Original Article

Comparison of efficacy of lignocaine, ropivacaine, and bupivacaine in pain control during extraction of mandibular posterior teeth

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.

Aim: The aim of this study was to compare the efficacy of 2% lignocaine with 1:80,000 adrenaline, 0.75% ropivacaine and bupivacaine in pain control during extraction of mandibular posterior teeth.

Materials and Methods: This prospective, cross-sectional study included 300 study participants indicated for mandibular third molar surgical extractions. The study subjects were categorized into three broad groups - (a) Group I (n = 100): Third molar extractions performed using 2% Lignocaine with 1: 80,000 epinephrine; (b) Group II (n = 100): This group included subjects who underwent extractions of mandibular third molars using 0.75% ropivacaine and (c) Group III (n = 100): This group included patients who underwent extractions of mandibular third molars with bupivacaine. Inclusion criteria were: (a) partially impacted mandibular third molars which were symptomatic; (b) written informed consent. Exclusion criteria were – (a) any systemic diseases and/or undergoing any medication for same; (b) subjects not willing for extraction after clinical and radiographic examination and opinion and (c) subjects undergoing orthodontic therapy. Subject response for pain was recorded using – (a) visual analog scale (VAS) and (b) Verbal Rating scale (VRS). Postoperative pain was assessed using requirement of analgesics after extraction. SPSS version 21.0 was employed as statistical software. Statistical tool used was the Analysis of Variance test which was used for determining statistical significance which was set at a P value of lesser than 0.05 (significant).

Results: On analysis of visual analog scale (VAS), it was observed that in Group I (2% Lignocaine with 1:80,000), no pain during the extraction procedure was demonstrated in 30 study participants while minimal or less pain was present in 70 patients, while in Group II (0.75% ropivacaine), 90 patients presented with no pain while ten patients had presented with minimal amount of pain during tooth extraction. While on the other hand, Group III patients whose mandibular third molars were extracted using local anesthesia by injecting bupivacaine, lack of any pain was observed in 69 patients while minimal pain was noted in 31 individuals. While making statistical comparison between three groups, a significant P = 0.03 was observed. Also, postoperative pain was noted in 60% of cases who underwent extraction using 2% lignocaine (Group I), 10% patients who had third molar extractions under Bupivacaine anesthesia presented with pain whereas none of the patients (0%), demonstrated the presence of pain following third molar extraction.

Conclusion: 0.75% Ropivacaine is the most effective local anesthetic agent that can be used for extracting mandibular third molars due to its effective pain control both during and following the procedure when compared to 2% lignocaine and bupivacaine.

Keywords: Extraction, mandibular third molar, pain

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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 definable as the "temporary loss of any sensation or that of pain in any part of a body which is be produced by applying or injecting an anesthetic drug or agent which aids in causation of depression of consciousness level."[2] Lignocaine is most widely used local anesthetic agent due to low cost and rapid onset. It has a pKa of 7.85 and undergoes rapid diffusion through interstitial tissues inside the lipid enriched neuronal fibers resulting in rapid onset.[3]

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 2.7 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.[3] Brunetto *et al*. reported that bupivacaine possessed a higher therapeutic ratio when compared to lignocaine in surgical extraction of impacted third molar.[4] 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.[5] 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.[6-8]

Ropivacaine is a long-acting amide local anesthetic agent. It is a physicochemical properties similar to that of bupivacaine.[6] It is 1'-propyl-2',6'-pipecoloxylidide structurally and is medium to long duration acting local anesthetic of the class-amino amide. It is a pure S-enantiomer when compared to other local anesthetics which are racemic mixtures. This anesthetic agent produces peripheral nerve anesthetic action of longer duration compared to the R or racemic forms. Furthermore, it has demonstrated less potential for cardio as well as nervous system toxicities.[9] This anesthetic agent has been reported to provide a concentration-dependent sensory or motor effect.[10] 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.[11-13] 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.[14] 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.

MATERIALS 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 300 subjects those were indicated for mandibular third molar surgical extractions were included in the study. The study was conducted in compliance with the protocol; ethical approval was obtained from the institutional ethical committee (Ethical Approval Number – NM/ ETH/2019/069) . The subjects participating in the present study provided their informed written consent before taking the survey by signing the consent form. The study participants were categorized into three groups – (a) Group I: Third molar surgeries performed using 2% Lignocaine with 1: 80,000 epinephrine (n = 100); (b) Group II: This group included subjects who underwent surgical extractions of mandibular third molars under 0.75% ropivacaine local anesthesia (n = 100) and (c) Group III: This group included study participants indicated for surgical extraction of mandibular third molars under local anesthesia achieved

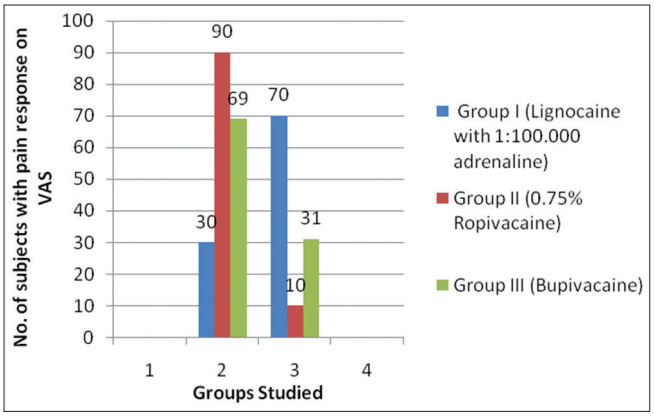
with bupivacaine (n = 100). Inclusion criteria for subject inclusion were – (a) symptomatic partially impacted mandibular third molars and (b) written informed consent from study participants while exclusion criteria for subject inclusion were – (a) any systemic disease; (b) subjects not willing for surgical extraction of concerned tooth and (c) those undergoing orthodontic therapy. Subject response for pain was recorded using the – (a) Visual Analog Scale (VAS) and (b) Verbal Rating scale (VRS) [Graph I]. Postoperative pain was analyzed using the assessment of analgesic used. Graph 2 demonstrates the number of subjects requiring analgesia following post extraction of mandibular third molars.

Statistical software SPSS version 21.0 (IBM, Armonk, NY, USA) was employed. Statistical tool–analysis of variance was used for determining statistical significance. *P* value which was lesser than 0.05 was statistically significant.

RESULTS

On analyzing the Visual Analogue Scale (VAS), it was observed that in Group I (2% Lignocaine with 1:80,000), no pain during the extraction procedure was observed in 30 while minimal or less pain was seen in 70 subjects, while in Group II (0.75% ropivacaine), 90 patients demonstrated no pain and 10 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 69 patients and minimal pain in 31. On comparing these three groups, a statistically significant $P = 0.03$ was obtained [Table 1].

Postoperative pain was observed in 60% cases who received lignocaine anesthesia (Group I), 10% cases who underwent third molar extractions under bupivacaine anesthesia while none (0%) demonstrated pain following the extraction procedure [Table 2].



Graph 1: Graph demonstrating subjects on verbal rating scales in each group

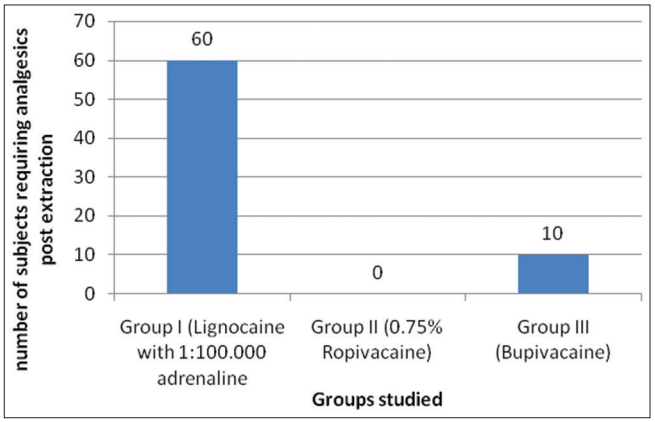
DISCUSSION

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.[15]

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. Hence, it was suggested that 0.75% ropivacaine was more effective in providing anesthesia, prolonged analgesia postoperatively and postoperative control of pain.[16]

In addition, Kaur *et al*. also concluded in their study that there was an early onset of activity of both sensory and motor nerve blocks with ropivacaine when compared to bupivacaine along with a fast recovery period.[17]



Graph 2: Graph demonstrating number of subjects requiring analgesics following postextraction of mandibular third molars

Table 1: Demonstrating intensity of inferior alveolar nerve block

Method of measurement of scale used	Intensity			*P*
	Group I (lignocaine with 1:100.000 adrenaline)	Group II (0.75% ropivacaine)	Group III (bupivacaine)	
VAS (mm)				
No pain	30	90	69	0.03
Minimal pain	70	10	31	
VRS				
Little pain	60	Nil	20	
Moderate pain	28	Nil	Nil	
Severe pain	09	Nil	Nil	
Extreme unbearable pain	02	Nil	Nil	

VRS: Verbal rating scale, VAS: Visual analogue scale

Table 2: Demonstrating postoperative analgesic activity

	Groups		
	Group I (lignocaine with 1:100.000 adrenaline	Group II (0.75% ropivacaine)	Group III (bupivacaine)
Postoperative pain	60	0	10

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.[18] 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.[19] However, it has been reported to have a narrow safety margin due to its cardio- and neurotoxic side-effects.[20]

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.[21]

Brkovic *et al*. compared 0.75% ropivacaine (2 mL) and 0.5% bupivacaine (2 mL) for onset of action and duration of anesthesia. Intensity of anesthetic effect was determined using the visual analogue scale and verbal rating scales. They reported no significant difference in parameters. However, patients who were administered ropivacaine demonstrated prolonged duration of analgesia when compared to bupivacaine.[22]

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.[8]

Kamal in his study found that recovery period of sensory nerve block was prolonged significantly in ropivacaine when compared to lidocaine.[23]

Haidry *et al*. on statistical analysis demonstrated average time of onset for lignocaine and bupivacaine as 2.5 and 5 min, respectively. Bupivacaine was shown to demonstrate extended duration of action and relatively less intensity of pain.[3]

Bansal *et al*. conducted a study to evaluate the efficacy, safety, and clinical acceptability of the local anesthetic agent ropivacaine 0.75% in comparison with lignocaine 2% with adrenaline 1:200,000 in minor oral surgical procedures. It was concluded that ropivacaine is a safe, clinically acceptable long acting local anesthetic agent with added advantage of effective diffusion property.[24]

Saralaya *et al*. in their study compared 4% articaine with 1:100,000 epinephrine and 2% lignocaine with 1:100,000 epinephrine in patients operated for mandibular third molar impaction and concluded that 4% articaine is more potent and has longer duration of action with better postoperative analgesia and could be considered as an alternative to lignocaine in clinical practice.[25]

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.[26]

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.[27]

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.[28]

Khan *et al*. in their comparative study on evaluating efficacy of lignocaine and bupivacaine on surgical mandibular third molar extraction found no statistically significant difference between both the anesthetic agents for controlling intraoperative pain.[29]

CONCLUSION

Pain is an unpleasant physical experience which ranges from mild local discomfort to intense sensation. It is the most common symptom which is experience in oral surgical procedures. To circumvent this, usually various local anesthetic injectable drugs or agents and analgesics are made use for controlling pain during and following these procedures of which the most common is the surgical removal of mandibular third molars. In the current 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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Nil.

Conflicts of interest

There are no conflicts of interest.

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