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Effect of 2% lignocaine with and without magnesium sulfate for inferior alveolar block in symptomatic mandibular molars

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Abstract
Background and Aim: Magnesium sulphate is used in the field of anaesthesia to increase the quality of anaesthesia. the aim of our prospective randomized, double-blind, controlled clinical trial was to combine $MgSO_4$ with 2% lignocaine in two different concentrations (75 mg and 150 mg) to evaluate the onset, duration and anesthetic efficacy, and postoperative analgesia during routine root canal treatment in patients with symptomatic irreversible pulpitis and symptomatic apical periodontitis
Material and Methods: The study consisted of three groups: 1.5 ml of 2% LA only (group 1), 1.5 ml of 2% LA with 0.15 ml of $MgSO_4$ containing an osmolar concentration of approximately 4.060 mosmol/ml that is equivalent to 75 mg of $MgSO_4$ (group 2). Group 3 consisted of 1.5 ml of 2% LA with 0.3 ml of $MgSO_4$ equivalent to 150 mg of $MgSO_4$. Pre-operative vitals and Heft Parker–Visual Analogue Scale (HP-VAS) pain scores were recorded. The onset of anesthesia, anesthetic efficacy, and duration of anesthesia were evaluated post administration of the local anesthetic solution. The post-operative analgesia was examined at intervals of 2, 6, 12, 24, and 48 h.
Results: Both experimental groups showed a significant difference in the onset, duration, and anesthetic efficacy compared to the control group. There was no significant difference between groups 2 and 3 in terms of the onset and anesthetic efficacy, but a significant difference was observed in the duration of anesthesia. Friedman non-parametric test showed significant reduction in pain from the 12th hour in the experimental groups.
Conclusion: Present study shows that both 75 mg and 150 mg of $MgSO_4$ in combination with LA are more effective than 2% LA alone. The anesthetic duration achieved with 75 mg of $MgSO_4$ is more than adequate for most of the dental procedures. Pertaining to the post-operative analgesia, both 75 mg and 150 mg did not have significant difference from 24 h onwards.

Keywords: Anesthesia, irreversible pulpitis lignocaine, magnesium sulphate

Introduction
One of the primary challenges faced by the clinician during endodontic therapy of mandibular teeth is the accomplishment of a successful anesthesia in patients with irreversible pulpitis using the inferior alveolar nerve block (IANB). This poses major difficulty from a clinical point of view as an inadequately anesthetized hot tooth with severe pain will not only lead to elevation of apprehension by the patient but also cause distress in the practicing clinician. Studies reported that the failure ratio of a single IANB block injection of local anesthetic in patients with irreversible pulpitis ranges between 30 and 90 percent [1, 3]. The success rate of the inferior alveolar nerve block (IANB) routinely used to anesthetize the mandibular's posterior region is only approximately 75-90% due to the large surface area covered by the inferior alveolar nerve [4]. However, it becomes inadequate in inflamed tissues, where the success rate is approximately 30-80% in patients with symptomatic irreversible pulpitis, which is challenging [5]. This lower success rate of local anesthetics (LA) could be attributed to anatomical variations, local tissue pH, acute tachyphylaxis, effect of nociceptors, central sensitization, psychological reasons, and more. To overcome such failures, various supplementary anesthetic techniques such as intraligamentary, intraosseous, and intrapulpal are used routinely [6]. However, the additional needle prick may have a negative effect on the patient's psychology. Instead, an adjuvant such as epinephrine, mannitol, or ketorolac added to the LA produces synergistic anesthetic effect [7]. A thorough review of the literature showed that only limited drugs that are potent inhibitors of N-methyl D-aspartate (NMDA) glutamate receptor are available that provide

central sensitization and block pain perception. Previous studies have also reported that the use of preoperative medication increases the success rate of IANB in symptomatic irreversible pulpitis [8, 9]. Inflammation is a result of inflammatory mediators like prostaglandins. Ketorolac which is a pyrolo-pyrolederivativeinhibits the enzyme cyclooxygenase thereby decreasing pain and inflammation [10].

Magnesium sulphate is used in the field of anaesthesia to increase the quality of anaesthesia [11]. Local anaesthetics inhibit the phospholipid facilitated calcium transport in order to achieve anaesthesia. Magnesium reversibly binds to phospholipid molecules and acts in a synergestic effect with the local anaesthetic solution, thereby improving the quality of anaesthesia [12].

Narang *et al*. (2008) [13] evaluated the use of $MgSO_4$ added to lignocaine as a single dose in intravenous regional anesthesia for upper limb surgery and concluded that $MgSO_4$ had better anesthetic and analgesic effects [13]. In dentistry, Shetty KP *et al*. (2016) [14] showed that administering pre-injection of $MgSO_4$ before giving IANB increased the anesthetic efficacy [14]. However, this requires two needle pricks for the patient, which may be a psychological deterrent. There are no clinical studies evaluating $MgSO_4$ combined with lignocaine as a single dose. Hence, the aim of present prospective randomized, double-blind, controlled clinical trial was to combine $MgSO_4$ with 2% lignocaine in two different concentrations (75 mg and 150 mg) to evaluate the onset, duration and anesthetic efficacy, and postoperative analgesia during routine root canal treatment in patients with symptomatic irreversible pulpitis and symptomatic apical periodontitis.

Material and Methods

Patients classified under the American Society of Anesthesiologists (ASA) categories I and II, within the age groups of 18 to 60 years were screened in the study. The study consisted of three groups: 1.5 ml of 2% LA only (group 1), 1.5 ml of 2% LA with 0.15 ml of $MgSO_4$ containing an osmolar concentration of approximately 4.060 mosmol/ml that is equivalent to 75 mg of $MgSO_4$ (group 2). Group 3 consisted of 1.5 ml of 2% LA with 0.3 ml of $MgSO_4$ equivalent to 150 mg of $MgSO_4$. After thorough clinical and radiographic examination along with sensitivity tests, those who were diagnosed with symptomatic irreversible pulpitis and symptomatic apical periodontitis of mandibular molar teeth were recruited into the study. Ethical approval was taken from the institutional ethical committee and written informed consent was taken from all the participants.

Patients with pain of moderate-to-severe intensity (American association of endodontists guidelines) (85 to 170 Heft Parker–Visual Analogue Scale (HP-VAS) pain score) in the mandibular posterior teeth and those who were able to understand the pain scale and respond immediately to electric pulp testing were included in the study.

Patients younger than 18 years, patients allergic to local anaesthesia and ketorolac, patients who have a significant medical history, those who are pregnant or lactating, patients who have taken medication for pain within 8 hours of treatment and those patients who are unable to give informed consent were excluded from the study.

On basis of the results of the pilot study and individual power calculation, 15 subjects per group (N = 45) would provide a minimum of 90% power in all categories. Considering 20% drop-outs, the total sample size was calculated to be 20 per group. The recruited 60 patients were randomly allocated to three groups using block randomization. The experimental solutions were freshly prepared by an anesthesiologist (operator 1) who maintained the master coded list of the patients with the respective solutions. The patients, endodontist (operator 2) who performed the treatment and evaluator (operator 3) who recorded the pre and post-operative parameters were blinded to the anesthetic solution used. Before starting the procedure, the evaluator recorded the baseline pain values using the HP-VAS pain score. The endodontist then injected the coded anesthetic solution prepared by the anesthesiologist, on the landmark of corresponding operating IANB quadrant on the affected site. After negative aspiration, the local anesthetic solution was slowly deposited at the rate of 1.5 ml over 60 seconds. The Electric pulp tester (EPT) is a device to determine the vitality of the pulp. The onset of anesthesia was evaluated by EPT for every 1 min until the corresponding vital tooth stopped responding. Root canal treatment was initiated and access cavity preparation was done under rubber dam isolation. The anesthetic efficacy was calculated using HP-VAS pain score on placement of the first 10 size K file (Mani Inc., Japan). Cleaning and shaping of the root canal system was performed subsequently, sterile cotton pellet was placed, and closed dressing given using Cavit-G (3M ESPE, Germany). The duration of anesthesia was evaluated every 15 min using EPT till the adjacent normal tooth responded on the working side. In this study, none of the patients experienced pain during the procedure and thus no other supplementary injection was required in both groups. Post-operative analgesic efficacy was assessed up to 2 h after the procedure at the operating site. Subsequently, the patient was handed a HP-VAS pain scale and was requested to respond to our telephonic evaluation at 6, 12, 24, and 48 h. Post-operative instructions were given to all the patients along with the prescription of an antiinflammatory drug, to be consumed only if pain arises. On the subsequent visit, the endodontic therapy was completed.

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

The patients were equally distributed between the groups and show no significant difference. The mean and standard deviation of onset, duration and anesthetic efficacy of the three groups are mentioned in Table 2. Both experimental groups showed a significant difference in the onset, duration, and anesthetic efficacy compared to the control group. There was no significant difference between groups 2 and 3 in terms of the onset and anesthetic efficacy, but a significant difference was observed in the duration of anesthesia. The mean HP-VAS scores of post-operative analgesic efficacy at different time points for all the three groups are given in Table 3. Friedman non-parametric test showed significant reduction in pain from the 12th hour in the experimental groups.

Table 1: Demographic data and pre-operative vital signs

	Group 1	Group 2	Group 3	P value
Pulse rate	70.50 ±6.10	68.50 ± 5.12	72.40 ± 5.47	P > 0.05
Peripheral Oxygen saturation level (SpO2)	94.40 ±2.76	95.20 ±3.12	94.11 ± 4.12	P > 0.05
Respiratory rate	12.10 ± 1.01	12.01 ± 0.92	12.04 ± 0.10	P > 0.05
Blood pressure	96.9 ±- 5.10	97.10 ±- 5.47	99.02 ± 2.66	P > 0.05
Gender distribution (M:F)	6:04	8:01	4:03	P > 0.05
Pre-operative EPT	2.40 ± 1.10	2.20 ± 0.81	2.49 ± 1.10	P > 0.05
Pre-operative HP-VAS pain score	123.40 ± 22.30	122.51 ±14.02	122.59 ± 18.10	P > 0.05

Statistically significance at $p \leq 0.05$

Table 2: Onset, duration and anesthetic efficacy of the 3 groups

Groups	Onset (Mins)	Duration (Mins)	Anesthetic efficacy (HP-VAS Pain score)
Group 1	3.33 ± 0.85	109.10 ± 37.50	34.90 ± 31.50
Group 2	2.10 ± 0.50	189.10 ± 37.25	9.01 ± 13.12
Group 3	1.25 ± 0.62	246.90 ± 26.30	3.30 ± 8.3

Statistically significance at $p \leq 0.05$

Table 3: Onset, duration and anesthetic efficacy of the 3 groups

Groups	2	6	12	24	48
Group 1	50.10 ± 51.10	32.70 ± 32.70	21.50 ± 25.14	21.01 ± 18.8	15.01 ± 16.99
Group 2	24.99 ± 34.25	24.12 ± 35.1	13.10 ± 32.6	4.10 ± 11.0	1.20 ± 6.11
Group 3	30.90 ± 41.9	12.01 ± 24.15	1.62 ± 6.10	0	0

Statistically significance at $p \leq 0.05$

Discussion

Inferior alveolar nerve block is the most common nerve block used to provide anaesthesia of the mandibular molar teeth. As proposed by Malamed, it is the nerve block that fails usually. This could be due to the accessory innervations, inaccurate injection technique, needle deflection and cross innervations. The action of local anaesthetics is by diffusion across the cell membrane and blockade of the sodium channel. This action requires a shift of the form of the local anaesthetic between the acidic (charged form) and the basic form (uncharged form). The pH of the local anaesthetic in the cartridge is made low (pH = 3-4), because at a lower pH, the shelf life is longer and the solution is more stable. When injected into the tissues, its transition into base form depends upon the tissue pH. In inflamed tissue, the low pH of the tissue leads to greater portion of the local anaesthetic being trapped in its charged form thus making it unavailable to cross the cell membranes. This hypothesis of "ion trapping" is considered the major mechanism of failure of local anaesthetics in inflamed tissue. Lidocaine hydrochloride has been the widely used local anaesthetic agent since its introduction because of its proven efficacy, low allergenicity and minimal toxicity. Articaine has gained popularity due to its enhanced anaesthetic property. Many studies comparing the anaesthetic efficacy of articaine over lidocaine including those done by Aggarwal *et al*. [15], Kanaa *et al* and Poorni *et al*. [16] reported a higher success rate of articaine when compared with lidocaine. Articaine is a4- methyl-3-2-thiophene carboxylic acid, methyl ester hydrochloride that is the only amide local anaesthetic containing thiophene ring in its structure. The higher lipid solubility of this agent allows for its easier penetration through the nerve membrane and the surrounding tissues. Hence the higher lipid solubility of Articaine could contribute to the enhanced efficiency of this agent [17].

In this study, patients diagnosed as symptomatic irreversible pulpitis with symptomatic apical periodontitis were included because inflamed pulp causes pain, but once the inflamed pulp is treated, the pain progressively subsides. Whereas, in case of symptomatic apical periodontitis, the inflammatory mediators that are present increase the neuropeptides such as prostaglandins E2 and bradykinin and can cause exaggerated central sensitization even in the presence of a small stimulus. This results in more post-operative pain. For IANB, 1.5 ml of 2% lignocaine without methylparaben and adrenaline was used in this study. This is to standardize the anesthetic solution, rule out hypersensitivity reaction in patients, avoid any interaction between methylparaben and $MgSO_4$, and avoid the influence of adrenaline on the heart rate and blood pressure, respectively. Literature states that even 1.0 ml of 2% lignocaine is an effective volume for obtaining clinical success in IANB. Usual regimen of $MgSO_4$ administered as intravenous injection were a dose of 30–50 mg/kg followed by a continuous dose of 6–20 mg/kg/h till the end of surgery. According to the literature, 150 mg is the lowest concentration used in regional anesthesia for plexus block [21]. Since the inferior alveolar nerve is a peripheral nerve without a multiple plexus of nerves, a smaller dose of 75 mg was also chosen along with 150 mg of $MgSO_4$ in this randomized controlled clinical trial. The experimental anesthetic solution was freshly mixed to retain the chemical properties of the drug. However, Houlihan S *et al*. earlier observed that freshly mixed anesthetic solution showed no precipitation for up to 168 days when stored at 25ºC and 40ºC [22].

There was no significant difference in the demographic data and pre-operative vitals, indicating a random and an even distribution of subjects between the three groups (Table 1). This is in accordance to the statement of Wolff (1940) and Mumford (1965) who stated that the perception of pain is independent of age and sex [23, 24]. The results of this study show that 150 mg of $MgSO_4$ when added to lignocaine provided faster and longer duration of anesthesia, maximum anesthetic efficacy, and better post-operative analgesia as compared to 2% LA. Hence, the null hypothesis was rejected. In addition, 75 mg of $MgSO_4$ also showed better results comparable to those of 150 mg $MgSO_4$, though there

was a significant difference between the 2 experimental groups in terms of the anesthetic efficacy.

Hargreaves and Keiser have proposed several hypotheses to explain local anesthetic failure including effect of inflammation on central sensitization. Central sensitization is due to upregulation of N-methyl-D-aspartate (NMDA) receptors [25]. Magnesium sulphate interfere with these NMDA receptors and prevent the induction of central sensitization due to peripheral nociceptor stimulation and eliminate the hypersensitivity.

This study also proves that the addition of $MgSO_4$ to 2% LA has a dose dependent increase in the onset, duration, anesthetic efficacy, and post-operative analgesia. From the results of the study, we can extrapolate that 75 mg $MgSO_4$ is sufficient in endodontics, since the duration of anesthesia with this group was found to be 189.10 ± 37.25, which is more than adequate for the endodontic procedure to be completed. It was further observed that the patients of the control group had lesser pain relief at 2 and 6 h compared to groups 2 and 3, though not statistically significant. Siqueira JF and Barnett F stated that the highest peak of post-operative pain was present at the 6th hour due to the action of the inflammatory mediators as a result of the local immune response. It can be inferred that action of $MgSO_4$ on the NMDA receptor and calcium channel blockers progressively reduced the postoperative pain and also proved to be effective at the 6th hour time point in Table 3. $MgSO_4$ in both concentrations proved to be effective in post-operative analgesia at 12, 24, and 48 h with significant reduction in pain compared to group 1. However, contradictory results were reported in the literature by few authors who showed that $MgSO_4$ has limited or no effect on post-operative pain in patients undergoing abdominal hysterectomy and caesarean delivery. Tramer MR and Glynn CJ also observed that the pre-treatment of $MgSO_4$ for ambulatory ilioinguinal hernia repair or operation of varicose vein had no effect on postoperative analgesia because of the heterogeneous populations and dose variation. In our study, the pre-serum values of Mg2+ were not taken into consideration, although they may have an influence on the results.

In a study done by Krishna Prasad Shetty *et al*. [14], there was a significant increase in the success rate of IANB in patients with symptomatic irreversible pulpitis when anaesthesia was achieved along the a pre-operative magnesium sulphate compared with a pre-operative placebo group. This is in accordance with this study where magnesium sulphate showed significant decrease in the pain values compared to the other two groups. Further studies with increased number of samples are required to validate the results of the current study.

Conclusion

Present study shows that both 75 mg and 150 mg of $MgSO_4$ in combination with LA are more effective than 2% LA alone. The anesthetic duration achieved with 75 mg of $MgSO_4$ is more than adequate for most of the dental procedures. Pertaining to the post-operative analgesia, both 75 mg and 150 mg did not have significant difference from 24 h onwards. Hence, considering the dental procedure that requires only half the duration compared to general surgery, a lower concentration or dose should be more than adequate for most dental procedures.

References

1. Hargreaves HKMG, Seltzer S. Te Dental Pulp, Quintessence Publishing Co, 4th edition 2002.
2. Cohen HP, Cha BY, Sp˚angberg LSW. Endodontic anesthesia in mandibular molars: A clinical study, Journal of Endodontics 1993;19(7):370-373.
3. Nusstein J, Reader A, Nist R, Beck M, Meyers WJ. Anesthetic efcacy of the supplemental intraosseous injection of 2% lidocaine with 1:100,000 epinephrine in irreversible pulpitis, Journal of Endodontics 1998;24(7):487-491.
4. Malamed SF. Handbook of local anesthesia. 3rd ed. Philadelphia, Elsevier's Health Sciences 1990, 1-332.
5. Nusstein J, Reader A, Nist R, Beck M, Meyers WJ. Anesthetic efficacy of the supplemental intraosseous injection of 2% lidocaine with 1:100,000 epinephrine in irreversible pulpitis. J Endod 1998;24:487-91.
6. Boopathi T, Sebeena M, Sivakumar K, Harikaran J, Karthick K, Raj A, *et al*. Supplemental pulpal anesthesia for mandibular teeth. J Pharm Bioallied Sci 2013;5(Suppl 1):S103-8.
7. Swain A, Nag DS, Sahu S, Samaddar DP. Adjuvants to local anesthetics: Current understanding and future trends. World J Clin Cases 2017;5:307-23.
8. Simpson M, Drum M, Nusstein J, Reader A, Beck M. Effect of combination of preoperative ibuprofen/ acetaminophen on the success of the inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. J Endod 2011;37:593-7.
9. Ianiro SR, Jeansonne BG, McNeal SF, Eleazer PD. The effect of Preoperative Acetaminophen or a Conbination of Acetaminophen and Ibuprofen on the success of Inferior Alveolar Nerve Block for Teeth with Irreversible Pulpitis. J Endod 2007;33:11-4.
10. Mishra H, Khan FA. A double-blind, placebo-controlled randomized comparison of pre and postoperative administration of ketorolac and tramadol for extraction pain. J Anaesthesiol Clin Pharmacol 2012;28:221-5.
11. Tramer RM, Glynn CJ. Magnesium Beir's block for treatment of chronic limb pain: randomized, doubleblind, cross-over study. Pain 2002;99:235-41.
12. Countinho EM. Calcium, magnesium and local anesthesia. J Gen Physiol 1996;49:845-6.
13. Narang S, Dali JS, Agarwal M, Garg R. Evaluation of the efficacy of magnesium sulphate as an adjuvant to lignocaine for intravenous regional anaesthesia for upper limb surgery. Anesth Intensive Care 2008;36:840-4.
14. Shetty KP, Satish SV, Kilaru KR, Sardar P, Luke AM. Comparison of anesthetic efficacy between lidocaine with and without magnesium sulfate USP 50% for inferior alveolar nerve blocks in patients with symptomatic irreversible pulpitis. J Endod 2015;41:431-3.
15. Aggarwal V, Singla M, Kabi D. Comparative evaluation of effect of preoperative oral medication of ibuprofen and ketorolac on anesthetic efficacy of inferior alveolar nerve block with lidocaine in patients with irreversible pulpitis: a prospective, double-blind, randomized clinical trial. Journal of Endodontics 2010;36:375-8.
16. Poorni S, Veniashok B, Senthilkumar AD *et al*. Anesthetic efficacy of four percentarticaine for pulpal

anesthesia by using inferior alveolar nerve block and buccal infiltration techniques in patients with irreversible pulpitis: a prospective randomized doubleblind clinical trial. J Endod 2011;37:1603-1607.
17. KE Yapp, MS Hopcraft, P Parashos. Articaine: a review of the literature. Br Dent J 2011;210(7);323-9.
18. Ianiro SR, Jeansonne BG, McNeal SF, Eleazer PD. The effect of Preoperative Acetaminophen or a Conbination of Acetaminophen and Ibuprofen on the success of Inferior Alveolar Nerve Block for Teeth with Irreversible Pulpitis. J Endod 2007;33:11-4.
19. Mishra H, Khan FA. A double-blind, placebo-controlled randomized comparison of pre and postoperative administration of ketorolac and tramadol for extraction pain. J Anaesthesiol Clin Pharmacol 2012;28:221-5.
20. Tramer RM, Glynn CJ. Magnesium Beir's block for treatment of chronic limb pain: randomized, doubleblind, cross-over study. Pain 2002;99:235-41.
21. Countinho EM. Calcium, magnesium and local anesthesia. J Gen Physiol 1996;49:845-6.
22. Aggarwal V, Singla M, Kabi D. Comparative evaluation of effect of preoperative oral medication of ibuprofen and ketorolac on anesthetic efficacy of inferior alveolar nerve block with lidocaine in patients with irreversible pulpitis: a prospective, double-blind, randomized clinical trial. Journal of Endodontics 2010;36:375-8.
23. Wolff HG, Hardy JD, Goodell H. Studies on pain. Measurement of the effect of morpine, codeine and other opiates on the pain threshold and analysis of their relation to the pain experience. J Clin Invest 1940;19:659-80.
24. Mumford JM. Pain perception threshold and adaptation of normal human teeth. Arch Oral Biol 1965;10:957-68.
25. O Matzner, M Devor. Hyperexcitability at sites of nerve injury depends on voltage-sensitive Na+ channels," Journal of Neurophysiology 1994;72(1):349-359.