Oral and Maxillofacial Surgery (2019) 23:225–231
https://doi.org/10.1007/s10006-019-00779-w

ORIGINAL ARTICLE

Is 0.75% ropivacaine more efficacious than 2% lignocaine with 1:80,000 epinephrine for IANB in surgical extraction of impacted lower third molar?

K. Varun Reddy [1] · Anendd Jadhav [1] · Nitin Bhola [1] · Apoorva Mishra [1] · Prachet Dakshinkar [1]

Received: 29 December 2018 / Accepted: 2 May 2019 / Published online: 14 May 2019

Abstract

Purpose We aim to compare and evaluate the anesthetic efficacy and safety of inferior alveolar nerve block (IANB) using 0.75% ropivacaine and 2% lignocaine with 1:80,000 epinephrine in lower impacted third molar (LI3M) surgery.

Patients and method We designed a prospective randomized, double-blind, split-mouth study evaluating 60 systemically healthy patients with the presence of bilateral symmetrically oriented LI3M. The sides and sequence of drug administered were randomly allocated. The primary outcome variables analyzed were hemodynamic stability, profoundness of anesthesia, and duration of postoperative analgesia. Time of onset, duration of soft tissue anesthesia, patients requiring analgesics, and their quantity for five postoperative days were recorded.

Results Early onset of anesthesia was seen in Lignocaine (68.6 ± 20.4 s) compared with Ropivacaine (104.1 ± 17.7 s) with significant differences ($p = 0.001$). Both the anesthetic solutions were found to be equipotent in providing profound intraoperative anesthesia. No significant difference emerged in perioperative hemodynamic stability. Ropivacaine exhibited statistically significant differences in the duration of soft tissue anesthesia ($p = 0.001$) and postoperative analgesia ($p = 0.001$). Patients requiring rescue pain medication and the number of analgesics consumed were greater on first and during five postoperative days in lignocaine when compared with that of ropivacaine with significant differences $p < 0.001$ and $p < 0.001$ respectively.

Conclusion The results suggest that 0.75% ropivacaine is effective in providing adequate anesthesia, prolonged postoperative analgesia, and better postoperative pain control with a safer cardiovascular profile in LI3M surgery. It can be an addition to the existing list of long-acting local anesthetics used for LI3M surgery.

Keywords Impacted tooth · Ropivacaine · Lignocaine · Postoperative pain · Analgesia

Introduction

Lower impacted third molar (LI3M) are frequently encountered in daily clinical dental practice. Its removal triggers a cascade of coordinated inflammatory events caused by surgical trauma to the investing tissues approximating the LI3M [1]. These are manifested clinically in the form of pain, edema, and trismus which affect patients' quality of life adversely. Pain initiated following LI3M surgery reaches its maximal intensity within 3–5 h just after cessation of local anesthetic action causing severe discomfort and apprehension to the patient. Effective management of postoperative pain results in beneficial psychological outcomes imparting greater satisfaction and briefer convalescence, thus fostering better quality of life.

Long-acting local anesthetic agents are the main tenets to control pain in dentistry. Preemptive analgesia by long-acting local anesthetics entails blockage of transmission of a pain

✉ K. Varun Reddy
varun.chinchin@gmail.com

Anendd Jadhav
anendd.j@gmail.com

Nitin Bhola
drnitinbhola@gmail.com

Apoorva Mishra
drmishraapoorva@gmail.com

Prachet Dakshinkar
pracdak@gmail.com

[1] Department of Oral and Maxillofacial Surgery, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha, Maharashtra 442004, India

impulse before surgical incision/procedure ultimately resulting in lesser postoperative pain. Lignocaine is considered as the gold standard anesthetic agent against whom all other agents are compared. However, lignocaine with adrenaline is not the preferred blend for extended procedures owing to its brief duration of action and undesirable effects on CVS and CNS system at higher doses. A local anesthetic agent with prolonged duration of action and prolonged analgesia with minimal effects on CNS and CVS system is an appropriate choice. Bupivacaine for a considerable time was considered as an ideal long-acting anesthetic agent; however, it soon fell out of favor owing to its cardiotoxic effects [2]. Recently, ropivacaine gained a better clinical recognition owing to its safer profile and equivalent potency compared to bupivacaine. At lower concentrations, it is a vasoconstrictor [3] obviating the need for additional vasoconstrictor. One of its discerning features is the residual analgesic property which instigates enhanced postoperative analgesia [4, 5]. It replaced bupivacaine as a gold standard amongst long-acting local anesthetics.

Ropivacaine is commercially available at various concentrations, viz., 0.5%, 0.75%, and 1%. It has successfully been used in various gynecological, ophthalmic, and orthopedic procedures consistently demonstrating a potent anesthetic efficacy and safer systemic profile compared with other anesthetics when used for peripheral nerve blocks, infiltration, or epidural anesthesia. However, its utility in dentistry is limited to few studies in endodontics, L3M surgeries and periodontic procedures evaluating its anesthetic efficacy. In a recent comparative analysis between 0.5 and 0.75% ropivacaine for inferior alveolar nerve block in L3M surgery, it was concluded that 0.75% ropivacaine was more efficacious and desirable. [6]

Limited studies [6, 7] are available till date regarding the use of ropivacaine (0.75%) in minor surgical interventions, including extraction of LI3M appraising about the postoperative analgesia and requirement of additional analgesics. Hence, we aimed to compare and analyze the efficacy and safety of 0.75% ropivacaine and 2% lignocaine with 1:80,000 epinephrine in LI3M surgery hypothesizing that 0.75% ropivacaine is a superior alternative to 2% lignocaine with adrenaline. The primary outcome variables were the profoundness of anesthesia, hemodynamic stability, postoperative analgesia, and requirement of analgesic intake.

Patients and method

The present randomized, double-blind, split-mouth study prospectively evaluated 60 systemically healthy patients reporting to the outpatient department of Oral and Maxillofacial Surgery at Sharad Pawar Dental College and Hospital, Sawangi (Meghe), Wardha, Maharashtra between August 2016 to May 2018. The study was performed in accordance with the Helsinki declaration and its later amendments or comparable ethical standards and institutional ethical guidelines prescribed by the Central Ethics Committee on Human Research (CECHR) of Datta Meghe Institute of Medical Sciences (IEC # DMIMS(DU)/IEC/2016-17/6039).

Sixty systemically healthy individuals with the presence of bilaterally asymptomatic vertical/mesioangular LI3M with same difficulty index, depth, and relationship with ramus were recruited in the study sample. Patients with a history of systemic diseases such as endocrinopathies, HTN, blood dyscrasias, any chronic facial pain, acute/chronic infection on the side of intervention, patients on antipsychotic and antidepressant drugs, lactating mothers or females on oral contraceptives, and smokers were excluded. Hypersensitivity to the anesthetic agents used in the study and teeth with radiologic evidence of approximation to the inferior alveolar canal were also excluded from the study. The study was performed according to the CONSORT guidelines for randomized controlled trials [8] (see Fig. 1).

After obtaining written informed consent, thorough clinical and radiological evaluations were performed predicting the difficulty of the third molar. The split-mouth design was implemented, and each patient was treated surgically to remove LI3M by administering 2 ml ropivacaine on one random side (Ropivacaine) and 2 ml lignocaine on the contralateral side (Lignocaine) by using the computer-generated table of random numbers in a sealed opaque paper envelop. The anesthetic solution too was randomly selected by using a coin toss, ascertaining the random sequence of drugs being administered. All patients in both groups were subjected to intradermal sensitivity test for LA solution following randomization; baseline heart rate and blood pressure were recorded before the procedure.

Each patient was explained in detail about the study protocol and the Verbal Rating Scale (VRS) [9, 10]. The local anesthetic composition was prepared by senior nursing staff who was not further involved in the study to avoid bias. Both the patient and the operator were unaware of the composition of the anesthetic solution being administered. Post recruitment exclusion criteria included any patient eliciting a VRS pain score ≥ 3 during any point of the surgical procedure was given rescue analgesia (IANB) using 2 ml of 2% lignocaine with 1:80,000 epinephrine. The need to re-anesthetize the surgical site was noted, and such patients were excluded from further evaluation. Also, the patients who had reported with iatrogenic neurosensory damage of IAN and lingual nerve were excluded.

All the IANB and surgical LI3M extractions were carried out by a single experienced surgeon. Postoperatively, all the patients were prescribed cap amoxicillin 500 mg 8 hourly and tab ibuprofen 400 mg 8 hourly for the first five postoperative days and thereafter as and when required. Postoperative

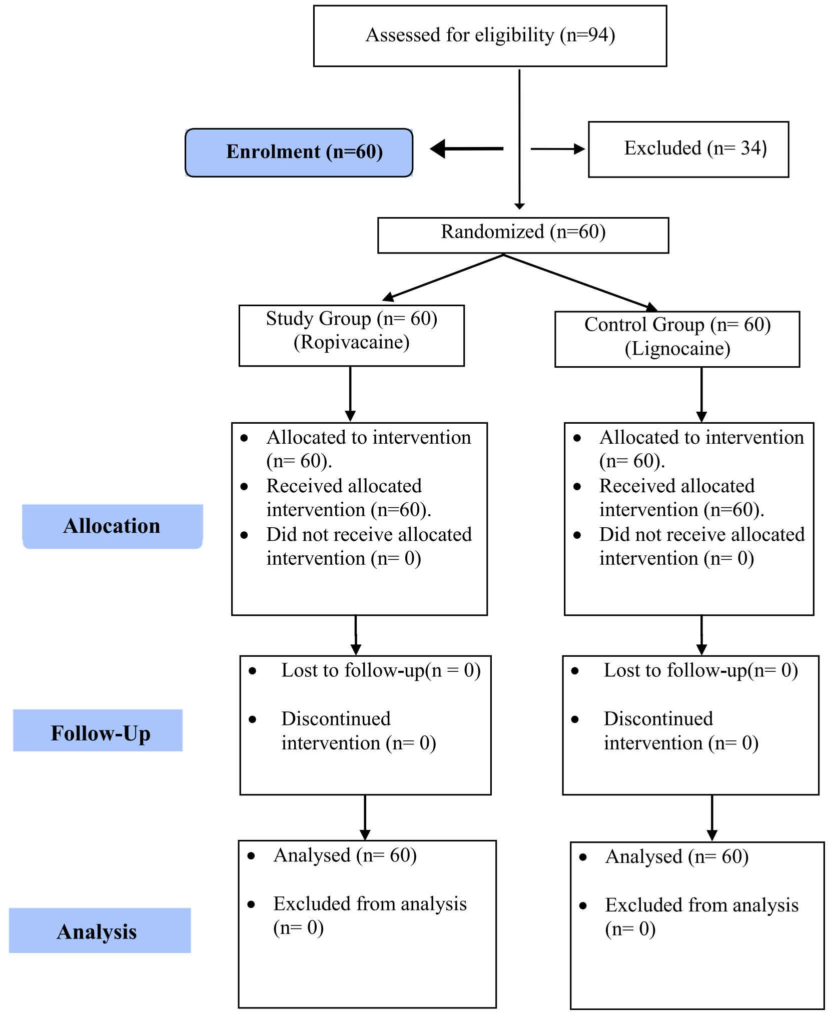

Fig. 1 CONSORT (CONsolidated Standards of Reporting Trials) flow diagram

instructions were given, and patients were dispensed off with the VRS and ordered not to consume any analgesic postoperatively until he/she experiences a pain score of ≥ 3 on VRS. The patients were instructed to record the time of consumption of analgesic along with the number of analgesics consumed at the end of the day. Any need for additional analgesic to be consumed was asked to be recorded. The chart with a time of consumption of analgesics and its quantity was collected on the seventh day postoperatively from the patients.

The intervention on the contralateral side was carried out after a washout period of 21 days. There were no drop-outs of patients from the study. The outcome variables assessed were the following: (a) time of onset of anesthesia—measured from the time of needle withdrawal after injection to the time when the anesthetic effect first reported and was confirmed objectively by using a blunt atraumatic probe by a digital stopwatch. (b) The profoundness of anesthesia was measured by assessment of pain intensity felt during the following events (incision, flap reflection, osteotomy, tooth sectioning/elevation) of surgery and was measured on VRS.

(c) Hemodynamic parameters included non-invasive measurement of the semi-supine positioned heart rate (HR) and systolic and diastolic blood pressure (SBP, DBP) at intervals of 05, 15, 30, 60, 120, and 180 min following from first anesthetic injection during and after the procedure. (e) The duration of soft tissue anesthesia was measured from the time of onset of anesthesia to the time of cessation of numbness of the homolateral half of lower lip and tongue. (f) The duration of postoperative analgesia was recorded from the time of completion of surgical procedure to the time when the pain intensity score reached a point ≥ 3 on VRS or when the patient consumed an analgesic postoperatively. All the data were recorded including the patients requiring analgesics, and quantity of analgesics consumption on first and during 5 days was entered on MS excel sheet and extrapolated for statistical analysis.

The software package used for analysis was SPSS (Statistical Package for Social Sciences) version 17.0 (IBM Corp., Chicago, USA). The significant differences between both groups were assessed using Students unpaired *t* test and chi-square test. $p < 0.05$ was considered as the level of significance.

Results

The study sample consisted of 27 males (M) and 33 females (F) with a mean age of 30.3 ± 5.2 years (ranging 23–35 years). The data suggests the early onset of anesthetic action in Lignocaine (68.6 ± 20.4 s) than that in Ropivacaine (104.1 ± 17.7 s) exhibiting significant difference ($p = 0.001$) (Table 1). None of the patients from both groups experienced a significant discomfort during incision, flap reflection, osteotomy, and tooth sectioning/elevation, and the overall pain intensity score was always < 3 on VRS during the entire procedure ($p > 0.05$) (Table 1). Insignificant differences were noted with regard to hemodynamic parameters (HR, SBP, and DBP) in both groups at time intervals of 05, 15, 30, 60, 120, and 180 min ($p > 0.05$ (Table 1).

The duration of soft tissue anesthesia and postoperative analgesia was found to be greater in Ropivacaine with significant differences ($p = 0.001$) (Table 1). The durations of soft tissue anesthesia and postoperative analgesia respectively were 91.20 ± 20.34 min and 109.33 ± 30.45 min in Lignocaine and that in Ropivacaine was 355.67 ± 53.07 min and 424.33 ± 75.37 min in Ropivacaine (Table 1). Statistically significant differences ($p < 0.001$) were observed each in terms of the number of patients requiring analgesics and its quantum of consumption in the first 24 h and during 5 days. A significant reduction in need of postoperative rescue medication in the first 24 h was seen in Ropivacaine compared with Lignocaine ($p < 0.001$). Similarly, significant differences emerged ($p < 0.001$) in the quantum of analgesics consumption after first 24 h and during first five postoperative days with greater consumption in Lignocaine when compared with Ropivacaine (Table 2).

Discussion

Ropivacaine is a pure S (−) enantiomer developed with the rationale of reducing the toxicity and thus improvising the sensory and motor block profiles. It provides adequate intraoperative anesthesia and prolonged postoperative analgesia with a wider safety margin. Dental impaction pain model would be an ideal study model to study the efficacy of any new drug especially in acute pain study [11]. Its wide applicability can be attributed to its proven success rate and rapid recruitment of subjects and it being more versatile and economical, and it gives better predictability than any other study model.

Ever since ropivacaine was introduced commercially in the market, it has been widely used in perioperative pain management through peripheral, regional epidural blocks in the discipline of gynecology, orthopedics, and ophthalmology demonstrating consistently improved results compared with other local anesthetic agents. However, its utility in dentistry especially in LI3M surgery remains to be completely unexplained. Only two studies [6, 7] have considered evaluating the safety, anesthetic, and analgesic efficacy in a parallel arm study model. The present study was aimed to evaluate the safety, anesthetic, and analgesic efficacy of 0.75% ropivacaine with 2% lignocaine with 1:80,000 adrenaline with the hypothesis that 0.75% ropivacaine can provide improved anesthesia and postoperative analgesia compared with lignocaine mixed with adrenaline with a steady cardiovascular profile.

In the present study, we selected a homogenous sample size having asymptomatic bilateral similarly oriented LI3M exhibiting a similar difficulty index. Each group comprised 38 (63.33%) vertical and 22 (36.66%) mesioangular teeth. The data suggests that the onset of anesthesia was shorter in Lignocaine (68.6 ± 20.4 s) than that in Ropivacaine (104.1 ± 17.7 s); these results were in accordance with the studies reported by Evangelos G. Keramidas et al. [12], A. Budhrapu et al. [13], Vishal Bansal et al. [2] in which they observed that lignocaine had faster onset of anesthetic action when compared with ropivacaine. The latency of drug is influenced by the pKa value; the lower the pKa value is, the shorter the time of onset is. Lignocaine with a pKa value of 7.86 is close to physiological pH (7.4) enabling quicker penetration into the nerves, whilst ropivacaine solution has a pKa value of 8.2, elucidating its delayed onset of action.

The profoundness of anesthesia was assessed subjectively by measurement of pain intensity scores on VRS by the patients. The VRS consists of a list of 6-point scale phrases (0, no pain; 1, just noticeable pain; 2, weak pain; 3, moderate pain; 4, severe pain; 5, excruciating pain). None of the patients from both groups experienced pain during incision, flap reflection, osteotomy, and tooth sectioning/elevation, and they tolerated the procedure well without any discomfort. The findings were similar to other studies [2, 13, 14] reported in literature reporting equivalent efficacy of ropivacaine solution in terms of the profoundness of anesthesia when compared with lignocaine ($p > 0.05$).

The addition of a vasoconstrictor to a local anesthetic agent delays its absorption into the circulation, prolonging the duration of anesthetic drug and thereby reducing the systemic toxicity level of the drug. It transiently increases blood pressure and heart rate. Concerning the hemodynamic stability, the heart rate and blood pressure were assessed at time intervals of 05, 15, 30, 60, 120, and 180 min respectively during and after the procedure in both the groups. The transient increase in hemodynamic parameters was evident in both groups at time intervals, however, with insignificant differences ($p > 0.05$).

The transient increase in heart rate and blood pressure immediately following the injection can be attributed to the release of endogenous catecholamines as a result of pain or

Table 1 Mean (SD) observation made before the procedure, in time intervals of 05, 15, 30, 60, 120, and 180 min during and after the procedure

Variables	Lignocaine ($n = 60$)	Ropivacaine ($n = 60$)	p value
Time of onset of anesthesia	68.6 (20.4)	104.1 (17.7)	0.001*
VRS (pain intensity)			
(a) Incision	0	0	–
(b) Flap reflection	0	0	–
(c) Bone guttering	0.17 (0.46)	0.10 (0.31)	0.512 (NS)
(d) Tooth sectioning/elevation	0.70 (0.65)	0.63 (0.61)	0.685 (NS)
Heart rate (baseline)	77.13	78.73	–
05	79.0 (6.5)	79.6 (6.2)	0.717 (NS)
15	80.9 (6.1)	81.1 (6.0)	0.898 (NS)
30	80.9 (5.9)	79.5 (6.3)	0.359 (NS)
60	81.9 (5.1)	79.5 (6.3)	0.098 (NS)
120	81.9 (3.9)	80.3 (5.8)	0.234 (NS)
180	81.0 (4.6)	79.4 (6.1)	0.259 (NS)
Blood pressure (baseline)			
Systolic	116.80	115.07	–
Diastolic	75.20	75.80	–
(a) After 05 min			
Systolic	119.13 (7.51)	116.73 (9.04)	0.268 (NS)
Diastolic	77.33 (7.87)	75.67 (4.40)	0.315 (NS)
(b) After 15 min			
Systolic	120.13 (6.81)	117.10 (6.23)	0.077 (NS)
Diastolic	78.07 (6.29)	75.60 (5.52)	0.112 (NS)
(c) After 30 min			
Systolic	118.60 (6.87)	116.20 (7.53)	0.202 (NS)
Diastolic	77.27 (6.38)	75.80 (5.02)	0.326 (NS)
(d) After 60 min			
Systolic	118.87 (6.07)	116.33 (8.27)	0.182 (NS)
Diastolic	77.27 (5.49)	75.47 (5.41)	0.103 (NS)
(e) After 120 min			
Systolic	117.8 (6.46)	115.07 (7.0)	0.122 (NS)
Diastolic	76.87 (5.37)	75.07 (4.86)	0.179 (NS)
(f) After 180 min			
Systolic	117.73 (5.63)	116.43 (5.08)	0.352 (NS)
Diastolic	76.60 (5.36)	74.73 (4.56)	0.152 (NS)
Duration of soft tissue	91.2 (20.3) min	355.6 (53.07)min	0.001*
Duration of postoperative analgesia	109.3 (30.45) min	424.4 (75.37) min	0.001*

Table 2 Postoperative analgesic consumption after anesthesia with 2% lignocaine with 1:80,000 epinephrine and 0.75% ropivacaine solution

Parameters	Group L	Group R	p value
N1	26/30	8/30	< 0.001
N2	28/30	16/30	< 0.001
Pain medication (mg) 24 h (mean ± SD)	1350 ± 244	608 ± 130	< 0.001
Pain medication (mg) 5 days (mean ± SD)	3960 ± 465	1906 ± 510	< 0.001

N1, patients requiring pain medication during 24 h; *N2*, patients requiring pain medication during 7 days

$p < 0.05$ considered level of significance stress and not of pharmacologic effect as it has been shown that the action of exogenous administration of epinephrine which reaches a peak concentration within 3 to 5 min after an injection [15]. We noticed that both the anesthetic solutions exerted minimal effects on the CVS system offering greater hemodynamic stability in the intraoperative and postoperative period. However, prolonged postoperative analgesia reduces the level of anxiety and stress, which can be considered an additional desirable advantage of ropivacaine use in minor oral surgical procedures pertaining to the long-term stability of hemodynamic parameters [14].

The duration of soft tissue anesthesia is a direct measure of the duration of local anesthetic solution acting on the nerve and was found to be 91.20 ± 20.34 min and 355.67 ± 53.07 min in Lignocaine and Ropivacaine respectively exhibiting significant differences ($p = 0.001$). This observation is in line with other studies [2, 6, 13, 14, 16] which demonstrated a prolonged duration of anesthetic effect with the use of ropivacaine solution. The prolonged duration of anesthesia with ropivacaine might also be due to its inherent vasoconstrictive properties together with its strong ability to bind to plasma proteins. The reported protein binding values of the lidocaine and ropivacaine is 64% and 94% respectively [17]. It also depends on individual response to the drug, the status of tissue at the site of drug administration, the concentration of vasoconstrictor, and amount and concentration of drug administered. Prolonged homo-lateral lower lip numbness is an undesirable property causing inadvertent lip and tongue biting and difficulty in eating, drinking, and speaking requiring patients to exercise caution [18].

The duration of postoperative analgesia was found to be 109.33 ± 30.45 min and 424.33 ± 75.37 min in Lignocaine and Ropivacaine respectively, for which the difference was found to be significant ($p = 0.001$). 0.75% ropivacaine solution offered prolonged postoperative analgesia as compared with lignocaine. To the best of our knowledge, none of the studies reported in literature have evaluated the postoperative analgesic properties and need of rescue analgesics for pain control postoperatively with 0.75% ropivacaine solution after IANB.

Analgesic properties of ropivacaine are due to its selective action on the pain-transmitting Aδ and C nerve fibers rather than Aβ fibers [19], which are involved in motor function due to its less lipophilic nature signifying that ropivacaine solution provides a prolonged postoperative analgesic effect when compared with that of lignocaine with adrenaline solution. We assessed pain as an individual entity and did not relate it to other perceptions such proprioception, temperature, and pressure, so the durations of anesthesia and pain onset during the postoperative period are not comparable.

A distinct advantage of using long-acting local anesthetics for nerve blocks is prolonged postoperative analgesia which leads to decreased demand for analgesic drugs. The postoperative pain following LI3M is largely caused by peripheral sensitization and secondary central sensitization rather than direct central sensitization caused by surgical tissue damage. Since Aδ and C nerve fibers from the nociceptors are under peripheral sensitization, the pain experienced is enhanced and sustained. Ropivacaine selectively acts on these fibers, inhibiting impulses and subsequently offering analgesia. The postoperative pain after LI3M surgery reaches its maximum intensity within the first 3 to 5 h, and ropivacaine has been shown to efficiently cover this early postoperative period, thereby conferring better postoperative pain. In the present study, the number of patients requiring analgesics in first 24 h and following 5 days was 86.7% ($n = 52$) and 90% ($n = 54$) in Lignocaine which were found to be greater compared with Ropivacaine at 26.7% ($n = 16$) and 53% ($n = 31$) with statistically significant difference ($p < 0.001$).

Similarly, the numbers of analgesics (dosage in mg) consumed in the first 24 h (1350 ± 244 mg) and following 5 days, respectively, in Lignocaine (3960 ± 465 mg) were significantly higher than that in Ropivacaine (608 ± 130 mg) and (1906 ± 510 mg) demonstrating significant difference ($p < 0.001$). This can be attributed to the selective action of ropivacaine on Aδ and C nerve fibers preventing peripheral sensitization. This leads to a decrease in dependency in terms of dosage and frequency, fostering better patient compliance and helping to minimize the systemic potential adverse effects of NSAIDS.

The study did not consider the evaluation of the plasma concentration of ropivacaine which would have provided more details about its effects on the cardiovascular system. Effects of ropivacaine solution on the CVS system with impedance cardiography would have been more desirable. The safety of ropivacaine would be best evaluated in patients with compromised cardiovascular status.

Conclusion

0.75% ropivacaine solution proved to be a superior alternative to lignocaine with epinephrine effectively providing profound anesthesia and prolonged postoperative analgesia with minimal CVS effects and can be considered as an inclusion to the existing list of long-acting anesthetic solutions used in LI3M surgeries.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional ethical guidelines prescribed by the Central Ethics Committee on Human Research (CECHR) of Datta Meghe Institute of Medical Sciences and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. McGrath C, Comfort MB, Lo ECM, Luo Y (2003) Changes in life quality following third molar surgery–the immediate postoperative period. Br Dent J 194(5):265–268; discussion 261
2. Bansal V, Kumar D, Mowar A, Bansal A (2018) Comparison of Ropivacaine 0.75% and lignocaine 2% with 1:200,000 adrenaline in dental extractions: single blind clinical trial. J Maxillofac Oral Surg 17(2):201–206
3. Moffitt DL, Berker DARD, Kennedy CTK, Shutt LE (2001) Assessment of ropivacaine as a local anesthetic for skin infiltration in skin surgery. Dermatol Surg 27(5):437–440
4. Buric N (2006) The assessment of anesthetic efficacy of ropivacaine in oral surgery. N Y State Dent J 72(3):36–39
5. Casati A, Fanelli G, Aldegheri G, Berti M, Colnaghi E, Cedrati V, Torri G (1999) Interscalene brachial plexus anaesthesia with 0.5%, 0.75% or 1% ropivacaine: a double-blind comparison with 2% mepivacaine. Br J Anaesth 83(6):872–875
6. Bhargava D, Chakravorty N, Rethish E, Deshpande A (Dec. 2014) Comparative analysis of the anesthetic efficacy of 0.5 and 0.75% ropivacaine for inferior alveolar nerve block in surgical removal of impacted mandibular third molars. J Maxillofac Oral Surg 13(4): 431–434
7. B. et al Bozidar (2008) Analgesic efficacy of 0.75% ropivacaine for lower third molar surgery. Balk J Stom 12:31–33
8. Pandis N, Fleming PS, Hopewell S, Altman DG (Jun. 2015) The CONSORT statement: application within and adaptations for orthodontic trials. Am J Orthod Dentofac Orthop 147(6):663–679
9. Bech RD, Lauritsen J, Ovesen O, Overgaard S (2015) The verbal rating scale is reliable for assessment of postoperative pain in hip fracture patients. Pain Res Treat. Available: https://www.hindawi.com/journals/prt/2015/676212/. Accessed 26 Dec 2018
10. Williamson A, Hoggart B (Aug. 2005) Pain: a review of three commonly used pain rating scales: pain rating scales. J Clin Nurs 14(7):798–804
11. Cooper SA, Desjardins PJ (2010) The value of the dental impaction pain model in drug development. Methods Mol Biol Clifton NJ 617:175–190
12. Keramidas EG, Rodopoulou SG (2007) Ropivacaine versus lidocaine in digital nerve blocks: a prospective study. Plast Reconstr Surg 119(7):2148–2152
13. Budharapu A, Sinha R, Uppada UK, Subramanya Kumar AVSS (2015) Ropivacaine: a new local anaesthetic agent in maxillofacial surgery. Br J Oral Maxillofac Surg 53(5):451–454
14. Brković B, Andrić M, Ćalasan D, Milić M, Stepić J, Vučetić M, Brajković D, Todorović L (2017) Efficacy and safety of 1% ropivacaine for postoperative analgesia after lower third molar surgery: a prospective, randomized, double-blinded clinical study. Clin Oral Investig 21(3):779–785
15. Niwa H, Sugimura M, Satoh Y, Tanimoto A (2001) Cardiovascular response to epinephrine-containing local anesthesia in patients with cardiovascular disease. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 92(6):610–616
16. Ernberg M, Kopp S (2002) Ropivacaine for dental anesthesia: a dose-finding study. J Oral Maxillofac Surg Off J Am Assoc Oral Maxillofac Surg 60(9):1004–1010; discussion 1010-1011
17. McClure JH (1996) Ropivacaine. Br J Anaesth 76(2):300–307
18. Crincoli V, Favia G, LImongelli L, Tempesta A, Brienza N (2015) The effectiveness of ropivacaine and mepivacaine in the postoperative pain after third lower molar surgery. Int J Med Sci 12(11):862–866
19. El-Sharrawy E, Yagiela JA (2006) Anesthetic efficacy of different ropivacaine concentrations for inferior alveolar nerve block. Anesth Prog 53(1):3–7