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ORIGINAL ARTICLE

Effectiveness of Lidocaine versus Lidocaine with Magnesium Sulphate During Inferior Alveolar Nerve Block in Patients with Symptomatic Irreversible Pulpitis: A Randomised Double-Blinded Clinical Trial

Kavimalar SITHARTHAN,[1] Dhanavel CHAKRAVARTHY,[1] Vijayaraja SELVAPANDIYAN,[1] Subramanian AJITHKUMAR,[1] Manoj THIRUNAVUKARASU,[2] Harshavardhan MANOKARAN[3]

[1]Department of Conservative Dentistry and Endodontics, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth, Pondicherry, India
[2]Department of Conservative Dentistry and Endodontics, Rajas Dental College & Hospital, Tamil Nadu, India
[3]Department of Conservative Dentistry and Endodontics, JKKN Dental College & Hospital, Tamil Nadu, India

ABSTRACT

Objective: This study aimed to compare the effectiveness of lidocaine with magnesium sulphate in patients undergoing root canal treatment following irreversible pulpitis.

Methods: A total of 86 patients were randomised to receive 1.8 ml of 2% lidocaine replaced with 0.2 ml of 10% magnesium sulphate with 1:80,000 epinephrine (n=43) as MGS group and 1.8 ml of 2% lidocaine with 1:80,000 epinephrine (n=43) as LDC group. Preoperative visual analogue scale (VAS) pain scores were recorded. Patients were instructed to report any perioperative pain felt during the access cavity preparation and when introducing the first patency file (#10 k) in the root canal and perioperative VAS recorded.

Results: The success rate of the inferior alveolar nerve block (IANB) was higher in the MSG group. The mean±SD of perioperative pain was 0.16±0.37 in the MSG group and 3.13±0.77 in the LDC group. The MGS group produced better anaesthetic efficacy with a p-value of 0.01.

Conclusion: Based on the results, adding 10% magnesium sulphate to 2% lidocaine increased the effectiveness of IANB in patients with symptomatic irreversible pulpitis of mandibular molar teeth.

Keywords: Anaesthetic effectiveness, irreversible pulpitis lidocaine, magnesium sulphate

HIGHLIGHTS

- Inflammation alters the anaesthetic efficacy.
- IANB has a failure rate of 44–81% in symptomatic irreversible pulpitis.
- Magnesium, a physiological and pharmacological blocker of NMDA, has antinociceptive effects in irreversible pulpitis.

INTRODUCTION

The main goal of endodontic therapy is forestallment and treatment of conditions of the dental pulp with irreversible pulpitis (1). The failure of local anaesthesia or difficulty in obtaining satisfactory analgesia in patients with irreversible pulpitis causes excruciating pain during the root canal treatment, which instils fear and may restrain patients from receiving treatment (2). Inflammation alters various anaesthetic solutions' pharmacokinetics and pharmacodynamics, decreasing their effectiveness. It also causes metabolic acidosis, lowering the pH of affected tissues and activating the peripheral free terminals of nociceptive neurons (3). The posterior mandibular teeth are anaesthetised by the IANB, which is the conventional and superior technique (4). However, per studies on anaesthetic failure, IANB had a 44–81% failure rate in patients with

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Address for correspondence:
Kavimalar Sitharthan
Department of Conservative Dentistry and Endodontics, Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth, Pondicherry, India
E-mail: kavisiddarth5@gmail.com

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symptomatic irreversible pulpitis (5, 6). To overcome this anaesthetic failure, modifications and the addition of adjuncts to the anaesthetic formulations have been made.

Neurophysiological studies have demonstrated that magnesium is a physiological and pharmacological blocker of N-methyl-D-aspartate (NMDA) receptors in neuronal tissue and can block voltage-dependent ion channels, thus providing an antinociceptive effect (7). Magnesium is a secondary analgesic as it enhances the efficacy of drugs with no primary analgesic activity (8). When used as an adjuvant with local anaesthetic, magnesium sulphate is more compatible and achieves more profound anaesthesia when added to lidocaine (9). Limited literature is available correlating magnesium sulphate and lidocaine in irreversible pulpitis.

Therefore, the purpose of this prospective, randomised controlled, double-blind study aims to investigate the effect of 0.2 ml of 10% magnesium sulphate added to 1.6 ml of lidocaine with 1:80,000 epinephrine local anaesthetic on the success of IANB in patients with symptomatic irreversible pulpitis undergoing root canal treatment.

MATERIALS AND METHODS

The Indira Gandhi Institute of Dental Sciences Institutional Review Board and Institutional Ethical Committee approved the study protocol of this randomised clinical trial. The study was registered in the Clinical Trial Registry of India (CTRI/2020/09/027979) on 23.09.2020. This study was reported according to the Consolidated Standards of Reporting Trials (CONSORT) guidelines and conducted by the Declaration of Helsinki. The study period was from 30.09.2020 to 25.10.2021, with a duration of 1 year and 25 days.

Patients reported to the Department of Conservative Dentistry and Endodontics with symptoms of irreversible pulpitis of the mandibular molar, and between 18–45 years of age, with moderate to severe pain and lingering response to cold test (Endo-Frost cold spray, Roeko; Coltene Whaledent, Langenau, Germany) were recruited in the study.

The sample size was estimated based on the outcomes of Sadaghiani et al. (10). Mean±SD was taken as 141.50±15.71 mm for the MGS test group and 133.03±12.07 mm for the control group,

$\alpha=0.05$, $\beta=0.02$,

$$n=\frac{2\sigma^2 (z1-\beta+z1-\alpha^2)^2}{(\mu1-\mu2)^2}$$

86 patients were allocated into two groups by double-blinded block randomisation as

LDC GROUP (n=43): 1.6 ml of 2% lidocaine with 1:80,000 adrenaline (Septodont, France) and 0.2 ml of 10% magnesium sulphate (Magneon, Neon Laboratories, Mumbai, India)

MGS GROUP (n=43): 1.8 ml of 2% lidocaine (Septodont, Saint-Maur-des-Fossés, France) with 1:80,000 adrenaline.

According to the American Association of Endodontists guidelines, patients with a pain intensity score of 6–10 on the visual analogue scale were considered to have moderate to severe pain. Only mandibular molar teeth that responded immediately to electric pulp testing without evidence of peri-apical lesions were included in the study. Patients classified as ASA category III and above, those who had taken any prior medications, individuals with allergies to local anaesthesia, pregnant women, and lactating women were excluded from the study. Informed consent was obtained from all participants, and their demographic data was recorded. Pain intensity was measured using the visual analogue scale (VAS). The study's primary outcome measure was to evaluate the difference in pain levels, while the secondary outcome measure was to assess the efficacy of the anesthesia.

Operator 1 prepared the experimental solutions and maintained the master code list. Operator 2, an endodontist, performed the treatment, and operator 3, an evaluator, recorded the VAS parameters of preoperative and perioperative pain. Operators 2 and 3 were blinded to the anaesthetic solution used.

Treatment Protocol

The evaluator recorded the baseline pain values using the VAS before the procedure. IANB was administered using a 27 G, 1.5-inch needle (Septodont, Saint-Maur-des-Fossés, France) with a coded standard aspirating dental injection syringe. Operator 2 gave IANB at the corresponding landmark. The local anaesthetic solution was slowly deposited at a rate of 1.8 ml over 60 seconds once negative aspiration was confirmed. Profound lip numbness within 15 minutes of the IANB block was considered a success. The electric pulp tester (EPT) (Waldent, New Delhi, India) confirmed the anaesthetic effect and objectively determined the pulp sensibility. Fifteen minutes after the injection and confirmation of adequate anaesthesia, #2 endoaccess bur (Dentsply Maillefer, Ballaigues, Switzerland) was used to prepare the access cavity under rubber dam isolation. 10-size K files (Mani Inc., Tochigi Japan) were used to explore the canal in watch winding motion. Working length was established using the Root ZX apex locator (J Morita Corp, Saitama, Japan) and confirmed radiographically. If the patient felt any pain during the placement of the K file, the treatment procedure was ceased immediately and the VAS score was recorded. If not, cleaning and shaping of root canals were done, and closed dressing was given using Cavit-G (3M ESPE, Bayern, Germany).

Assessment of Pain

Patients were requested to rate their preoperative and perioperative pain on a 10-point VAS scale, with different descriptors for pain levels. The scale was categorized as follows: 'no pain' for 0; 'faint, weak, or mild' pain for 1–3; 'moderate' pain for 4–6; and 'strong, intense, and maximum possible' pain for scores greater than 6.

Statistical Analysis

Results of the Normality tests, Kolmogorov-Smirnov and Shapiro-Wilks tests reveal the study followed a normal distribution. Therefore, a parametric test was applied to analyse the data. Descriptive statistics were done to assess the mean among the study variables. The dependent 't' test was used to compare the mean values for all the variables within the group. An in-

TABLE 1. Descriptive statistics of age among the study groups

Variables	MGS group 1.6 ml of 2% lidocaine and 0.2 ml of 10% magnesium sulphate	LDC group 1.8 ml of 2% lidocaine
Mean	30.37	26.39
Standard error of the mean	1.37	1.17
Standard deviation	9.02	7.72

MGS: Magnesium sulphate, LDC: Lidocaine

TABLE 2. Descriptive statistics of preoperative and perioperative VAS score of the two groups

Variables	MGS group 1.6 ml of 2% lidocaine and 0.2 ml of 10% magnesium sulphate		LDC group 1.8 ml of 2% lidocaine	
	Preoperative pain	Perioperative pain	Preoperative pain	Perioperative pain
Mean	7.48	0.16	7.83	3.13
Standard error	0.13	0.05	0.14	0.11
Standard deviation	0.85	0.37	0.94	0.77
Variance	0.73	0.14	0.90	0.59
Range	3.00	1.00	3.00	3.00
Minimum	6.00	0.00	6.00	2.00
Maximum	9.00	1.00	9.00	5.00

MGS: Magnesium sulphate, LDC: Lidocaine; VAS: Visual analogue scale

TABLE 3. Comparison of preoperative and perioperative periods among the LDC group and MGS group

Variables	LDC group preoperative Vs MGS group preoperative	LDC group perioperative Vs MGS group perioperative
Mean	-0.34	2.97
Standard error	0.20	0.12
Standard deviation	1.32	0.80
95% Confidence interval of the difference		
Lower	-0.75	-3.22
Upper	0.05	2.73
t-value	-1.72	24.35
p-value	0.09	<0.01*

*: P-value <0.05, indicates statistical significance. LDC: Lidocaine, MGS: Magnesium sulphate

dependent 't' test was used to compare the mean value between the groups included in the study, and a chi-square test was done to find an association between sex and age groups. SPSS (IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp., Released 2019) was used to analyse the data. The significance level is fixed at 5% (α=0.05). A p-value <0.05 was considered to be statistically significant.

RESULTS

The demographic information of the patients can be found in Table 1 and Figure 1. The patients were evenly distributed between the MGS group and the LDC group, with no notable variances between the two groups. The anaesthetic success rates were analyzed using a t-test. Table 2 displays the mean, standard error of the mean, and standard deviation of preoperative and perioperative pain for both groups. Significant differences in perioperative pain were observed in both experimental groups. However, when comparing the preoperative periods within the MGS group, no statistically significant differences were found among the study groups. On the other hand, comparing the perioperative periods between the MGS group and the LDC group revealed a highly statistically significant difference among the study groups, as shown in Table 3 and Figure 2.

DISCUSSION

There was no statistical difference in the effect of age, gender, and preoperative pain between the study groups, indicating a random and even distribution of subjects between the two groups. The mean preoperative pain was 7.48 for the MGS group and 7.83 for the LDC group, indicating severe pain on the VAS. The mean perioperative pain was 0.16 for the MGS group and 3.13 for the LDC group. The p-value <0.01 for the

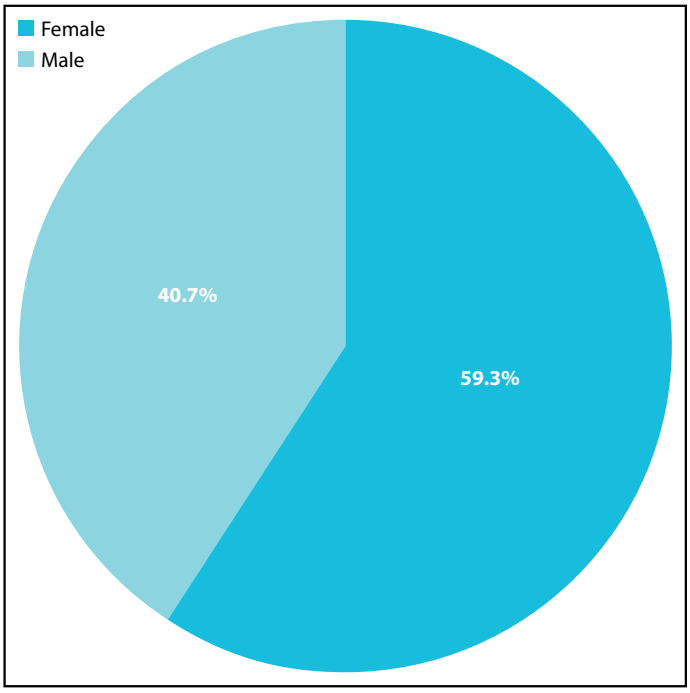

Figure 1. Gender distribution of the study individuals

P-value = 0.82, no significant difference

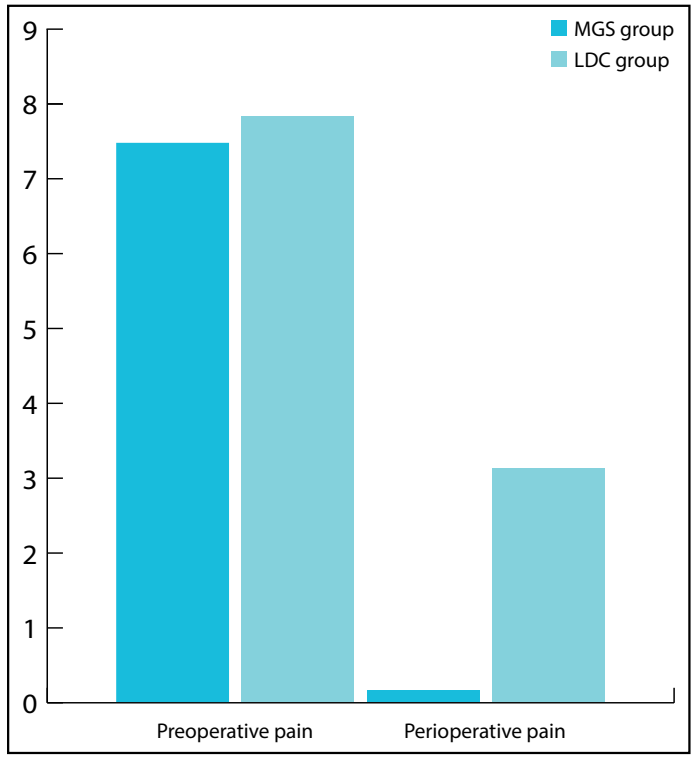

Figure 2. Difference of preoperative and perioperative values among the LDC group and MGS group

Preoperative pain: Pain that was measured before the procedure, Perioperative pain: Pain that is measured during the procedure. LDC: Lidocaine, MGS: Magnesium sulphate

perioperative pain period among the experimental groups, meaning a significant difference was observed. Hence, the null hypothesis was rejected.

Management of dental pain is a knackering challenge in dentistry (1). In this study, patients diagnosed with symptomatic irreversible pulpitis were included because various studies concluded that inflammation (pulpitis) reduces the success rate of IANB (<20%), thus compromising the treatment (11). Several hypotheses are proposed for the failure of local anaesthesia in inflammation, such as 'ion trapping' of local anaesthetics because of inflammation-induced tissue acidosis (11). An immense increase in the tetrodotoxin-resistant voltage-dependent gate present in the sensory nerve fibres of pain neurons (12) and an increase in NMDA receptors in the second-order neurons, causing secondary hyperalgesia and central sensitisation (13). This causes activity-dependent plasticity by increasing the synaptic strength of the receptor.

Even though LA mainly acts by inhibiting sodium influx through sodium-specific ion channels in the neuronal cell membrane (voltage-gated sodium channels), it also inhibits the raising of action potential and signal conduction (14). Magnesium, a divalent cation, is the natural calcium antagonist available in the body at different voltage-gated channels and enhances LA action in case of inflammation. Magnesium also regulates the entry and exit of calcium ions in the cell membrane (15).

In this study, 0.2 ml (10%) magnesium sulphate was added as an adjuvant to 2% lidocaine. To maintain the chemical properties, the anaesthetic solution was mixed freshly. In 2016, Houlihan et al. (16) evaluated whether the combination of commercially available magnesium sulphate and lidocaine hydrochloride is physically and chemically stable in a prefilled syringe for at least 168 days when maintained at 25°C and 40°C. Halsted described the effective and gold-standard conventional form of IANB injection as being effective (17).

The findings of this study are consistent with the results of the study by Shetty et al. (18), who compared anaesthetic efficacy between lidocaine and magnesium sulphate but 1 ml magnesium sulfate USP 50% or distilled water (placebo) 1 hour before administration of conventional IANB. It was proven that 500 mg (4.06 mEq/ml) of Magnesium Sulphate showed a significant increase in anaesthetic efficacy.

In a study by Mendonca et al. (19), the patients who received both lidocaine 2 mgkg-1 in a bolus of 100 ml and maintained at 3 mgkg-1h-1 and magnesium sulfate 50 mgkg-1 in a bolus of 100 ml and maintained at 15 mgkg-1h-1. This group was found to have a better analgesic effect, with lower pain scores both intra-operatively and postoperatively.

The limitation of this study is that a single concentration of magnesium sulphate was used, and comparisons for effective anaesthetic efficacy were to be done between different concentrations. The addition of magnesium sulphate to different anaesthetic solutions needs to be performed in future studies.

CONCLUSION

To conclude this clinical trial, 0.2 ml of magnesium sulphate added to 1.6 ml of lidocaine with 1:80,000 epinephrine exhibited the least amount of perioperative pain and thus increased anaesthetic effectiveness in symptomatic irreversible pulpitis of mandibular molars.

Disclosures

Ethics Committee Approval: The study was approved by the Indira Gandhi Institute of Dental Sciences Institutional Review Board and Institutional Ethical Commitee (no: IGIDSIEC2020NRP09PGKMCDE, date: 16/12/2019).

Authorship Contributions: Concept – K.S., D.C.; Design – K.S., D.C.; Supervision – D.C., V.S.; Data collection and/or processing – K.S., S.A.; Data analysis and/or interpretation – K.S., M.T.; Literature search – K.S., H.M.; Writing – K.S., D.C., H.M.; Critical review – D.C., V.S.

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REFERENCES

1. Modaresi J, Davoudi A, Badrian H, Sabzian R. Irreversible pulpitis and achieving profound anesthesia: Complexities and managements. Anesth Essays Res 2016; 10(1):3–6. [CrossRef]
2. Karapinar-kazandag M, Tanalp J, Ersev H. Effect of premedication on the success of inferior alveolar nerve block in patients with irreversible pulpitis : A systematic review of the literature. Biomed Res Int 2019; 2019(1):1–25.
3. Chaudhary P, Martenson ME, Baumann TK. Vanilloid receptor expression and capsaicin excitation of rat dental primary afferent neurons. J Dent Res 2001; 80(6):1518–23. [CrossRef]
4. Khalil H. A basic review on the inferior alveolar nerve block techniques. Anesth Essays Res 2014; 8(1):3–8. [CrossRef]
5. Claffey E, Reader A, Nusstein J, Beck M, Weaver J. Anesthetic efficacy of articaine for inferior alveolar nerve blocks in patients with irreversible pulpitis. J Endod 2004; 30(8):568–71. [CrossRef]
6. Matthews R, Drum M, Reader A, Nusstein J, Beck M. Articaine for Supplemental Buccal Mandibular Infiltration Anesthesia in Patients with Irreversible Pulpitis When the Inferior Alveolar Nerve Block Fails. J Endod 2009; 35(3):343–6. [CrossRef]
7. Woolf CJ, Thompson SWN. The induction and mainterkmce of central sensitization is dependent on N-methyl-D-aspartic acid receptor activation; implications for the treatment of post-injury pain hypersensitivity states. Pain 1991; 44(3):293–9. [CrossRef]
8. Do SH. Magnesium: a versatile drug for anesthesiologists. Korean J Anesthesiol 2013; 65(1):4–8. [CrossRef]
9. Sinha R, Sharma A, Ray BR, Chandiran R, Chandralekha C. Effect of addition of magnesium to local anesthetics for peribulbar block: A prospective randomized double-blind study. Saudi J Anesth 2016; 10(1):64–7.
10. Mousavi SA, Sadaghiani L, Shahnaseri S, Zandian A, Farnell DJJ, Vianna ME. Effect of magnesium sulphate added to lidocaine on inferior alveolar nerve block success in patients with symptoms of irreversible pulpitis: a prospective, randomized clinical trial. Int Endod J 2020; 53(2):145–53.
11. Hargreaves KM, Keiser K. Local anesthetic failure in endodontics:: Mechanisms and Management. Endodontic Topics 2002; 1(1):26–39. [CrossRef]
12. Gold MS. Tetrodotoxin-resistant Na+ currents and inflammatory hyperalgesia. Proceedings of the National Academy of Sciences 1999; 96(14):7645–9.
13. Latremoliere A, Woolf CJ. Central sensitization: A generator of pain hypersensitivity by central neural plasticity. J Pain 2009; 10(9):895–926. [CrossRef]
14. Taylor A, McLeod G. Basic pharmacology of local anaesthetics. BJA Education 2020; 20(2):34–41. [CrossRef]
15. Miranda HF, Bustamante D, Kramer V, Pelissier T, Saavedra H, Paeile C, et al. Antinociceptive effects of Ca2+ channel blockers. Eur J Pharmacol 1992; 217(2–3):137–41. [CrossRef]
16. Houlihan S, Decarie D, Benes C, Cleve R, Vidler M, Magee LA, et al. Magnocaine: Physical compatibility and chemical stability of magnesium sulphate and lidocaine hydrochloride in prefilled syringes. J Obstet Gynaecol Can 2016; 38(10):936–44. [CrossRef]
17. Chandrasekaran C, Amirtharaj L V, Sekar M, Nancy S M. Post-operative analgesia of 2% lignocaine with or without magnesium sulfate for inferior alveolar nerve block in symptomatic mandibular molars - a randomized double blind controlled clinical trial. J Dent Anesth Pain Med 2020; 20(3):147–54.
18. 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(4):431–3. [CrossRef]
19. Mendonça FT, Pellizzaro D, Grossi BJ, Calvano LA, de Carvalho LSF, Sposito AC. Synergistic effect of the association between lidocaine and magnesium sulfate on peri-operative pain after mastectomy: A randomised, double-blind trial. Eur J Anaesthesiol 2020; 37(3):224–34. [CrossRef]