Original Research Article

# Comparative analysis of lignocaine, ropivacaine, and bupivacaine in pain control during extraction of mandibular posterior teeth

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## Abstract

**Background:** The management of pain during extraction of mandibular third molars is an important requisite to achieve patient comfort and to obtain desired result in an effective manner. There are various anesthetics that can be used to achieve regional or local anesthetic effect in this regard. The primary indication for using long-acting anesthetics in dentistry is extensive dental procedures that require pulpal anesthesia beyond 90 min and management of postoperative pain. Present study was done with an aim of comparing efficacies of lignocaine, ropivacaine, and bupivacaine in control of pain during extraction of mandibular posterior teeth. **Material and Methods:** This was a prospective, cross-sectional study designed to analyze efficacies of three local anesthetic drugs - 2% lidocaine with 1: 80,000 adrenaline, ropivacaine, and bupivacaine on pain control during mandibular third molar surgical extractions. A total sample of 240 subjects those were indicated for mandibular third molar surgical extractions were included in the study. The study participants were categorized into three groups – (a) Group I: Third molar surgeries performed using 2% Lignocaine with 1: 80,000 epinephrine (n = 80); (b) Group II: This group included subjects who underwent surgical extractions of mandibular third molars under 0.75% ropivacaine local anesthesia (n = 80) and (c) Group III. Subject response for pain was recorded using the – (a) Visual Analog Scale (VAS) and (b) Verbal Rating scale (VRS). Postoperative pain was analyzed using the assessment of analgesic used. **Results:** that in Group I (2% Lignocaine with 1:80,000), no pain during the extraction procedure was observed in 23 while minimal or less pain was seen in 57 subjects, while in Group II (0.75% ropivacaine), 75 patients demonstrated no pain and 5 presented with minimal pain during extraction procedure. On the one hand, the Group III subjects whose mandibular third molars were surgically removed using local anesthesia induced by bupivacaine, demonstrated lack of any pain sensation in 60 patients and minimal pain in 20. On comparing these three groups, a statistically significant P=0.01 was obtained. **Conclusion:** 0.75% ropivacaine is a better anesthetic when compared to bupivacaine and lignocaine for pain control during third molar extractions.

**Key Words:** Bupivacaine, Lignocaine, Mandibular third molars, Ropivacaine

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## INTRODUCTION

Pain is an unpleasant sensation which has led to devising many pharmacological as well nonpharmacological methods of controlling it. For this, in dental and oral surgical procedures, the use of a variety of local anesthetics has been implicated. Thus, the contribution of a variety of local anesthetics in the field of dentistry is immense as nearly all branches in dentistry and medicine field make use of them. For this purpose, these local anesthetic agents have evolved through various synthesized molecules along with various advancements in techniques for pain free treatment.[1] Local anesthesia is an effective method of pain control since 1884.[2-7] In dentistry, 2% lidocaine is most

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frequently used.[8] However, lidocaine is short acting (vasodilator).[9] To increase the depth and duration of anesthesia, epinephrine was added to lignocaine.[9] Nonetheless, epinephrine containing local anesthetic solution is contraindicated in hyperthyroidism and significant cardiovascular diseases (American Society of Anesthesiologists physical status grade 3–4).[9] Furthermore, adding vasoconstrictor reduces the pH of the solution (acidic), rendering the injections uncomfortable to the patients. Hence, search for a long-acting local anesthetic agent with inherent vasoconstrictive property still endures. There are several local anesthetic solutions available, such as lidocaine, prilocaine, mepivacaine, bupivacaine, articaine, and ropivacaine. However, there has been continuous research to find the ideal local anesthetic solution with a prolonged duration of action, good postoperative analgesia, and low toxicity. The duration of action of a local anesthetic is dependent on two factors: protein binding and redistribution of the local anesthetic. Protein binding of the local anesthetic is an inherent drug characteristic with the longer duration of action indicating more protein binding of the drug. Furthermore, researchers have reported that the piperidine ring of cocaine and the xylidine component of lidocaine combine to form the pipecoloxylidine family of local anesthetics, including long-acting local anesthetics such as mepivacaine, bupivacaine, and ropivacaine. These drugs possess enhanced lipid solubility characteristics and display an increased affinity for protein binding, which dramatically increases the duration of achievable anesthesia. This biochemical trait enhances the superiority of this group of drugs more than their short-acting analogs.[10-12] Ropivacaine was introduced in 1996 and was found suitable for peripheral nerve blocks in the medical field.[13-16] Limited data are available concerning the dental use of ropivacaine.[17-19] PubMed search revealed no studies comparing 0.75% ropivacaine with 2% lidocaine for pterygomandibular nerve block.

Bupivacaine (1-butyl-2', 6'-pipecoloxylidide) was first synthesized by B af Ekenstam (1957). It is a long-acting amide-type local anesthetic which was first introduced for clinical usage in 1963. It has longer duration of action compared to lignocaine due to higher lipid solubility and protein-binding capability. Its onset of action varies between 1 to10 min. It has the duration of action that lasts up to 2–9 h It has half-life duration of approximately [20] h. Its potency is four times when compared to lignocaine in equal dosages. In block anesthesia, its duration of activity has been found to be equivalent to lignocaine. However, its duration of action is similar to that of lignocaine in case of anesthesia achieved but means of infiltration technique. One of the major advantages of using bupivacaine is that following return of normal sensation, an extended period of analgesia follows which reduces the requirement for analgesic use in postoperative period. However, bupivacaine is nearly four times toxic than lignocaine. Brunetto *et al.* reported that bupivacaine possessed a higher therapeutic ratio when compared to lignocaine in surgical extraction of impacted third molar.[21] It has been demonstrated to exhibit ten times greater potency when compared to lignocaine in equivalent dosage. It is a long duration acting local anesthetic agent with residual analgesia postoperatively whereas lignocaine demonstrates severe postoperative pain with wearing off of its anesthetic effects. Surgical trauma and resulting inflammation cause sensitization of nociceptive receptors from where neural impulse take postoperative period of 8–12 h during which maximum pain intensity is achieved. Thus, longer acting local anesthetic agents demonstrates better role in controlling postoperative pain when compared to the short-acting local anesthetics.[10,11] This anesthetic agent has been reported to provide a concentration dependent sensory or motor effect. It has been seen that at lower dosages, sensory block is achieved due to selective analgesia of the thinner Aδ and C fibers when compared to large sized Aββ fibers.[22-24] Rate of systemic absorption of various local anesthetic agents is dependent on their dosage and drug concentration; vascularity of injection site and whether epinephrine is present or absent. Thus, based on the above literature support, this study was designed with an aim of comparing efficacies of lignocaine, ropivacaine, and bupivacaine in control of pain during extraction of mandibular posterior teeth.

## MATERIAL AND METHODS

This was a prospective, cross-sectional study designed to analyze efficacies of three local anesthetic drugs - 2% lidocaine with 1: 80,000 adrenaline, ropivacaine, and bupivacaine on pain control during mandibular third molar surgical extractions. A total sample of 240 subjects those were indicated for mandibular third molar surgical extractions were included in the study. Ethical approval was taken from the institutional ethical committee and written informed consent was taken from all the participants. The study participants were categorized into three groups – (a) Group I: Third molar surgeries performed using 2% Lignocaine with 1: 80,000 epinephrine (n = 80); (b) Group II: This group included subjects who underwent surgical extractions of mandibular third molars under 0.75% ropivacaine local anesthesia (n = 80) and (c) Group III: This group included study participants indicated for surgical extraction of mandibular third molars under local anesthesia achieved with bupivacaine (n = 80). The inclusion criteria were patients in the age range of 30–60 years and requiring

pterygomandibular nerve block for dental extraction of bilateral mandibular posterior teeth of similar grade of mobility. Patients with a history of any systemic diseases, allergy to components of lidocaine or ropivacaine, local malignancies, recent history of consumption of antimicrobial and anti-inflammatory drugs, and those with grossly destructed teeth were excluded from the study. Subject response for pain was recorded using the – (a) Visual Analog Scale (VAS) and (b) Verbal Rating scale (VRS). Postoperative pain was analyzed using the assessment of analgesic used.

**Statistical analysis:** The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

## RESULTS

It was observed that in Group I (2% Lignocaine with 1:80,000), no pain during the extraction procedure was observed in 23 while minimal or less pain was seen in 57 subjects, while in Group II (0.75% ropivacaine), 75 patients demonstrated no pain and 5 presented with minimal pain during extraction procedure. On the one hand, the Group III subjects whose mandibular third molars were surgically removed using local anesthesia induced by bupivacaine, demonstrated lack of any pain sensation in 60 patients and minimal pain in 20. On comparing these three groups, a statistically significant P=0.01 was obtained [Table 1]. Postoperative pain was observed in 67.5% cases who received lignocaine anesthesia (Group I), 8.75% cases who underwent third molar extractions under bupivacaine anesthesia while none (0%) demonstrated pain following the extraction procedure [Table 2].

**Table 1:** Demonstrating intensity of inferior alveolar nerve block

| Method of measurement of scale used | Intensity | | | P value |
|---|---|---|---|---|
| | Group I (lignocaine with 1:100.000 adrenaline) | Group II (0.75% ropivacaine) | Group III (bupivacaine) | |
| **VAS (mm)** | | | | |
| **No pain** | 23 | 75 | 60 | |
| **Minimum pain** | 57 | 5 | 20 | **0.01*** |
| **VRS** | | | | |
| **Little pain** | 54 | 0 | 15 | |
| **Moderate pain** | 18 | 0 | 0 | |
| **Severe pain** | 6 | 0 | 0 | |
| **Extreme unbearable pain** | 2 | 0 | 0 | **0.002*** |

VRS: Verbal rating scale, VAS: Visual analogue scale, *indicates statistically significant at p≤0.05

**Table 2:** Demonstrating postoperative analgesic activity

| Variable | Groups | | |
|---|---|---|---|
| | Group I (lignocaine with 1:100.000 adrenaline) | Group II (0.75% ropivacaine) | Group III (bupivacaine) |
| **Post-operative pain** | 54 | 0 | 7 |

## DISCUSSION

Ropivacaine is a long-duration local anesthetic agent that is extensively used in surgical procedures as well as in clinical dentistry. It has inherent vasoconstrictive properties, fewer cardiac and CNS adverse effects, and provides a concentration dependent separation of sensory and motor effects.[25] Several studies have reported that sensory blockade is obtained at lower concentrations; therefore, ropivacaine at low concentrations may be suitable for providing postoperative analgesia.[26,27] In our study, 0.75% ropivacaine demonstrated better local anesthetic properties when compared with 2% lignocaine and bupivacaine. On assessing the visual assessment scale (VAS), comparatively greater number of patients demonstrated no pain with ropivacaine and on verbal rating scale, no subjects were found to demonstrate any negative response with ropivacaine administration. Similar observations have been reported by many investigators who demonstrated superior efficacy of ropivacaine induced anesthesia and subsequent, postoperative analgesia which are as follows- Tijanic and Buric in their comparative study for the evaluation of anesthetic potencies of bupivacaine and ropivacaine in surgical removal of horizontally impacted mandibular third molars demonstrated local anesthesia success in 96.6% patients who were administered 0.75% ropivacaine. The durations of anesthesia reported were - 412.17 ± 110.04, 376.30 ±

98.51 and 216.13 ± 47.69 min, respectively for ropivacaine, bupivacaine, and lignocaine with 1:100,000 epinephrine. There was a statistically significant P value ($P < 0.001$) obtained. Reddy *et al.* compared the anesthetic effectiveness of inferior alveolar nerve block by 0.75% ropivacaine and 2% lidocaine with 1:80,000 epinephrine during mandibular third molar surgical extraction. Significantly different $P < 0.001$ was obtained for rescue pain analgesic medication requirement and the amount of analgesic drug consumed.[28] Hence, it was suggested that 0.75% ropivacaine was more effective in providing anesthesia, prolonged analgesia postoperatively and postoperative control of pain.[28] Bupivacaine is a long-acting anesthetic agent with its duration of action extending between seven to 11 h and 9 h for inferior alveolar nerve block and infiltration anesthesia, respectively.[29] It has demonstrated longer anesthesia of soft tissues and reduced postoperative pain along with late peak in pain (12 h) and lesser intensity on visual analog scale. However, it has been reported to cause high diastolic and low systolic blood pressures though these are not statistically significant.[30] However, it has been reported to have a narrow safety margin due to its cardio- and neurotoxic side-effects.[31] Ozkiriş *et al.* also reported significant reduction in pain in subjects treated with ropivacaine when compared with bupivacaine. Postsurgical pain was the most common morbidity associated with any surgical procedure.[32] In a study conducted by Chan *et al.*, it was observed that there was a sustained motor block with ropivacaine when compared with lignocaine ($P < 0.05$). Thus, a longer period of residual anesthesia was observed with ropivacaine. Kamal in his study found that recovery period of sensory nerve block was prolonged significantly in ropivacaine when compared to lidocaine.[33] Mishra *et al.* observed that ropivacaine demonstrates comparable efficacy as lignocaine with the added advantage of a longer duration of action and superior postoperative pain control. However, Ranjan *et al.* compared the efficacy of 0.75% ropivacaine and 2% lidocaine hydrochloride with 1:200000 adrenaline in the extraction of mandibular posterior teeth and concluded that even though ropivacaine had a long duration of action, they did not find any advantage of using 0.75% ropivacaine in pterygomandibular nerve block.[34] The study by Rajpari *et al.* compared the efficacy of 0.75% ropivacaine alone and 0.5% ropivacaine with 2% lignocaine along with 1:200,000 adrenaline and found that ropivacaine (0.75%, 0.5%) was more efficacious than 2% lignocaine demonstrating faster onset and longer duration of action. Contrasting evidence has been provided by Ranjan *et al.* who in their split-mouth study compared effectiveness of 2% lignocaine and 0.75% ropivacaine for control of pain in extraction of mandibular posterior teeth. No significant difference was observed in comparing both the study groups.[34] Similarly, Mansour *et al.* compared 0.5% bupivacaine and 0.75% ropivacaine for assessing durations of anesthesia and analgesia along with postoperative pain following surgical extraction of impacted mandibular third molar by means of inferior alveolar nerve block. It was observed that the median durations of anesthesia were approximately 6 and 7 h, respectively for 0.75% ropivacaine and 0.5% bupivacaine. Furthermore, analgesic effects were found to be 10.3 and 9.6 h, respectively for bupivacaine and ropivacaine, respectively. Thus, equal efficacy was observed for both the anesthetic agents.[35] Kumar *et al.* in their comparative efficacy found no significant difference in patients undergoing tooth extractions with different concentration of lignocaine, i.e., 2% lignocaine with 1:80000 concentration of adrenaline and 2% lignocaine with 1:200000 concentration.[36]

## CONCLUSION

In the Present study three local anesthetic agents - 2% Lignocaine hydrochloride with 1:80,000 adrenaline; bupivacaine and ropivacaine have been compared for their efficacy in pain control during extraction of studied teeth. It was found that 0.75% ropivacaine is a better anesthetic when compared to bupivacaine and lignocaine for pain control during third molar extractions. This study demonstrated that Ropivacaine, a long-acting amide anesthetic provides better intraoperative and postoperative pain control during extractions of posterior mandibular teeth.

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