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Ropivacaine vs. Ropivacaine-Dexmedetomidine for IANB in Mandibular Third Molar Extraction

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This randomized double-blinded crossover study evaluated the effectiveness of ropivacaine alone compared to ropivacaine combined with dexmedetomidine for an inferior alveolar nerve block in patients undergoing mandibular third molar extraction. The study included 60 patients aged 18-45 years. Key outcomes measured were the onset time of anaesthesia, duration of anaesthesia, hemodynamic stability, and pain intensity during and after the procedure. The addition of dexmedetomidine to ropivacaine significantly accelerated the onset of anaesthesia (110.8 ± 12.6 seconds vs. 126 ± 14.4 seconds, $p<0.05$), extended the duration of anaesthesia (443.6 seconds vs. 332.5 seconds, $p<0.05$), and improved postoperative pain control as evaluated by the visual analog scale (VAS). Hemodynamic parameters—systolic and diastolic blood pressure, respiratory rate, heart rate, and oxygen saturation—remained stable with no significant differences between the two groups at any point ($p>0.05$). Patients receiving dexmedetomidine reported lower pain scores consistently at 1, 3, 6, and 12 hours postoperatively ($p<0.05$). No significant adverse effects were observed in either group. These results indicate that adding dexmedetomidine to ropivacaine enhances the efficacy of inferior alveolar nerve blocks for mandibular third molar extraction by providing faster onset, longer duration, and superior postoperative pain management without affecting hemodynamic stability.

Keywords: Ropivacaine – Dexmedetomidine – Inferior Alveolar Nerve Block – Mandibular Third Molar Extraction – Local Anesthesia – Hemodynamic Stability – Pain Management.

1. Introduction

In oral and maxillofacial surgery, the inferior alveolar nerve block (IANB) is a frequently used local anesthetic medication, particularly for mandibular tooth surgeries such as third molar extractions. Effective pain management is provided by this approach, making surgery more comfortable and tolerable for both patients and surgeons. Anaesthetic potency, latency, i.e.,

the amount of time it takes for anesthesia to set in, and duration of the anesthetic effect all play essential roles in the choice of anesthetic agent for IANB. Long-acting amide local anaesthetic ropivacaine is frequently used for IANB because of its good anaesthetic properties and favourable safety profile. Researchers have investigated several adjuncts that can be combined with local anesthetics to increase their effectiveness and maximize anaesthetic results. One such adjunct is the highly selective alpha-2 adrenergic agonist dexmedetomidine [1-3].

Dexmedetomidine is widely known for having a 1620-fold higher selectivity for alpha-2 receptors than other medicines [4]. Attaching itself to presynaptic α-adrenoreceptors prevents norepinephrine from being released, which stops pain signals from spreading. Due to this mechanism, Dexmedetomidine is a potentially helpful addition for local anaesthesia, which also provides sedative and hemodynamic stability while delivering analgesia [2,5]. According to earlier research, dexmedetomidine can improve the anaesthetic effect of local anaesthetics, improving clinical outcomes for various localized anesthetic methods [6-8].

This study examines the effectiveness of ropivacaine alone versus ropivacaine with dexmedetomidine for intractable infection (IANB) among patients having their mandibular third molar extracted. The primary outcomes measured are the duration of anaesthesia and start time, hemodynamic stability, and the degree of pain experienced during and after the procedure. This study aims to optimize anaesthetic management in oral surgery by assessing these characteristics and offering insights into the possible advantages of combining dexmedetomidine with ropivacaine for IANB.

2. MATERIAL AND METHODS

Study Design

This study was designed as a randomized, double-blinded crossover trial. The primary objective was to compare the efficacy of ropivacaine alone versus ropivacaine with dexmedetomidine for inferior alveolar nerve block (IANB) in patients undergoing mandibular third molar extraction.

Patient Selection

A total of 60 patients, aged between 18 and 45 years, who were scheduled for the surgical extraction of mandibular third molars, were enrolled in the study. Inclusion criteria included patients in good general health (ASA I or II) without any contraindications to the study medications. Exclusion criteria included patients with known allergies to local anesthetics or dexmedetomidine, pregnant or lactating women, patients with significant medical conditions (e.g., cardiovascular diseases, renal impairment), and those on medications that could interfere with the study outcomes.

Randomization and Blinding

Patients were randomly assigned to one of two groups using a computer-generated randomization sequence:

Group R: Received 1.8 mL of 0.75% ropivacaine alone for IANB.

Group D: Received 1.8 mL of 0.75% ropivacaine with 1 μg/kg dexmedetomidine for IANB.

Both the patients and the administering clinicians were blinded to the group allocations.

Anesthetic Technique

The same oral surgeon performed all procedures to maintain consistency. The inferior alveolar nerve block was administered using a standard technique. The solution was injected slowly over 60 seconds to minimize discomfort and ensure adequate deposition of the anesthetic agent.

Assessment Parameters

The following parameters were assessed:

- Onset Time of Anesthesia: Time from the completion of the injection to the loss of sensation in the lower lip and tongue, measured in seconds.
- Duration of Anesthesia: Time from the onset of anesthesia to the return of sensation, measured in seconds.
- Hemodynamic Stability: Monitored using non-invasive blood pressure (systolic and diastolic), heart rate (HR), respiratory rate (RR), and oxygen saturation (SpO2) at three points—preoperative, intraoperative, and postoperative.
- Pain Intensity During Procedure: Assessed using a Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst pain imaginable).
- Postoperative Pain: Measured at 1, 3, 6, and 12 hours postoperatively using the VAS.
- Adverse Effects: Any adverse effects such as hypotension, bradycardia, or allergic reactions were recorded.

Statistical Analysis

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation (SD) and compared using paired t-tests or Wilcoxon signed-rank tests, as appropriate. Categorical variables were expressed as frequencies and percentages and compared using Chi-square tests. A p-value of <0.05 was considered statistically significant.

3. RESULTS

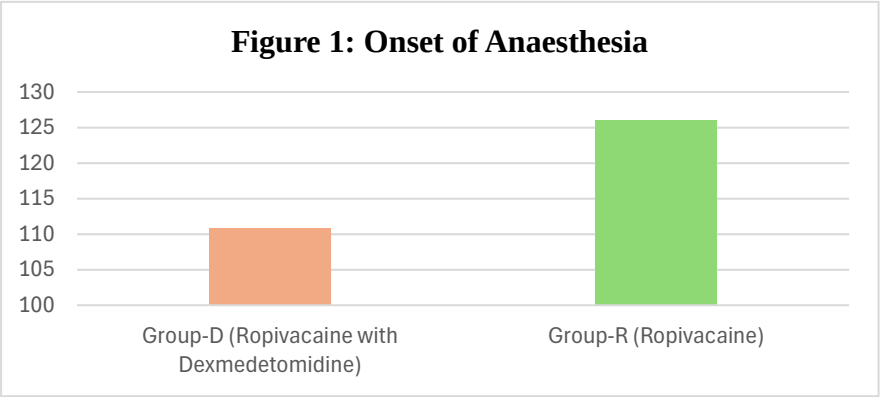
The study findings demonstrated significant differences in several key parameters between ropivacaine alone (Group R) and ropivacaine with dexmedetomidine (Group D).

Onset of Anaesthesia:

The mean onset time of anesthesia was significantly faster in Group D compared to Group R (110.8 ± 12.6 seconds vs 126 ± 14.4 seconds, respectively; $p<0.05$) [Table 1; Figure 1]. This represents a reduction in onset time of approximately 12% with the addition of dexmedetomidine.

Table 1: Onset of Anaesthesia

Group	Time of Onset
Group-D (Ropivacaine with Dexmedetomidine)	110.8 ± 12.6 seconds
Group-R (Ropivacaine)	126 ± 14.4 seconds

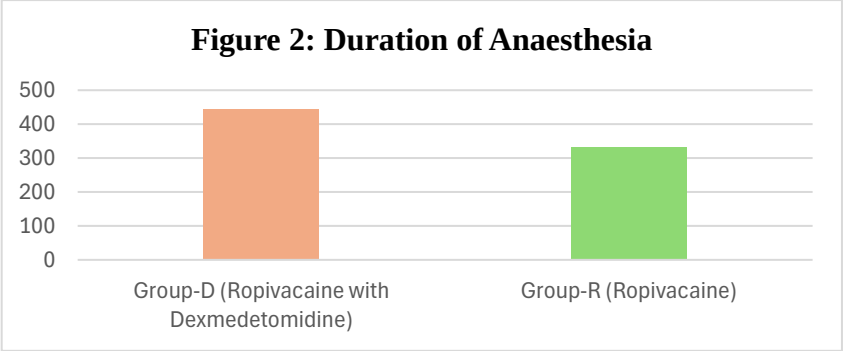


Duration of Anesthesia:

The mean duration of anesthesia was markedly longer in Group D compared to Group R (443.6 seconds vs 332.5 seconds, respectively; $p<0.05$) [Table 2; Figure 2]. This indicates an increase in anesthesia duration of about 33% when dexmedetomidine was added to ropivacaine.

Table 2: Duration of Anaesthesia

Group	Duration
Group-D (Ropivacaine with Dexmedetomidine)	443.6 seconds
Group-R (Ropivacaine)	332.5 seconds



Hemodynamic Parameters:

Analysis of vital parameters revealed no statistically significant differences between the two groups across all time points (preoperative, intraoperative, and postoperative) [Table 1]. Specifically:

- Mean Systolic Blood Pressure: No significant differences were observed preoperatively (Group D: 121.04 ± 6.89 mmHg; Group R: 119.04 ± 8.21 mmHg; p=0.190), intraoperatively (Group D: 111.80 ± 7.85 mmHg; Group R: 112.32 ± 7.14 mmHg; p=0.730), or postoperatively (Group D: 115.12 ± 7.79 mmHg; Group R: 119.04 ± 8.86 mmHg; p=0.21).

- Mean Diastolic Blood Pressure: No significant differences were found at any time point ($p>0.05$ for all comparisons).
- Mean Respiratory Rate: Both groups maintained similar respiratory rates throughout the procedure ($p>0.05$ for all comparisons).
- Mean Heart Rate: No significant differences were observed between the groups at any time point ($p>0.05$ for all comparisons).
- Mean Oxygen Saturation: Both groups maintained 100% oxygen saturation throughout the procedure.

Table 3: Hemodynamic Parameters

	Parameter	Group D	Group R	p-value
Pre-Operative	Mean Systolic	121.04±6.90	119.04±8.21	0.19
	Mean Diastolic	80.44±6.01	78.88±7.27	0.245
	Mean RR	17.86±1.55	17.54±1.14	0.28
	Mean HR	81.56±9.57	81.24±9.67	0.868
	Mean SPO2	100±0.00	100±0.00	1
Intra-Operative	Mean Systolic	111.80±7.86	112.32±7.14	0.73
	Mean Diastolic	72.24±6.02	73.28±5.95	0.387
	Mean RR	20.88±1.22	20.76±1.20	0.622
	Mean HR	81.24±9.67	81.46±9.65	0.91
	Mean SPO2	100±0.00	100±0.00	1
Post-Operative	Mean Systolic	115.12±7.79	119.04±8.86	0.21
	Mean Diastolic	78.04±8.10	78.04±8.10	1
	Mean RR	19.00±1.77	18.52±1.66	0.165
	Mean HR	79.92±6.78	79.96±6.79	1
	Mean SPO2	100±0.00	100±0.00	1

Pain Intensity:

Patients in Group D reported consistently lower pain scores on the Visual Analog Scale (VAS) at all postoperative time points compared to Group R [Figure 3]:

At 1 hour: Group D: 5; Group R: 7

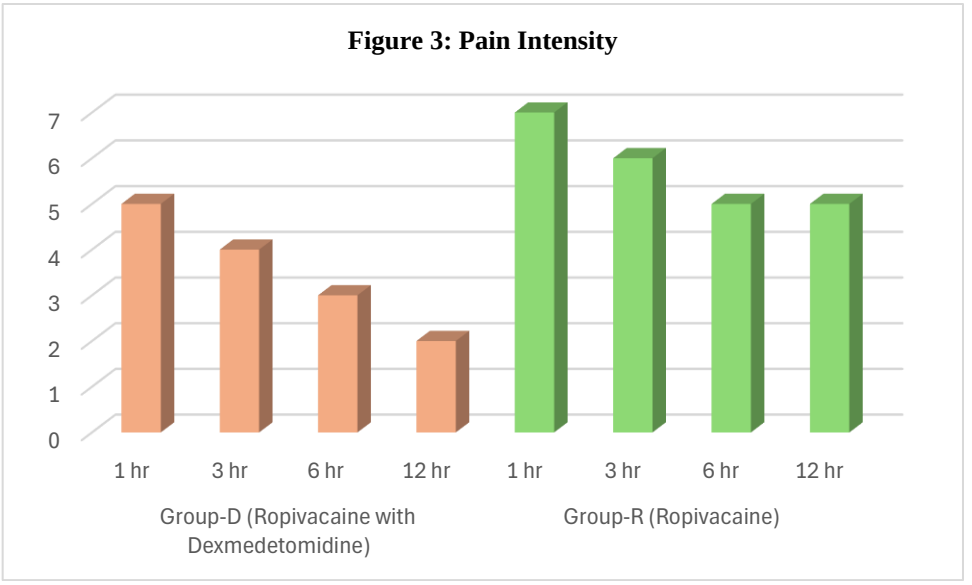
At 3 hours: Group D: 4; Group R: 6

At 6 hours: Group D: 3; Group R: 5

At 12 hours: Group D: 2; Group R: 5

These differences were statistically significant ($p<0.05$) at all time points, indicating superior pain control in the dexmedetomidine group throughout the 12-hour postoperative period.

Figure 3: Pain Intensity



Adverse Effects:

No significant adverse effects were reported in either group during the study period.

4. DISCUSSION:

This study demonstrates that adding dexmedetomidine to ropivacaine significantly enhances the efficacy of inferior alveolar nerve blocks in the surgical extraction of mandibular third molars. The key findings indicate that the combination reduces the onset time of anesthesia, prolongs its duration, and improves pain control during and after the procedure without compromising hemodynamic stability.

The faster onset of anesthesia observed in the dexmedetomidine group (110.8 ± 12.6 seconds vs 126 ± 14.4 seconds) is clinically significant and aligns with previous studies on dexmedetomidine's use in regional anesthesia[3,6]. This rapid onset can lead to more efficient surgical procedures, reducing overall operative time and potentially improving patient satisfaction. The prolonged duration of anesthesia in the dexmedetomidine group (443.6 seconds vs 332.5 seconds) is particularly noteworthy, as it suggests the potential for extended postoperative pain control[2, 9]. This prolonged effect could reduce the need for additional analgesics in the immediate postoperative period, aligning with multimodal pain management strategies.

One of the key concerns when using additives to local anesthetics is the potential for hemodynamic instability. However, our results show no significant differences in vital parameters (blood pressure, heart rate, respiratory rate, and oxygen saturation) between the two groups across all time points (preoperative, intraoperative, and postoperative). This finding is consistent with dexmedetomidine's known pharmacological profile and supports its safety as an additive to local anesthetics in oral surgery[5,10]. Maintaining hemodynamic stability is particularly important in patients with cardiovascular concerns or lengthy

procedures.

The lower pain scores reported in the dexmedetomidine group both during and after surgery highlight its analgesic properties. At all postoperative time points (1, 3, 6, and 12 hours), patients who received dexmedetomidine as an additive reported lower pain scores on the VAS scale. This enhanced pain control is likely due to dexmedetomidine's action on α2-adrenergic receptors, which modulates pain pathways both centrally and peripherally[4, 8]. The improved analgesia could contribute to better patient comfort, earlier mobilization, and reduced need for systemic analgesics.

Our findings align with and extend previous research on dexmedetomidine as an additive in regional anesthesia. Studies by Yamane et al. [6] and Singh et al. [3] have shown similar improvements in onset time and duration of anesthesia when dexmedetomidine is added to local anesthetics in oral procedures. The hemodynamic stability observed in our study is consistent with findings by Channabasappa et al. [5] in ophthalmic surgery, suggesting a consistent safety profile across different surgical contexts.

For oral surgeons and dental practitioners, the enhanced anesthetic profile achieved by combining dexmedetomidine with ropivacaine can lead to more efficient surgical procedures and improved patient outcomes. The reduced onset time allows for quicker initiation of surgery, while the prolonged duration of anesthesia provides adequate pain control during and after the procedure. This could reduce the need for additional analgesics and improve overall patient satisfaction.

Despite the promising results, this study has several limitations. The sample size of 60 patients, while adequate for detecting significant differences, is relatively small. The focus on a specific age group (18-45 years) and a single type of surgical procedure (mandibular third molar extraction) limits the generalizability of the findings. Future research should include a broader demographic and explore the effects of dexmedetomidine in various types of oral and maxillofacial surgeries.

Additionally, while we assessed pain scores up to 12 hours postoperatively, longer-term follow-up would be beneficial to evaluate any delayed effects or complications associated with dexmedetomidine use. Future studies could also explore dose-response relationships to optimize the concentration of dexmedetomidine for different procedures.

5. CONCLUSION:

The findings of this study demonstrate the significant benefits of adding dexmedetomidine to ropivacaine for inferior alveolar nerve block in mandibular third molar extraction. The combination resulted in a faster onset of anesthesia, prolonged duration of effect, and enhanced postoperative pain control without compromising hemodynamic stability. These advantages have the potential to improve both surgical efficiency and patient comfort. The faster onset allows for quicker procedure initiation, while the extended duration of anesthesia provides better pain management during and after surgery, potentially reducing the need for additional analgesics [1,3,8,10]. Moreover, the stable hemodynamic profile observed with the addition of dexmedetomidine supports its safety as an adjunct to local anesthetics in oral surgery. While these results are promising, further research involving more extensive and diverse patient

populations is warranted to fully elucidate the role of dexmedetomidine in various oral and maxillofacial surgical procedures. Nonetheless, this study provides compelling evidence for using dexmedetomidine as a valuable additive to local anesthetics in oral surgery, offering a potential advancement in pain management strategies for dental practitioners.

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