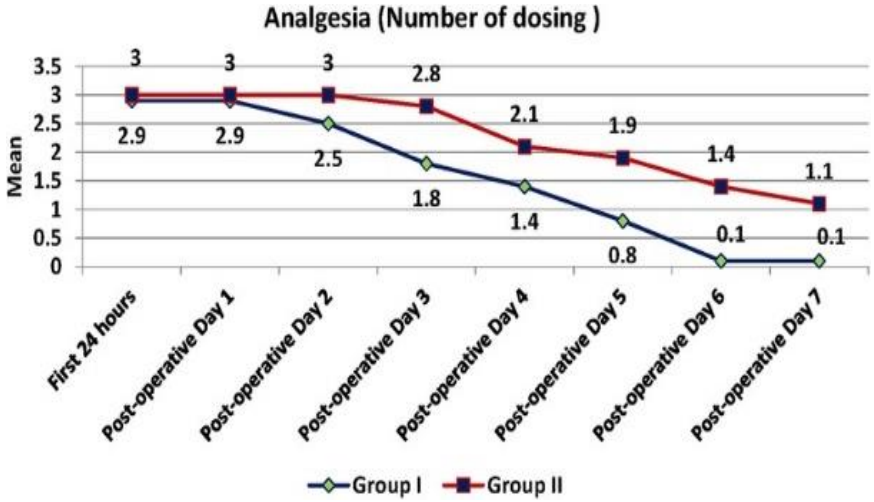

Figure 8. Analgesic dosing patterns during the first 7 postoperative days.

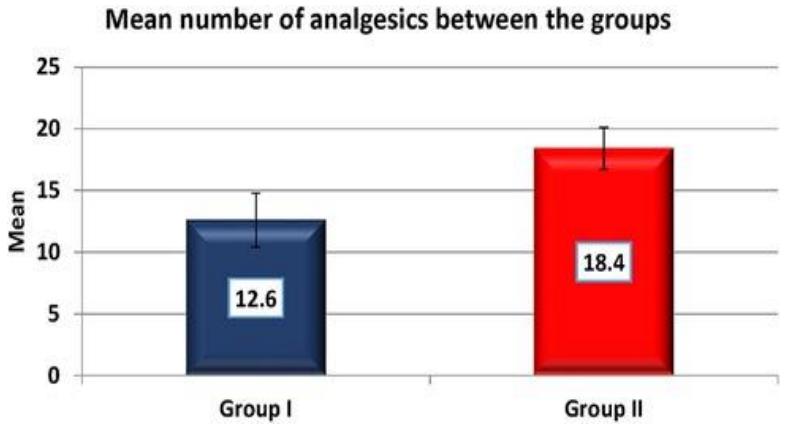

Figure 9. Mean cumulative analgesic intake in each group.

The first analgesic dose occurred 2 h later in the test arm, corresponding to the perceived duration of the nerve block until mild–moderate discomfort appeared; this was statistically significant ($p < 0.001$). Total analgesic consumption across 7 days also differed

significantly: 12.6 doses in the test group vs. 18.4 in the control group ($p < 0.001$).

Dexamethasone, a strong anti-inflammatory agent, is frequently administered to help mitigate surgery-related discomfort. Although various methods of giving dexamethasone have been documented, reports examining its combination with local anaesthetics to lessen postoperative reactions are limited. Operations involving third molars commonly lead to pain, edema, and restricted mouth opening, often impairing daily functioning, particularly during the initial 72 h [37]. Even simple extractions can be unpleasant, but removing an impacted lower third molar is highly technique dependent, involves manipulation of both bone and soft tissues, and carries a considerable infection risk due to its proximity to key fascial spaces of the head and neck [38–40]. The magnitude of these postoperative symptoms is influenced by intraoperative tissue handling, the extent of bone cutting, and the length of the procedure itself. Peak discomfort after third-molar removal is generally noted between 3 and 5 h after surgery [41, 42]. Insufficient pain control during this early interval can lead to mechanical sensitisation of the nerve, producing hyperalgesia [43]. This highlights the importance of pre-emptive analgesia or the need for stronger medication, especially given the relatively brief effect of lignocaine. Bupivacaine may prolong pain relief and reduce additional analgesic use, but its application is restricted due to the possibility of cardiotoxic effects [44]. Thus, combining strategies that extend anaesthetic duration and diminish postoperative inflammation is essential to reduce patient discomfort after removal of impacted mandibular third molars.

In this investigation, 8 mg of Dexamethasone was added to 2% Lignocaine with adrenaline, compared with a control mixture consisting of 2% Lignocaine with adrenaline plus sterile water. Both formulations were used for nerve blocks, and the onset and duration of anaesthesia were assessed. Postoperative variables—swelling, trismus, and pain—were also monitored.

Paracetamol was selected as the rescue drug because it provides moderate analgesia and has minimal anti-inflammatory activity owing to its weak inhibition of COX enzymes [45].

The results of the present work show that supplementing lignocaine with dexamethasone accelerates the onset of numbness and significantly lengthens the anaesthetic effect, allowing patients to better tolerate the peak pain period occurring within the first 3–4 h. Additionally, subjects in the test arm reported lower discomfort during the initial 24 h and across the 7-day period, with fewer analgesics consumed.

Glucocorticoids are believed to extend the duration of anaesthesia by restricting potassium channel-dependent discharge from nociceptive C fibres through glucocorticoid receptor interactions at the ion-channel level [46]. Although this mechanism does not produce anaesthesia by itself, it enhances the effect of local anaesthetics when deposited around nerves by keeping membranes hyperpolarised for a prolonged period [47]. Our observations regarding shorter latency and longer anaesthesia are consistent with previous findings in which dexamethasone administered perineurally extended the duration of bupivacaine-based anaesthesia [48, 49].

Movafegh *et al*. also reported that adding dexamethasone to lidocaine markedly extended sensory blockade of the axillary brachial plexus by 144 min, with a p-value <0.001 [50]. Corticosteroids stimulate the formation of intracellular proteins that prevent phospholipase A2 activation, thereby limiting the formation of arachidonic acid and subsequently reducing prostaglandins, leukotrienes, and other mediators linked to inflammation and pain. Unlike NSAIDs, corticosteroids intervene at the earliest point of the inflammatory pathway and demonstrate greater benefit when administered prior to the procedure [51]. Dexamethasone additionally produces mild to moderate vasoconstriction, helping retain the anaesthetic solution around the nerve for a longer period, which contributes to extended numbness [52]. The marked reduction in swelling and restricted mouth opening in the test group is likewise explained by the established anti-inflammatory properties of corticosteroids. The biochemical basis for the faster onset associated with dexamethasone remains uncertain, although clinical data consistently support its presence. Further investigation is needed to clarify this aspect.

The incorporation of corticosteroids has become increasingly common in oral and maxillofacial surgical practice, yet the optimal mode of delivery remains debated. Various systemic and local options—including intramuscular, intravenous, oral, submucosal, and endo-alveolar powder applications—have been described in the literature [53]. In this study, combining a steroid with a local anaesthetic in a single injection provided four distinct advantages while requiring only one needle penetration.

Drug uptake is strongly influenced by the vascular characteristics of the target site. The pterygomandibular space, which is routinely accessed during inferior alveolar nerve block administration,

contains abundant vasculature and loose connective tissue with minimal fibrous resistance. These anatomical features support rapid dispersion and absorption of injected agents as well as minimal needle deviation [54].

Structurally, the mandible consists of a dense cortical layer surrounding a thick cancellous centre, and areas such as the ramus and condyle retain hematopoietic marrow into adulthood—including beyond age 25 years [55]. This marrow hosts a capillary–venous network with discontinuous endothelial linings, enabling swift exchange between circulating blood and substances deposited into the surrounding tissue [1, 55]. Consequently, intra-osseous injection in this region may permit enhanced anaesthetic diffusion.

Applying steroids locally may offer distinct advantages, as the drug directly modulates eicosanoid release at injury sites, subsequently suppressing inflammatory cascades [56, 57]. Eicosanoids—derived from 20-carbon polyunsaturated fatty acids, particularly arachidonic acid—are central mediators of immune and inflammatory activity and include prostaglandins, thromboxanes, leukotrienes, and lipoxins [57–59].

Although perioperative steroids show clear clinical value, their routine integration into oral and maxillofacial surgery protocols remains inconsistent. Based on our findings, the steroid–anaesthetic combination appears to reduce predictable postoperative discomfort without producing any adverse reactions.

Dexamethasone demonstrates an anti-inflammatory potency approximately 20–30 times greater than cortisol and possesses a biological t1/2 of 36–54 h, making it well suited as a single-dose agent for mitigating postoperative sequelae associated with third molar removal [60, 61].

Our results parallel those of Shivanagi *et al*., who reported superior intra- and postoperative comfort in test groups receiving similar mixtures, although their formulation utilised bupivacaine and ropivacaine as the local anaesthetic components [62].

Only a limited number of investigations have explored whether adding dexamethasone to local anaesthetic solutions accelerates the onset or extends the duration. Broader clinical trials are necessary to confirm the efficacy of steroid–anaesthetic blends, establish pharmacokinetic profiles across delivery routes, determine whether they reliably enhance anaesthetic quality, and assess their impact on analgesic requirements. Standardisation of dexamethasone dosing remains another critical unmet need.

Clinically, lignocaine combined with dexamethasone demonstrated favourable outcomes in this study, reducing postoperative pain, trismus, and swelling in patients undergoing impacted mandibular third molar surgery. However, the chemical stability of the combined agents over time was not evaluated and warrants future investigation, along with studies focused on formulation, storage, latent effects, and shelf life for practical clinical use.

The strengths of this investigation include a consistent methodology, complete follow-up, and procedures completed by a single surgeon, thereby minimising operator-related variability. The split-mouth approach also reduced discrepancies in individual pain perception.

Postoperative swelling is influenced by numerous local factors—including tooth angulation, bone removal technique, haemostatic approach, suture tension, and tissue handling—as well as systemic considerations such as age, bleeding profile, diet, medications, and diabetes [63]. A limitation of the study is that these diverse variables make it challenging to determine whether dexamethasone affects all contributors to postoperative inflammation. The split-mouth design helped reduce some confounders, yet the larger injection volume compared with conventional 2 ml administration may cause momentary discomfort, particularly in anxious individuals. Additional work with expanded sample sizes and plasma-level monitoring of dexamethasone following injection is advised.

Conclusion

This study indicates that incorporating dexamethasone into lignocaine with adrenaline shortens the onset time and prolongs the anaesthetic effect, allowing patients to better tolerate periods of peak postoperative pain. Pain reduction was reflected in lower scores during the first 24 h and throughout the subsequent 7-day period, along with decreased overall analgesic intake. The mixture also diminished secondary postoperative effects, such as swelling and trismus.

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requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

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