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Original Article

Effect of Adding 8 mg Dexamethasone to 2% Lignocaine with Adrenaline in Inferior Alveolar Nerve Block for Mandibular Third Molar Surgery: A Split-Mouth Randomized Double-Blind Study

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ABSTRACT

Extraction of impacted lower third molars induces trauma within a highly vascularised area characterized by loose connective tissue, triggering a cascade of inflammatory after-effects, including postoperative discomfort, edema, restricted mouth opening, and widespread oral impairment throughout the healing period. An encompassing technique to extend anesthesia and curb the unavoidable postoperative aftermath in minor oral surgical interventions remains insufficiently investigated. To determine the effectiveness of dexamethasone incorporated into local anesthetic solutions for lengthening anesthetic depth and duration while diminishing postoperative morbidity following the surgical removal of impacted third molars. A prospective, controlled, randomized, split-mouth, double-blind investigation of lower third molar surgery was conducted on 35 subjects. The experimental cohort (Group I) was administered 8 mg dexamethasone combined with 2 ml of 2% lignocaine containing epinephrine. In contrast, the reference cohort (Group II) received 2 ml of sterile water combined with 2 ml of 2% lignocaine containing epinephrine. Anesthetic onset and duration were measured; subsequently, pain, swelling, and trismus were tracked over 7 postoperative days, with statistical analysis using an independent t-test and a repeated-measures ANOVA. The experimental cohort demonstrated an earlier anesthetic onset by 69 s and a prolonged anesthetic action lasting 128.4 min ($P < 0.001$). Pain intensity scores (Visual Analog Scale) during the initial 24 h were 4.9 and 7.5 in the experimental and reference cohorts, respectively ($P < 0.001$). Mean analgesic intake up to postoperative day 7 totaled 12.6 and 18.4 doses in the experimental and reference cohorts, respectively ($P < 0.001$). Swelling was notably diminished in the experimental cohort; furthermore, trismus was significantly decreased by 1 cm on postoperative days 1 and 2, and by 0.2 cm on day 7. Incorporating dexamethasone into the lignocaine nerve block reduces the onset latency and markedly prolongs the duration of anesthesia, while diminishing pain, edema, and trismus. Corticosteroids directly blended with the local anesthetic agent can reduce the postoperative burden linked to third molar surgery through a single needle puncture.

Keywords: Impacted tooth, Third molar, Local anesthesia, Dexamethasone, Steroids

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Introduction

The surgical removal of impacted third molars constitutes a standard minor oral surgical intervention conducted under local anesthesia. Multiple strategies have been explored to ease the postoperative course following surgical extraction of impacted third molars, spanning both drug-based and non-drug-based modalities [1]. In the absence of sufficient anesthetic depth and duration, minor surgical procedures can entail comparable levels of pain and discomfort [2].

Third molar surgical removal ranks among the most frequently performed oral surgical procedures, often resulting in pain, swelling, hemorrhage, infection, restricted mouth opening, and altered sensation that may be transient or lasting [3-5]. Postoperative consequences arise from an inflammatory cascade that promotes vasodilation and the release of pro-inflammatory signaling molecules, including histamine, bradykinin, and prostaglandins [6-8].

Investigations across other surgical specialties [9-12] and in vivo experiments have indicated that using corticosteroids alongside the local anesthetic agent extends the local anesthetic's duration of action.

Perineural dexamethasone, delivered as an adjunct to peripheral nerve blockade, has been associated with earlier anesthetic onset, more sustained anesthesia/analgesia, reduced postoperative pain severity, and lower analgesic demand compared with local anesthetic alone [13-16].

The attenuation of pain severity and the prolonged analgesia achieved with dexamethasone supplementation of local anesthesia may be attributed to these mechanisms. (a) Dexamethasone binds glucocorticoid receptors, triggering vasoconstriction and limiting the sequestration of local anesthetics into the systemic circulation [16]. (b) The suppression of pain signal transmission via C-fibers and a direct influence on the nerve cell to reduce neuronal firing [17, 18].

Substantial investigation into comparable approaches to merging local anesthetic formulations with dexamethasone has not been pursued in the domain of Oral and Maxillofacial Surgery [19-22].

Lignocaine, classified as an amide local anesthetic, offers surgeons the advantage of comfortably undertaking minor surgical procedures without resorting to general anesthesia. The combination of lignocaine with dexamethasone yields a pharmacological pairing that merits evaluation [10]. Earlier work has demonstrated that the solution produced by blending dexamethasone with lignocaine remains chemically stable and exhibits elevated pH, thereby improving the patient's experience during local anesthetic delivery while shortening onset latency and extending the action span of the local anesthetic preparation [23].

Dexamethasone is a synthetic glucocorticosteroid that lacks mineralocorticoid activity [24].

It curbs vascular dilatation and fluid extravasation, and exerts a slight unfavorable effect on leukocyte chemotaxis—factors collectively driving postoperative swelling and trismus [25]. Its potency exceeds that of hydrocortisone by 25–50 times; it has a plasma half-life of 100–300 min and a biological half-life of 36–72 h, and is regarded as one of the most powerful anti-inflammatory agents [26].

Administered at an anti-inflammatory dosage, dexamethasone does not exhibit the sodium-retaining characteristics of hydrocortisone. Moreover, it modulates the transcription rate of anti-inflammatory genes [27-29].

A 4 mg dose can generate five times the body's baseline physiological cortisol output [30]. The onset profile of dexamethasone is estimated at 1–2 h, a sufficient time for diffusion across the cell membrane [31]. Corticosteroids are effective within the first 24 h post-surgery and maintain their effect for up to 3 days [25].

The investigation's primary outcome was assessment of dexamethasone's efficacy as a supplement to lignocaine with adrenaline versus lignocaine with adrenaline alone in augmenting anesthetic depth and duration. The secondary outcome was the appraisal of the steroid–local anesthetic combination's effectiveness in attenuating postoperative complications, including pain, swelling, and trismus, along with documentation of any adverse incidents after delivery of the dual mixture.

Materials and Methods

The study was structured as a prospective, split-mouth, randomized, double-blinded clinical investigation, conducted within the Department of Oral and Maxillofacial Surgery at Manipal College of Dental Sciences, Mangalore. It recruited subjects who sought care at the outpatient unit for the extraction of impacted mandibular third molars, covering the period from December 2020 to November 2022. The requisite number of participants was computed using the equation below, yielding 70.

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

$Z_{1-\frac{\alpha}{2}}$=1.96 corresponds to the standard normal variate at the 5% significance cut-off.

$Z1-\beta$=0.84 corresponds to the standard normal variate for 80% statistical power.

σ = pooled standard deviation = 2.195

d = clinically meaningful difference = 1.5

At a 95% confidence interval, the count per bilateral cohort was 35, yielding an overall participant tally of 70.

After securing Institutional Ethics Committee (IEC) endorsement, individuals reporting to the Oral and Maxillofacial Surgery outpatient department for surgical extraction of impacted mandibular third molars were evaluated for eligibility. Once written, informed consent was procured from the patients, 35 individuals classified as ASA (American Society of Anaesthesiologists) physical status II, aged between 18 and 45 years, necessitating bilateral surgical removal of mandibular third molars positioned in class II position B, who exhibited no acute inflammatory signs, advanced decay, discomfort, or pathological processes in the region of the mandibular third molars, were enrolled as participants. Those presenting with an active infective process adjacent to impacted mandibular third molars; a medical background that included peptic ulcer disease, diabetes mellitus, systemic endocrine pathologies, hypertensive disorders, renal impairment, bleeding tendencies, marked adiposity, hypersensitivity to any pharmaceuticals or substances employed, antimicrobial therapy within the preceding fortnight, nonsteroidal anti-inflammatory drug intake within the preceding week; women who were pregnant or nursing, and any individuals declining study participation, were not considered eligible.

Screening

Subjects presenting at the Department of Oral and Maxillofacial Surgery, Manipal College of Dental Sciences, Mangalore, for surgical removal of impacted third molars underwent screening. At the point of first interaction, potential candidacy hinging on bilateral impaction and sufficient gingival soft tissue permitting wound closure without tension was corroborated on clinical grounds, whilst the spatial orientation and connection of the mandibular third molar to the investing bone and adjacent tooth structure were substantiated radiologically by capturing either an Orthopantomogram or an intraoral periapical radiograph. The plausibility of any exclusion criterion was weighed against the gathered clinical history and the radiographic images. Participants received a comprehensive briefing on the surgical protocol and the nature of the clinical study.

Every selected case was entirely asymptomatic, displaying no indications or manifestations of pain, restricted mouth opening, or swelling at the juncture of surgical removal of the impacted mandibular third molars.

Randomization and blinding procedure: Upon collection of written informed consent and reiterative verification that the enrolled individuals satisfied the inclusion criteria, details covering demographic and clinical parameters were transcribed. Demographic particulars encompassed the participant's name, chronological age, and biological sex (male or female). Clinical variables documented comprised contraceptive usage (reply: yes or no) over the most recent month, psychotropic agent consumption (reply: yes or no), and tobacco smoking habit (registered as the number of cigarettes smoked daily at the point of the intervention). The recruited subjects were thereafter assigned a unique subject identifier and randomized by operative side (left or right), using simple randomization. The random sequence was generated using Microsoft Excel. All numerals falling under odd designation were assigned to the left side, whereas even designations went to the right side; the designated side was administered the interventional mixture of 2 ml of 2% Lignocaine with 1:200,000 Adrenaline together with 2 ml of 8 mg Dexamethasone, while the contralateral side received 2% Lignocaine with 1:200,000 Adrenaline together with 2 ml of water for injection.

34 Allocation concealment was safeguarded via the "opaque envelope method," where each participant received an opaque receptacle containing the injectable materials housed in separate vessels, with the assigned injection side unambiguously marked on the label. Each participant's unique identifier code was inscribed upon the opaque receptacle.

Blinding – The administration step was performed by the operating surgeon without assistance; the already loaded syringe was passed to the surgeon by the co-investigator responsible for randomization and custody of the opaque receptacles. The 5 ml syringes filled with 2 ml of 2% Lignocaine with 1:200,000 Adrenaline, combined with 2 ml of 8 mg Dexamethasone, constituted the experimental group. In contrast, the comparator group consisted of 2 ml of 2% Lignocaine with 1:200,000 Adrenaline, combined with 2 ml of water for injection.

The two sides of each participant were placed into either the experimental group (2 ml of 2% lignocaine with 1:200,000 adrenaline blended with 2 ml of 8 mg dexamethasone) or the comparator group (2 ml of 2% lignocaine with 1:200,000 adrenaline blended with 2 ml of water for injection).

To mitigate variation stemming from operator differences, a single surgeon operated on all enrolled participants. Intraoperatively, the oral cavity was irrigated with 0.12% chlorhexidine mouthwash for 20 s. In the experimental group, 2 ml of 2% Lignocaine with 1:200,000 Adrenaline together with 2 ml of 8 mg Dexamethasone was aspirated into a 5 ml syringe. In the comparator group, an analogous volume of 2 ml of 2% Lignocaine with 1:200,000 Adrenaline and 2 ml distilled water was aspirated into an identically sized syringe. The anesthetic blockade of the inferior alveolar nerve, lingual nerve, and long buccal nerve was carried out according to the predetermined randomization sequence. A needle of 26-gauge caliber, dimensions 45 × 38 mm, and 1.5-inch length was utilized throughout.

Simple randomization was achieved using random numeric sequences generated in Microsoft Excel. Each of the two groups comprised 35 impaction sites, and every subject functioned as their own comparator. Concealment of allocation was realized through the "opaque envelope method." The operator performed the administration independently, using the pre-loaded syringe supplied by the co-investigator responsible for randomization and preservation of the opaque envelopes.

The surgical intervention was performed entirely by a single surgeon, using a standardized technique (buccal bone gutter creation and tooth division) across the board. On the operative day, a prophylactic dose of 1 g of amoxicillin was delivered to all participants preoperatively. A single antibiotic administration provides adequate coverage throughout the perioperative vulnerability window and curtails the emergence of antibiotic resistance and associated adverse effects. Repeat dosing for infection prophylaxis is superfluous, a factor that also enhances patient adherence and reduces administration-related errors. Under optimal circumstances, the antibiotic should be infused 30 min before the initial incision to ensure steady tissue levels. Should the surgical intervention exceed 3 hours, an additional intraoperative dose is advisable, though this scenario was not encountered in the present study. A single 1 g dose of amoxicillin was endorsed, given that its plasma concentration surpasses the minimum inhibitory concentration required to hold in check the common bacterial species implicated in surgical site infections [32-35].

Facial dimensions were obtained using a strand of 2–0 nylon suture material and a ruler graduated in millimeters at baseline, and again at 24 hours, 48 hours, and 1 week following the intervention. To ensure consistency, fixed anatomical sites were highlighted with a permanent marker: the angle of the mandible, tragus, labial commissure, alar border, lateral canthus, and soft tissue pogonion. The linear spans documented comprised:

- D1 - Angle of the mandible to Tragus
- D2 - Angle of the mandible to the lateral canthus
- D3 - Angle of the mandible to Nasal ala
- D4 - Angle of the mandible to the labial commissure
- D5 - Angle of the mandible to soft tissue Pogonion.

Exact quantification of facial edema is problematic because it requires three-dimensional mapping of an uneven, convex surface on both its inner and outer surfaces. The tumescence and inflammatory swelling provoked by surgical tissue disruption can intensify concurrent trismus, which itself arises from multiple contributory pathways.

The extent of the oral opening was determined by measuring the gap between the incisal edges with a divider before surgery and at 24 hours, 48 hours, and 1 week afterward.

Every measurement was transcribed onto a structured Proforma. After a 4-week healing window, participants were summoned back to undergo extraction of the contralateral third molar in strict accordance with the initial protocol.

A total injection of 4 ml of anesthetic solution, combined with either dexamethasone or sterile diluent, was administered to anesthetize the inferior alveolar, lingual, and long buccal nerves, in accordance with the blinding and randomization framework. The time from completion of the injection until the patient confirmed a loss of sharp sensation on atraumatic testing in the canine and molar zones—probed at intervals of 20 seconds—was noted as the onset of anesthesia. Surgical delivery of the impacted mandibular third molar proceeded under sterile conditions with local anesthesia. The window of anesthetic action was defined as the time from the moment the individual first reported mild-to-moderate discomfort to the point at which the person again declared an absence of sensation upon atraumatic testing. Each participant was issued a supply of Paracetamol 650 mg for oral consumption on an as-needed basis, along with Chlorhexidine mouthwash to be rinsed three times per day.

Patients were provided with a VAS (visual analog scale) ranging from 0 to 10, where 0 indicated complete absence of pain and 10 the most intense pain conceivable, to self-document their discomfort levels. The period of pain relief from the nerve block was defined as the interval from the onset of anesthesia until the time when pain was described as mild to moderate in intensity.

Pain outcomes were tracked using Visual Analog Scale (VAS) scores and the number of rescue analgesic doses, recorded at 24-hour intervals over 1 week.

Swelling was tracked by gathering facial dimensions at 24 hours (postoperative day 1 – POD1), 48 hours (postoperative day 2 – POD2), and 1 week (postoperative day 7 – POD7) after the operation.

Trismus was tracked by measuring the greatest inter-incisal clearance at 24 hours, 48 hours, and 1 week postoperatively. After a 4-week interval, participants were recalled for the matching procedure on the opposite side, executed under the same protocol.

Statistical computations were carried out using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.

Continuous parameters, specifically anesthetic onset time and duration, facial swelling magnitude, pain intensity, and mouth opening capacity, were summarised as mean and standard deviation for comparison across the test and control cohorts.

To evaluate differences in anesthetic onset and duration, as well as facial swelling, pain, and mouth opening between the test and control cohorts, the independent t-test was selected.

A repeated-measures ANOVA framework was adopted to assess swelling and mouth opening at the preoperative stage and at 24 hours, 48 hours, and 1 week after surgery in the test and control cohorts. A significance threshold was set at $P < 0.05$.

Assessment of data distribution confirmed that the outcome variables conformed to a normal pattern; accordingly, t-tests underpinned the statistical evaluations.

Adherence to the CONSORT guidelines [11] was maintained in the reporting of the study methods. The trial was duly recorded with the CTRI (registration identifier – CTRI/2021/08/035560).

Results and Discussion

The flow of participant enrolment and randomization allocation is depicted in **Figure 1**.

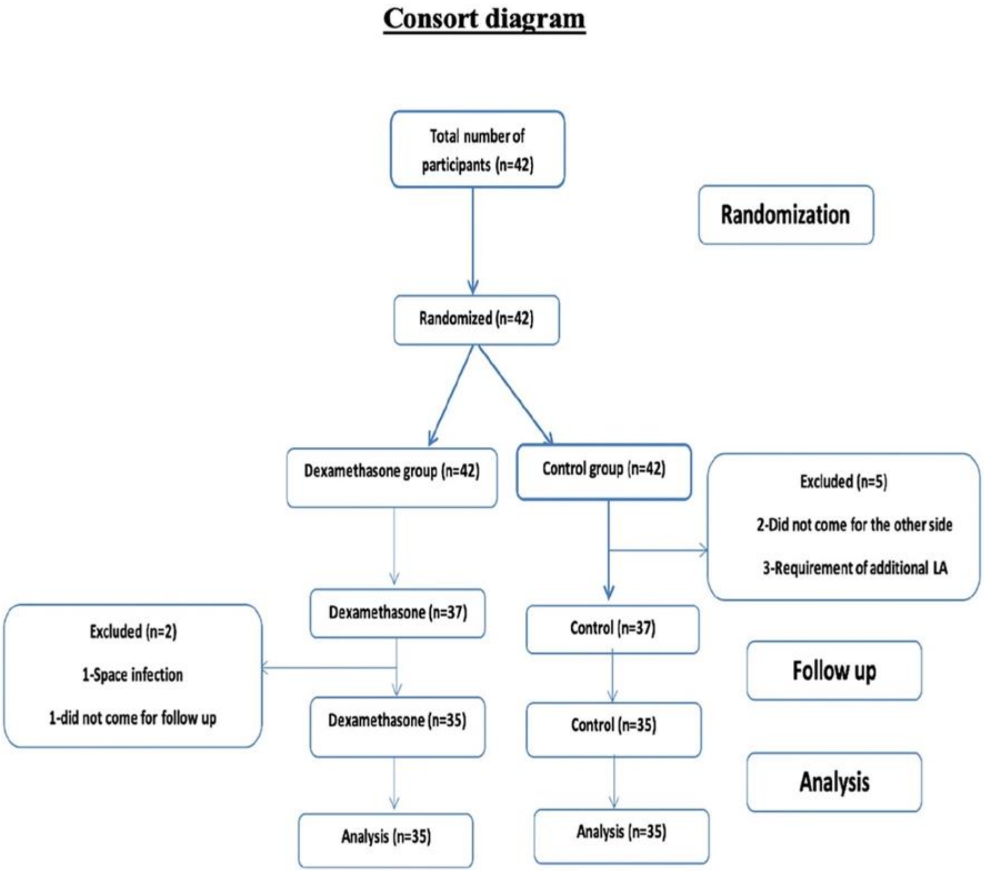

Figure 1. Consort diagram outlining the patient recruitment and randomization pathway.

The anesthetic onset intervals and action durations recorded for the test and control cohorts are presented in **Table 1**.

Table 1. Onset timing and duration of anesthesia were recorded in both the test and control groups.

Parameter	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Onset (seconds)	< 0.001	52.5	187.7	34.7	118.7

Duration (minutes)	< 0.001	24.3	111.9	44.3	240.3

Swelling, as indicated by linear measurements spanning fixed facial reference points (D1, D2, D3, D4, D5) **(Figures 2–5)**, was significantly (P-value < 0.001) reduced in the test when set against the control cohort **(Tables 2–6)**.

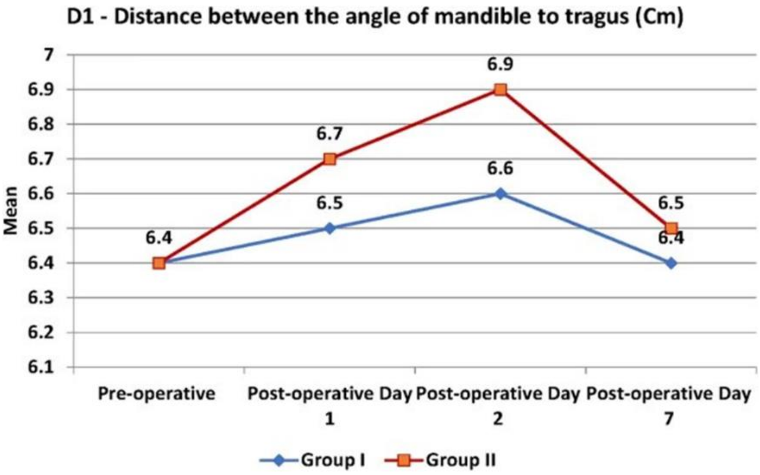

Figure 2. D1-distance spanning the mandibular angle to the ear Tragus.

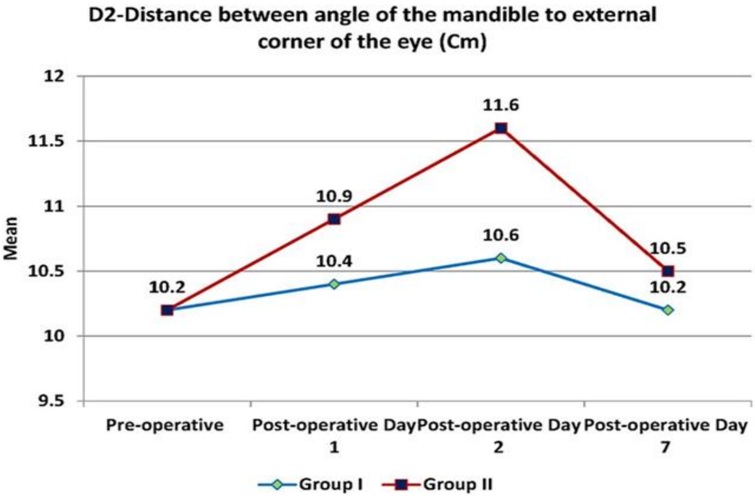

Figure 3. D2-distance spanning the mandibular angle to the external canthus.

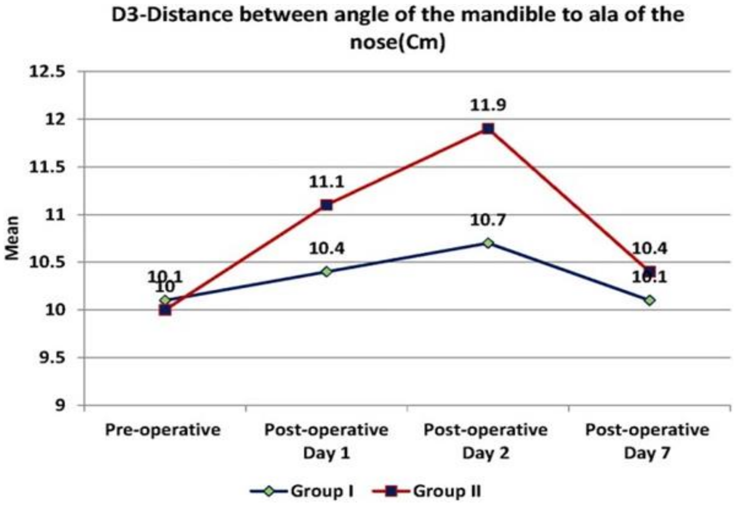

Figure 4. D3-distance spanning the mandibular angle to the nasal ala.

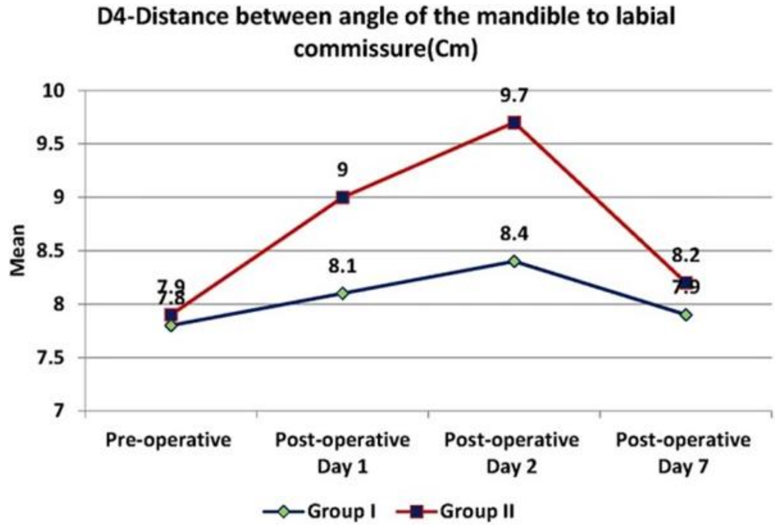

Figure 5. D4-distance spanning the mandibular angle to the oral commissure.

Table 2. D1-Distance spanning the mandibular angle to the tragus.

Time point	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.999	0.9	6.4	0.9	6.4
Postoperative Day 1	0.408	1.0	6.7	0.9	6.5
Postoperative Day 2	0.135	1.1	6.9	1.0	6.6
Postoperative Day 7	0.766	1.0	6.5	0.9	6.4

Statistical analysis:

- Between-group comparison: 0.500

Within-group (time effect): < 0.001

The gap from the mandibular angle to the tragus was 6.4 cm across both cohorts. It increased to 6.5 cm on postoperative day (POD) 1, rose to 6.6 cm on POD 2, and decreased to 6.4 cm on POD 7 in group I. Meanwhile, group II recorded 6.7 cm on POD1, 6.9 cm on POD2, and 6.5 cm on POD7 **(Table 2)**. Across the specified time intervals, no statistically significant difference in the mandibular angle-to-tragus dimension was observed between the two cohorts (P > 0.05). A meaningful alteration within participants over time was present, reflected by a P-value < 0.001.

Table 3. D2-Distance spanning the mandibular angle to the external canthus.

Time point	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.933	1.1	10.2	1.1	10.2
Postoperative Day 1	0.120	1.2	10.9	1.2	10.4
Postoperative Day 2	0.004	1.4	11.6	1.2	10.6
Postoperative Day 7	0.362	1.2	10.5	1.1	10.2

Statistical analysis:

- Between-group comparison: 0.149

Within-group (time effect): <0.001

The separation from the mandibular angle to the lateral canthus commenced at 10.2 cm in each cohort. It progressed to 10.4 cm on postoperative day (POD) 1, 10.6 cm on POD 2, and receded to 10.2 cm on POD 7 among test participants. Control counterparts showed 10.9 cm on POD1, 11.6 cm on POD2, and 10.5 cm on POD7 **(Table 3)**. By POD 2, a significant disparity of one centimeter in swelling dimension had become apparent between the two cohorts, with an associated P-value of 0.004. Outcomes within the test cohort were comparatively more favorable. Except for POD 2, no other time point showed a significant difference in swelling measurements between the cohorts; the P-values remained above 0.05. A significant time-dependent variation in swelling size was observed among participants (P-value < 0.001).

Table 4. D3-Distance spanning the mandibular angle to the nasal ala.

Time point	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.952	1.0	10.0	1.0	10.1
Postoperative day 1	0.003	1.0	11.1	0.9	10.4
Postoperative day 2	<0.001	0.9	11.9	0.9	10.7
Postoperative day 7	0.247	1.0	10.4	1.0	10.1

Statistical analysis:

- Between-group comparison: 0.016

Within-group (time effect): < 0.001

The initial span from the mandibular angle to the alar rim was 10.1 cm in group I and 10 cm in group II. Among test participants, it advanced to 10.4 cm on postoperative day (POD) 1, reached 10.7 cm on POD 2, and retracted to 10.1 cm on POD 7. In the control group, the figures climbed to 11.1 cm on POD1, peaked at 11.9 cm on POD2, and dropped to 10.4 cm on POD7 **(Table 4)**. Differences of 0.7 cm and 1.2 cm in swelling extent on POD 1 and POD 2, respectively, were statistically significant between the cohorts (p-values of 0.003 and <0.001, respectively). The test group demonstrated superior performance in reducing the magnitude of swelling. Both within-subject and between-cohort variation across the monitoring period were statistically significant, with p-values of <0.001 and 0.016, respectively.

Table 5. D4-measurement from the mandibular angle to the oral commissure.

Time point	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.939	0.9	7.9	0.9	7.8
Postoperative day 1	< 0.001	1.0	9.0	0.9	8.1
Postoperative day 2	< 0.001	1.1	9.7	1.0	8.4
Postoperative day 7	0.184	0.9	8.2	0.9	7.9

Statistical analysis:

- Between-group comparison: 0.007

Within-group (time effect): < 0.001

The dimension extending from the mandibular angle to the labial commissure commenced at 7.8 cm within group I and 7.9 cm within group II before any intervention. It subsequently increased to 8.1 cm on postoperative day (POD) 1, advanced to 8.4 cm on POD 2, and contracted back to 7.9 cm by POD 7 among group I subjects. Participants in group II exhibited readings of 9.0 cm on POD 1, 9.7 cm on POD 2, and 8.2 cm on POD 7 **(Table 5)**. Striking disparities in swelling extent, reaching 0.9 cm and 1.3 cm on POD 1 and POD 2, respectively, separated the two cohorts, attaining a P-value < 0.001. The magnitude of postoperative swelling was consistently lower in the test cohort than in the control cohort. Meaningful differences in swelling dimensions were detectable over time within the same individuals and between the two cohorts across the study period, yielding P-values of < 0.001 and 0.007, respectively.

Table 6. D5-measurement from the mandibular angle to the soft tissue pogonion.

Time point	P-value	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.979	0.9	11.4	0.9	11.4
Postoperative day 1	0.176	1.1	11.9	0.9	11.6
Postoperative day 2	0.046	1.0	12.2	0.9	11.7
Postoperative day 7	0.524	1.0	11.6	0.9	11.4

Statistical analysis:

- Between-group comparison: 0.290

Within-group (time effect): < 0.001

The distance between the mandibular angle and the soft-tissue pogonion was 11.4 cm in both cohorts at baseline. Among group I, the readings shifted to 11.6 cm on postoperative day (POD) 1, 11.7 cm on POD 2, and fell back to 11.4 cm on POD 7. In group II, the values moved to 11.9 cm on POD 1, peaked at 12.2 cm on POD 2, and descended to 11.6 cm on POD 7 **(Table 6)**. A notable separation of 0.5 cm in swelling magnitude emerged on POD 2 between the two cohorts, with a P-value of 0.046. A meaningful fluctuation in swelling size emerged among participants as the study progressed, as confirmed by a P-value of < 0.001.

Restricted mouth opening was assessed by maximal inter-incisal distance (MID) readings and was substantially greater in the test cohort than in the control cohort (P-value <0.001) **(Figure 6)**. In the test cohort, MID stood at 4 cm on POD 1, rose to 4.1 cm on POD 2, and reached 4.4 cm by day 7 of the postoperative phase.

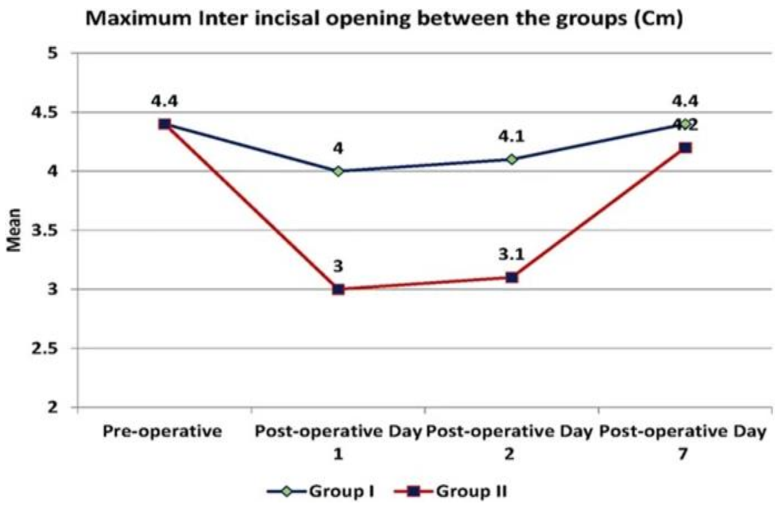

Figure 6. Oral opening capacity is presented as maximal inter-incisal distance.

Turning to the control cohort, MID narrowed to 3 cm on POD 1, crept up to 3.1 cm on POD 2, and plateaued at 4.2 cm on the seventh postoperative day **(Table 7)**.

Visual documentation of one participant, preoperatively and postoperatively, is shown in **Figure 7**.

Table 7. Oral opening capacity is presented as the maximal inter-incisal distance.

Time Point	P-value	Control group SD	Control group SD	Control group mean	Test group SD	Test group mean
Preoperative	0.976	0.4	0.4	4.4	0.4	4.4
Postoperative day 1	< 0.001	0.4	0.4	3.0	0.4	4.0
Postoperative day 2	< 0.001	0.4	0.4	3.1	0.4	4.1
Postoperative day 7	0.013	0.4	0.4	4.2	0.4	4.4

Statistical analysis:

- Between-group comparison: < 0.001

Within-group (time effect): < 0.001

The starting oral opening (Maximal Inter-incisal distance) was identical at 4.4 cm preoperatively for both cohorts. Subjects in group I demonstrated a reading of 4 cm on POD 1, 4.1 cm on POD 2, and a return to 4.4 cm on day 7 of the recovery interval. In group II, the measurement dropped to 3 cm on POD 1, then rose slightly to 3.1 cm on POD 2, and eventually recovered to 4.2 cm by the seventh postoperative day **(Table 7)**. Oral opening differed significantly between the two cohorts on POD 1, POD 2, and POD 7 alike, each yielding a P-value < 0.05. Those in the test cohort had substantially greater oral opening throughout the postoperative period than control participants.

A significant variation was observed between the two cohorts and within individual subjects over the observation period, reflected by a P-value of < 0.001.

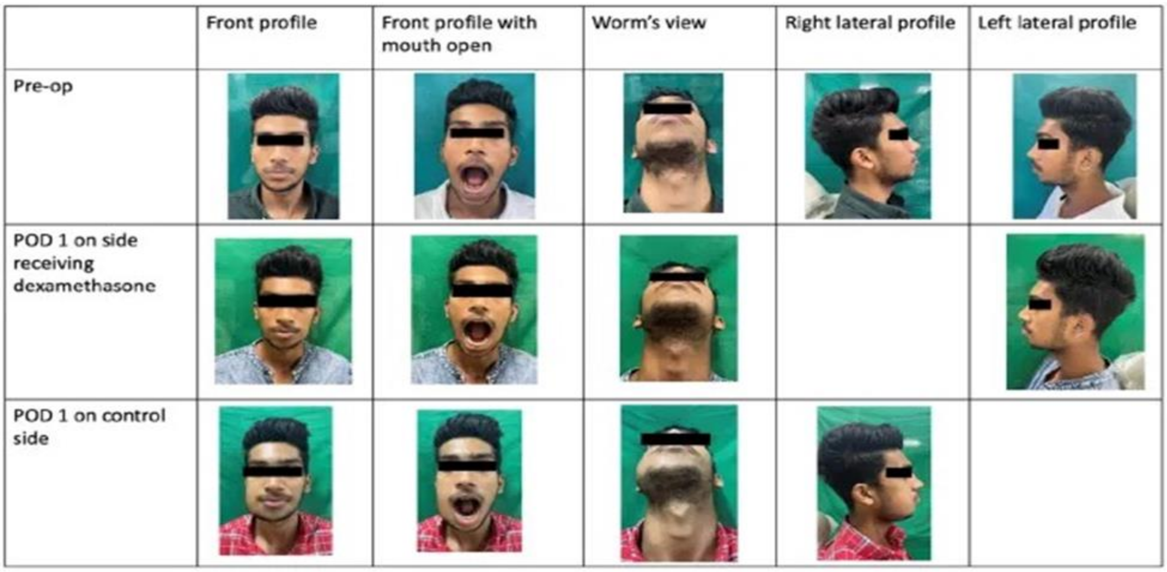

Figure 7. Clinical photographs showing preoperative and postoperative status.

Pain perception was captured via VAS ratings **(Table 8)** and through the count of analgesic tablets consumed every 24 hours spanning the first 7 days **(Figure 8)**. The average analgesic dose per cohort is depicted in **Figure 9**. Discomfort levels in the test cohort were significantly lower than those in the control cohort across both assessment parameters (P-value < 0.001).

Table 8. Pain severity was assessed using a visual analog scale.

Pain scores (VAS)	**Test**				**P-value**
	Mean	**SD**	**Mean**	**SD**	
First 24 h	4.9	0.7	7.6	0.5	<0.001
Postoperative Day 1	4.5	0.7	7.5	0.6	<0.001
Postoperative Day 2	3.9	0.6	6.6	0.9	<0.001
Postoperative Day 3	2.9	0.8	5.9	0.9	<0.001
Postoperative Day 4	1.9	0.8	4.6	1.2	<0.001
Postoperative Day 5	0.7	0.6	3.3	1.2	<0.001
Postoperative Day 6	0.1	0.3	2.3	1.1	<0.001
Postoperative Day 7	0	0.2	1.5	1.1	<0.001
Between subjects (groups)					<0.001
Within subjects (over time)					<0.001

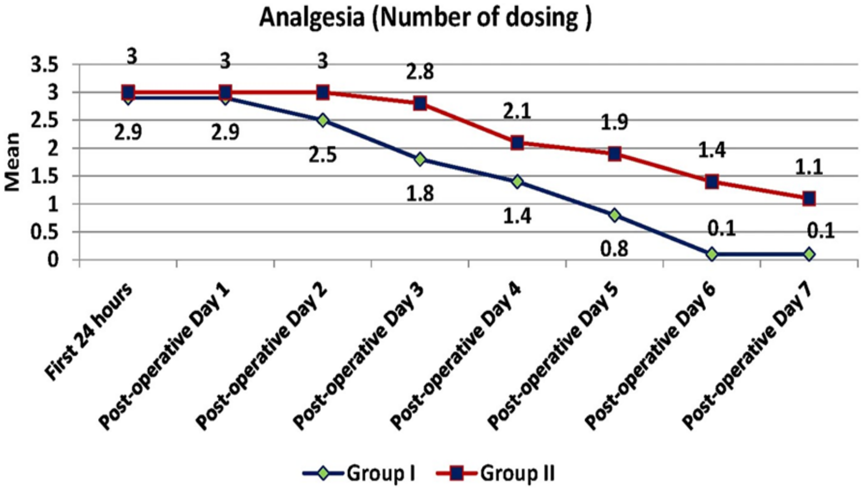

Figure 8. The frequency of analgesic intake was documented every 24 hours for the first 7 postoperative days in both test and control cohorts.

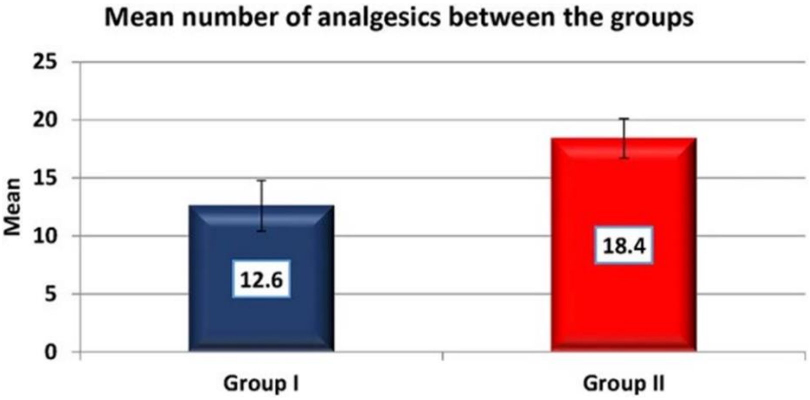

Figure 9. Mean cumulative analgesic consumption for the test and control cohorts.

The lag before the initial analgesic dose was 2 h longer in the test cohort than in the control cohort, aligning with the anesthetic coverage window as perceived by the patient through mild-to-moderate discomfort. This prolongation was statistically significant (P-value < 0.001). An additional statistically significant divergence emerged in the aggregate analgesic intake accumulated across the 7-day observation span between the two cohorts (Test standing at 12.6 doses while Control reached 18.4 doses), with a P-value of < 0.001.

Dexamethasone is a high-potency anti-inflammatory pharmaceutical frequently deployed to blunt operative discomfort. The published evidence describes a variety of dexamethasone administration modalities, each with distinct strengths and drawbacks. Yet, relatively few accounts detail the use of local anesthetic solutions combined with corticosteroids to counteract the postoperative inflammatory burden.

Extraction of third molars habitually provokes discomfort, facial swelling, and restricted jaw mobility, and can substantially erode one's sense of well-being, particularly within the opening three-day window [36]. While even an uncomplicated dental extraction is not an entirely agreeable undertaking, the surgical retrieval of a mandibular third molar buried within bone is technically demanding, disrupts the structural integrity of both calcified and mucosal tissues, and carries a considerable infectious threat given its anatomical site in proximity to the primary spaces of the head and neck region [37-39].

How pronounced these postoperative consequences become depends on the intraoperative handling of soft tissue envelopes, the extent of bone resection, and the total time required for the procedure.

The zenith of discomfort following surgical extraction of the mandibular third molar typically occurs between 3 and 5 hours after the operation [40, 41].

If adequate pain management is not secured during this decisive window, mechanical neural sensitization supervenes, leading to a hyperalgesic state [42]. This circumstance demands either pre-emptive analgesic coverage or an elevated analgesic dosage, especially in light of lignocaine's brief pharmacological lifespan. While the addition of Bupivacaine can counter pain and restrict reliance on supplementary analgesics, its broader uptake is hampered by concerns over cardiotoxicity risks [43].

Consequently, a two-part strategy—lengthening the anesthetic duration while simultaneously dampening the postoperative inflammatory response—becomes indispensable to ease the distress associated with the surgical removal of impacted mandibular third molars.

In the work presented here, the consequences of supplementing 2% Lignocaine with adrenaline with 8 mg Dexamethasone were contrasted against a comparator preparation comprising 2% Lignocaine with adrenaline blended with sterile water for injection, both delivered as a nerve block. The latency to anesthetic onset and the persistence of the anesthetic effect after nerve blockade with the aforementioned mixtures were recorded. Beyond this, the postoperative triad of swelling, trismus, and pain was systematically appraised.

Paracetamol was selected to serve as the backup analgesic—an agent possessing only moderate pain-relieving potency alongside almost negligible anti-inflammatory activity, consistent with its classification as a weak COX inhibitor [44].

The current findings indicate that combining dexamethasone with lignocaine for the nerve block abbreviates the onset interval and markedly prolongs the anesthetic cover, enabling the patient to withstand the maximal pain surge encountered during the first 3–4 hours.

Additionally, lower pain severity scores throughout the initial 24 hours and persisting for the subsequent 7 days, paralleled by a reduced need for analgesics, were observed in the experimental arm.

The pathway responsible for the extended anesthetic activity of glucocorticoids may be traced to their ability to suppress potassium channel-mediated firing of nociceptive C fibers by binding to glucocorticoid receptors located on ion channels [45]. Although this mode of action cannot, by itself, induce anesthesia, it can prolong the anesthetic period when applied perineurally alongside an anesthetic compound by locking the nerve membrane into a prolonged hyperpolarized state [46].

The observations from the present study, regarding both onset timing and duration, align with the anesthesia literature, which reports a noteworthy compression of latency and elongation of the anesthetic effect when dexamethasone is infiltrated perineurally with bupivacaine [47, 48].

A trial by researchers [24] examining the influence of dexamethasone as an additive to lidocaine reported that the persistence of sensory blockade from axillary brachial plexus anesthesia extended significantly by an additional 144 min, with a P-value of < 0.001.

Corticosteroid agents stimulate the synthesis of endogenous proteins that inhibit the activation of phospholipase A2, thereby curbing the downstream release of arachidonic acid. This cascade disruption halts the release of prostaglandins, leukotrienes, and other mediators that drive inflammation and pain. Departing from the mechanism exhibited by NSAIDs, corticosteroids impose their anti-inflammatory and analgesic influence at the very origin of the biochemical cascade and display superior effectiveness when introduced before the operative trauma [49].

Dexamethasone is further documented to elicit mild to moderate vasoconstrictive effects, a property that sequesters the local anesthetic compound perineurally over a more prolonged period, thereby explaining the more sustained anesthesia [50]. In parallel, the appreciably diminished swelling and trismus may also be attributed to the co-delivery of dexamethasone with lignocaine, owing to the well-established anti-inflammatory properties of corticosteroid therapy. The mechanistic underpinning behind the accelerated onset conferred by dexamethasone remains opaque at present, albeit supported by unambiguous clinical observations. Deeper exploration in this direction is necessary to unravel this effect.

The incorporation of corticosteroids has steadily gained favor across the oral and maxillofacial surgery landscape; nevertheless, the most contentious aspect of corticosteroid use is the optimal route of delivery. Diverse administration routes—whether systemic or local—each present their own virtues and limitations. Intramuscular, intravenous, oral, submucosal, and endoalveolar powder formulations represent the spectrum of pathways cataloged within the literature [51]. The dual-compound mixture of local anesthetic and steroid deployed throughout this investigation furnishes a fourfold benefit, all realizable through a single needle penetration.

The absorption of any pharmaceutical agent is heavily contingent upon the degree of vascular perfusion at the site of delivery. The pterygomandibular compartment constitutes a richly vascularised region, replete with loose areolar connective tissue and largely devoid of dense fibrous bands—characteristics that collectively facilitate rapid dispersal and uptake of local anesthetic solutions while permitting minimal needle deviation [52]. This compartment serves as the target zone for needle placement when executing an inferior alveolar nerve block.

The mandible features a peripheral cortical shell encasing a voluminous medullary core, with hematopoietic marrow persisting in the ramus and condylar regions well beyond age 25 years [53]. Such marrow architecture comprises an intricate lattice of capillaries and venous channels lined by a discontinuous endothelium, enabling fluids and assorted substances residing in the adjacent stroma to exchange freely with the circulating blood volume [1, 53]. This distinctive attribute of the mandible may also promote more rapid anesthetic diffusion when the agent is administered via an intraosseous route.

Regionally confined steroid delivery appears to confer superior advantages, as these agents exert a direct influence on the eicosanoids liberated from damaged tissues at the time of injury and thereby intercept inflammatory cascades [54, 55]. Eicosanoids constitute a molecular family derived from 20-carbon (“eicosa” translating from Greek as twenty) polyunsaturated fatty acids, predominantly arachidonic acid. These compounds function as the principal arbiters and modulators of inflammation and immune responses, encompassing prostaglandins, thromboxanes, leukotrienes, and lipoxins [55-57].

Although steroids confer measurable benefits during the postoperative window, their integration into standardized protocols within oral and maxillofacial surgical practice has yet to materialize. We advocate adopting the steroid–local anesthetic combination to reduce the predictable postoperative burden, and, as shown in our investigation, the compounded mixture did not cause any untoward reactions.

The anti-inflammatory potency of dexamethasone surpasses that of cortisol by a factor of 20–30, and its elimination half-life of 36–54 h positions it as the preferred agent for single-dose administration when managing the collateral effects of third-molar extraction [58, 59].

Our findings likewise correspond with those reported by Gaur *et al*. [60], who found that both intraoperative and postoperative comfort levels within the test cohort exceeded those documented in the control cohorts, thereby affirming the clinical utility of the dual-compound mixture for deployment during surgical extraction of mandibular third molars. The sole point of divergence lay in the local anesthetic formulation, which comprised Bupivacaine and Ropivacaine in that study.

Investigations exploring the impact of dexamethasone supplementation on local anesthetic agents, with respect to accelerating onset and extending duration, remain sparse. Broader, large-scale trials are justified to corroborate the effectiveness of this blended local anesthetic and steroid preparation, to quantify circulating steroid concentrations achieved via different routes of delivery, and to establish its role in providing sufficient anesthetic depth and persistence while reducing or obviating the need for analgesic rescue. The dexamethasone dosage regimen likewise requires standardization within the published literature when appraising postoperative parameters.

From a clinical standpoint, dexamethasone-fortified lignocaine delivered encouraging outcomes in the present trial, attenuating the postoperative triad of pain, trismus, and swelling among individuals undergoing surgical removal of impacted third molars. That said, the prolonged chemical stability of these combined solutions falls outside the remit of the current investigation. Supplementary research addressing the compounding, storage conditions, delayed effects, and shelf-life durability of these preparations is necessary to facilitate their optimal integration into routine clinical workflows.

The strengths of this study included a standardized experimental design and complete subject follow-up. The entire surgical workload was undertaken by a single operator, thereby neutralizing any operator-related bias. Potential interpersonal variability in pain perception was effectively eliminated by the split-mouth design.

The magnitude of postoperative oedema fluctuates in accordance with local variables such as the spatial orientation of the impacted tooth, the technique adopted for bone removal, haemostatic control, wound closure tension introduced by over-suturing, and the traumatic manipulation of both soft and hard tissues, alongside systemic determinants including chronological age, bleeding propensity, nutritional status, concurrent medication use, and the presence of diabetes mellitus [61]. The constraints of our study include the reality that multiple contributory factors increase the likelihood of pain, edema, trismus, and the broader inflammatory response, making it challenging to determine whether dexamethasone can favorably modulate each contributing factor. The split-mouth design was specifically selected to neutralize systemic and local factors that influence the postoperative outcomes of third molar surgery. Furthermore, the unavoidable prolongation of injection time necessitated by the larger injectate volume relative to the standard 2 ml may serve as a source of distress, most notably among anxious patients. Subsequent investigations with expanded sample sizes, along with serial measurement of plasma dexamethasone levels following administration, are warranted.

Conclusion

Our investigation establishes that supplementing lignocaine with adrenaline and dexamethasone shortens onset latency and extends the window of local anesthetic action, thereby equipping the patient to tolerate the interval of maximal pain. Discomfort is diminished, as reflected by lower pain scores during the initial 24 hours and the subsequent 7 days, and by reduced cumulative analgesic intake among individuals allocated to this therapeutic arm. Additionally, the local anesthetic–steroid admixture attenuates secondary endpoints, including swelling and trismus.

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Conflict of Interest: None

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Ethics Statement: The studies involving humans were approved by Manipal College of Dental Sciences, Mangalore. The studies were conducted in accordance with the local legislation and institutional 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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