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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF EFFICACY OF 20% AND 50% CONCENTRATION OF MAGNESIUM SULFATE AND KETOROLAC IN INCREASING THE EFFECTIVENESS OF INFERIOR ALVEOLAR NERVE BLOCK IN PATIENTS WITH SYMPTOMS OF IRREVERSIBLE PULPITIS AND PAIN ASSESSMENT WITH HELP OF HEFT-PARKER VISUAL ANALOGUE SCALE ; AN IN- VIVO STUDY

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ABSTRACT

Purpose:-The purpose of this randomized clinical trial was to compare the efficacy of 20% and 50% concentration of magnesium sulfate and ketorolac in increasing the effectiveness of inferior alveolar nerve block in patients with symptoms of irreversible pulpitis. **Materials and method** :- Fifty-six subjects with symptoms of irreversible pulpitis in mandibular molars were included in the study. Heft-parker visual analog scale (HP-VAS) was used to evaluate the initial pain and pain during access cavity preparation. Fifty six patients were randomly divided into 4 groups (n=14). 1 hour before administration of conventional IAN block one group received 1 ml magnesium sulfate USP 20% and the other groups received 50% magnesium sulfate, ketorolac and distilled water (placebo) respectively. After IANB injection when the patient reported of lip numbness and showed two negative responses to the electric pulp tester endodontic access cavity preparation was started. The patient's pain during access cavity preparation and initial instrumentation is evaluated by using HP-VAS. **Result:**- There was no statistical difference for the effect of gender, age and initial pain between the four groups. Anesthetic success for IAN block was more for ketorolac followed by 50% magnesium sulfate and 20% magnesium sulfate. **Conclusion:-** Ketorolac is more effective in increasing the efficacy of inferior alveolar nerve block followed by 50% magnesium sulfate and 20% magnesium sulfate.

Citation: Dr. Sharad Sharma, Dr. Asheesh Sawhny, Dr. Saurabh Sharma et al. *"*Comparative Evaluation Of Efficacy Of 20% And 50% Concentration Of Magnesium Sulfate And Ketorolac In Increasing The Effectiveness Of Inferior Alveolar Nerve Block In Patients With Symptoms Of Irreversible Pulpitis And Pain Assessment With Help Of Heft-Parker Visual Analogue Scale ; An In- vivo Study*", 2021. International Journal of Current Research, 13, (12), 19898-19904.*

INTRODUCTION

Local anesthetic to reach pulp for profound pulpal anesthesia is difficult in dentistry and also in Endodontics. In Endodontic practice adequate pulpal anesthesia is a mandatory requirement for painless root canal treatment which involves the extirpation of pulp. If adequate pulpal anesthesia is not achieved, the patient may experience intolerable pain, making root canal treatment extremely difficult. Various injection techniques donot provide 100% anesthetic success rates. Inferior alveolar nerve block is the most commonly used nerve block for performing endodontic treatment in mandibular molars diagnosed with irreversible pulpitis (Malamed).

However, clinical studies in patients with irreversible pulpitis in mandibular molar teeth have found that inferior alveolar nerve block fails to provide adequate anesthesia in 44 percent to 81 percent of cases (Bigby, 2007; Claffey, 2004; Matthew, 2009). It becomes inadequate in inflamed tissues, where the success rate falls to approximately 30-80% in patients with symptomatic irreversible pulpitis, which is very challenging (Nusstein, 1998). Patients who have preoperative pain and symptomatic pulpitis have even lower success rates. 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 (Hargreaves, 2002). Therefore a lot of research is undergone to enhance the success rate of inferior alveolar nerve block by addition of various adjuvants to local anesthesia. Hargreaves and Keiser have

proposed several hypotheses to explain local anesthetic failure including effect of inflammation on central sensitization (Hargreaves, 2002) It has been postulated that peripheral free terminals of nociceptive neurons and central mechanism plays a major role in decreasing the efficacy of inferior alveolar nerve block in case of inflamed pulp.Inflammatory and neuropathic pains both have central sensitization as a component. The upregulation of N-methyl-D-aspartate (NMDA) receptors causes central sensitization. Because magnesium sulfate is a non competitive antagonist of NMDA receptors, it prevents central sensitization along with antinociceptive effects so it would of great importance in facilitating anesthesia (Woolf, 1991). Magnesium Sulfate also interferes with voltage dependent ion channels which contributes to its anti-nociceptive effect (Miranda, 1992). Magnesium sulfate (mgso4) is used as an adjuvant in a variety of fields of general anesthesia (GA), including obstetrics, cardiovascular surgery, and epilepsy (Ryu, 2008). During general anesthesia and spinal anesthesia, for preoperative analgesia, the role of magnesium sulfate has been investigated by a number of studies. Magnesium sulfate has been shown to be effective in treating preoperative pain and blunting noxious stimuli-induced somatic, autonomic, and endocrine reflexes (Kara, 2002). Many studies conducted have shown a beneficial effect on decreasing the postoperative pain outcomes with a variety of magnesium sulfate pretreatments. Magnesium sulfate has been used intravenously, intrathecally as well as epidurally for pain relief (Mirkheshti, 2012). Recently the application of magnesium sulfate as an adjuvant to block anesthesia has been investigated with positive impact in terms of increased duration and enhanced quality of anesthesia (Lee, 2012).

In dentistry, Shetty KP *et al*. (2016) showed that administering pre-injection of 50%MgSO4 before giving IANB increased the anesthetic efficacy, however till date no study has compared different concentrations of magnesium sulfate and ketorolac on increasing the efficacy of inferior alveolar nerve block. Therefore the purpose of this study is to compare different concentration of magnesium sulfate and ketorolac on success of Inferior Alveolar Nerve Block for endodontic treatment in teeth with symptomatic irreversible pulpitis.

MATERIAL AND METHODS

SAMPLE SIZE: Means - Hypothesis testing for means (equal variances)

Standard deviation in group I = 20.24
Standard deviation in group II = 35.89
Mean difference = 40.36
Effect size = 1.43809014787101
Alpha Error (%) = 5
Power (%)= 95
Sided= 2

Required sample size per group = 14

Alpha Error (%)	Power (%)	Sample Size (n)
	70	10
1	80	12
	90	16
	70	6
5	80	8
	90	11
	70	5
10	80	6
	90	9

Considering the standard deviation of 20.24 & 35.89and mean difference as 40.36 from the pilot study/parent article, the calculated effect size came up to 1.4380. With 5%Alpha error and 95%Power; the calculated sample size came up to 14 per group.

SOURCE OF DATA: This study comprised of fifty-six patients aged 15 to 65 years, who had visited the Department of Conservative Dentistry and Endodontics of Rama Dental College and Hospital, Kanpur.

INCLUSION CRITERIA

- Mandible molars with symptoms of irreversible pulpits.
- Teeth exhibiting lingering response to cold test.
- Absence of any periapical radiolucency in radiograph except for widening of periodontal ligament space.
- A positive response to electronic pulp tester.

EXCLUSION CRITERIA

- Pregnant and lactating mothers.
- Patients below 18 years of age.
- Patients allergic to local anesthesia.
- Patients with significant medical condition.
- Patients with renal or liver disorders.
- Patients experiencing pain in more than one mandibular molar in each quadrant.
- Patients where the first injection of IANB doesnot produce lip numbness.

METHODOLOGY

Before commencement of the trial, Ethical clearance was sought from the Ethical Committee of the institution (Annexure-1) and the trial was registered with the Clinical Trial Registry- India. Informed written consent was obtained from each patient (Annexure-3). A written questionnaire regarding the patient's information, history of present illness and preoperative pain. Patients experiencing pain more than 54mm recorded using a Heft-Parker visual analogue scale in a mandibular molar, with prolonged response to cold testing are included. Those patients experiencing lingering pain to cold testing and initial response recorded as 0-40 with digital electric pulp tester, absence of periapical radiolucency and ability to evaluate their pain on the pain record scales were included in the study. Patients were asked to rate their pain on a 170mm Heft-Parker visual analogue scale (HP-VAS). Heft-Parker visual analog scale is marked with no pain on one side and maximum pain on the other side without the millimeter calibration. Heft-Parker visual analogue scale has markings ranging from 0mm to 170mm and is divided into 4 categories.

- No pain - 0 mm
- Mild pain - 1-54 mm
- Moderate pain - 55-113 mm
- Severe pain - 114-170 mm

Fifty-six consent forms, questionnaires, 2% lignocaine, 50% magnesium sulfate, ketorolac and 25 gauge syringes were provided.

PREPARATION OF 20% CONCENTRATION OF MAGNESIUM SULPAHTE: Since most commonly available solution of magnesium sulfate available in the market is 50%. So prior to injection 20% solution will be prepared from 50% solution by the following dilution method: Using a 20ml syringe draw 12ml of sterile water for injection. If 50 % of magnesium sulfate is available add 8ml of magnesium sulfate to 12 ml of water for injection to make 20 ml of 20%

solution (4g per 20ml)

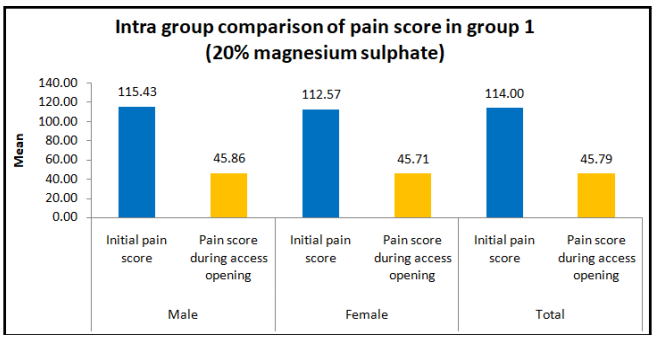
PROCEDURE

- After the preparation of the desired concentration of solution.
- In group 1 a 20% magnesium sulfate solution was administered at the injection site about one hour prior to procedure.
- Standard inferior alveolar nerve block was administered before the endodontic procedure.
- The pulpal anesthesia was evaluated every 5 minutes by using an electronic pulp tester and lip numbness.
- Profound lip numbness within 15 minutes was considered as success of inferior alveolar nerve block.
- After profound anesthesia teeth were isolated using a rubber dam and access cavity was prepared.
- Patient was asked to rate their pain felt during access cavity preparation on the Heft Parker visual analogue scale.
- In group 2 50% magnesium sulfate solution was administered at the injection site about one hour prior to procedure and preceded in the same way mentioned earlier.
- In group 3 ketorolac was administered at the injection site about one hour prior to procedure and preceded in the same way mentioned earlier.
- In group 4 normal saline was administered at the injection site about one hour prior to procedure and it acted as control group.

In any of the group if lip numbness was not profound the inferior alveolar nerve block will be considered as missed and the patient was excluded from the study. However treatment was performed using supplemental anesthesia in this case but it was not included in the study.

RESULTS

IN GROUP 1: For male patients initial pain score was 115.43 ± 25.35. Pain during access opening was 45.86 ± 14.77 the mean difference of initial pain score and pain score during access opening is 69.57. We observed that 60.27% pain score is decreased from initial pain score to pain score during access opening.

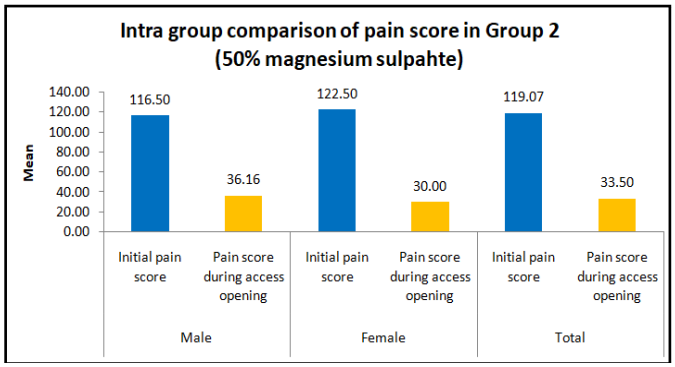


The result is statistically significant. For female patients initial pain score was 112.57 ± 36.34. Pain during access opening was 45.71 ± 24.15 the mean difference of initial pain score and pain score during access opening is 68.86. We observed that 59.39% pain score is decreased from initial pain score to pain score during access opening.

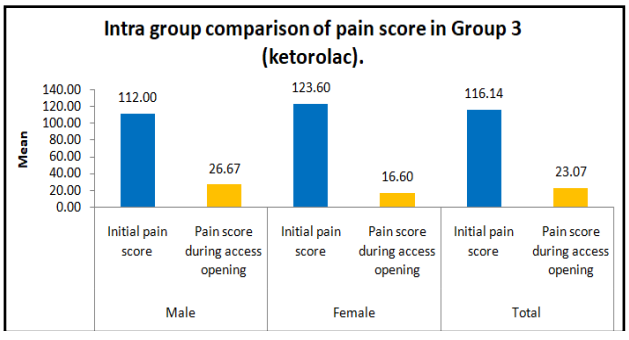
The result is statistically significant. For total patients initial pain score was 114.00 ± 30.14. Pain during access opening was 45.79 ± 19.23 the mean difference of initial pain score and pain score during access opening is 68.21. We observed that 59.83% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant.

GRAPHICAL REPRESENTATION

GROUP 2: For male patients initial pain score was 116.50 ± 25.35. Pain during access opening was 36.16 ± 22.41 the mean difference of initial pain score and pain score during access opening is 80.34. We observed that 68.96% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant. For female patients initial pain score was 122.50 ± 34.56. Pain during access opening was 30.00 ± 19.15 the mean difference of initial pain score and pain score during access opening is 92.50 we observed that 75.51% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant. For total patients initial pain score was 119.07 ± 28.55. Pain during access opening was 33.50 ± 20.53 the mean difference of initial pain score and pain score during access opening is 85.57. We observed that 71.87% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant.



GROUP 3: For male patients initial pain score was 112 ± 39.79. Pain during access opening was 26.67 ± 19.29 the mean difference of initial pain score and pain score during access opening is 85.33. We observed that 76.19% pain score is decreased from initial pain score to pain score during access opening.

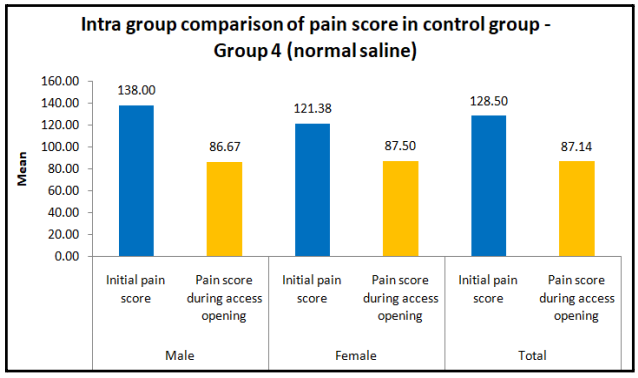


The result is statistically significant. For female patients initial pain score was 123.60 ± 25.82. Pain during access opening was 16.60 ± 19.15 the mean difference of initial pain score and pain score during access opening is 107.00. We observed that 86.57% pain score is decreased from initial pain score to pain score during access opening.

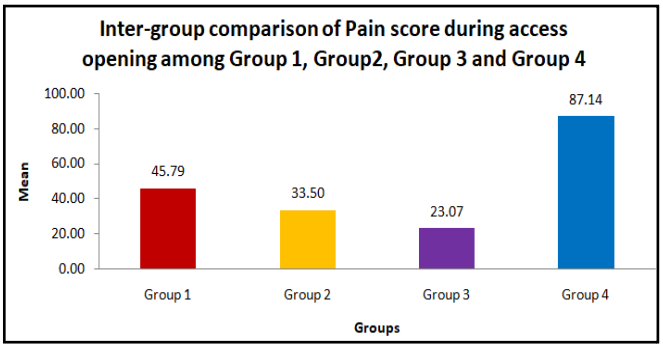
The result is statistically significant. For total patients initial

pain score was 116.14 ± 34.82.Pain during access opening was 23.07 ± 19.15 the mean difference of initial pain score and pain score during access opening is 93.07. We observed that 80.14% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant.

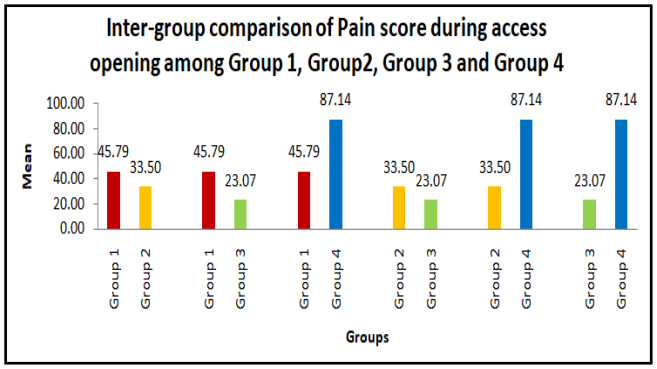
GROUP 4: For male patients initial pain score was 138 ± 32.9. Pain during access opening was 86.67 ± 23.42 the mean difference of initial pain score and pain score during access opening is 51.33. We observed that 37.20% pain score is decreased from initial pain score to pain score during access opening.

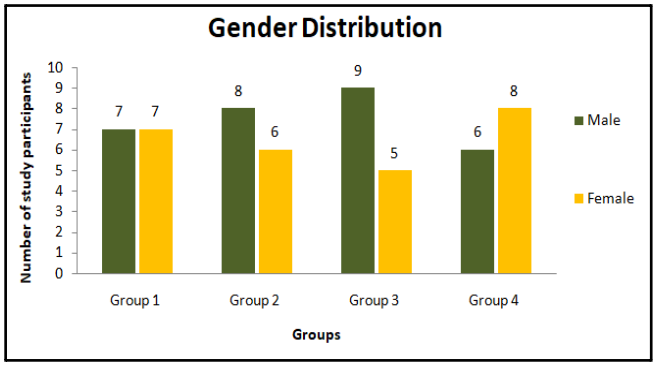


The result is statistically significant. For female patients initial pain score was 121.30 ± 25.20. Pain during access opening was 87.50 ± 20.98 the mean difference of initial pain score and pain score during access opening is 33.88. We observed that 27.91% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant. For total patients initial pain score was 128.50 ± 28.84. Pain during access opening was 87.14 ±21.17 the mean difference of initial pain score and pain score during access opening is 41.36. We observed that 32.19% pain score is decreased from initial pain score to pain score during access opening. The result is statistically significant. In inter group comparison the mean pain score during access opening in group1 is 45±19.23, in group 2 is 33.50±20.53, in group 3 is 23.07±19.15 and group 4 is 87.14±21.17. Statistical analysis was done with the help of ANOVA one way test and the results were statistically significant. In intergroup comparison mean pain score during access preparation in group1 is 45.79±19.23 and group 2 is 33.50±20.53. The mean difference is 12.29 and the p value is 0.114 which is statistically non significant. Mean pain score during access preparation in group1 is 45.79±19.23 and group 3 is 23.07±19.15. The mean difference is 22.72 and the p value is 0.004 which is statistically significant. Mean pain score during access preparation in group1 is 45.79±19.23 and group 4 is 87.14±21.17. The mean difference is 41.35 and the p value is 0.000 which is statistically significant. Mean pain score during access preparation in group2 is 33.50±20.53 and group3 23.07±19.15. The mean difference is 10.43 and the p value is 0.176 which is statistically non significant. Mean pain score during access preparation in group2 is 33.50±20.53 and in group4 is 87.14±21.17. The mean difference is 53.64 and the p value is 0.000 which is statistically significant. Mean pain score during access preparation in group3 is 23.07±19.15 and in group4 is 87.14±21.17. The mean difference is 64.07 and the p value is 0.000 which is statistically significant. In group 1 males are 7(50%) and females are 7 (50%). In group 2 males



are 8 (57.1%) and females are 6 (42.9%). In group 3 males are 9 (64.3%) and females are 5 (35.7%). In group 4 males are 6 (42.9%) and females are 8 (57.1%). Chi square test is used to evaluate the significance and the distribution of males and females among the groups are statistically non significant as p=.0697 i.e. p>.05. In group I mean age of the patients is 32.57±14.89, in group 2 the mean age of the patients is 29.14±13.27, in group 3 the mean age of the patients is 38.29±9.34 and group 4 the mean age of the patients is 37.14±14.80. ANOVA test is used as the test of significance and the mean age are statistically non significant among the groups as p= 0248 which is >.05.





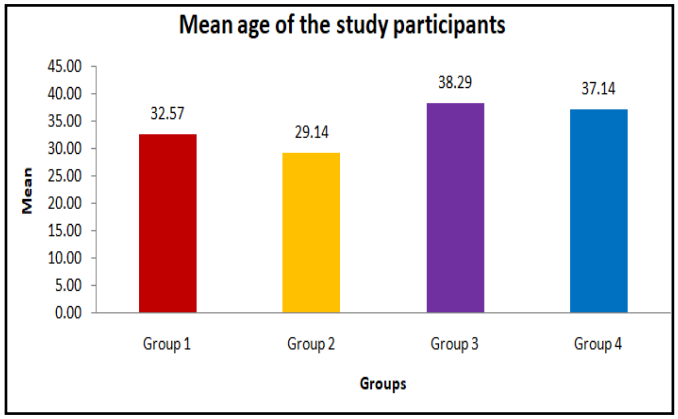


Table 1. Intra group comparison of pain score in group 1 (20% magnesium sulfate)

Gender	Time	N	Mean	SD	Mean difference	% of mean change	t value	P value
Male	Initial pain score	7	115.43	25.35	69.57	-60.27	9.231	P<0.05
	Pain score during access opening	7	45.86	14.77				
Female	Initial pain score	7	112.57	36.34	66.86	-59.39	5.863	P<0.05
	Pain score during access opening	7	45.71	24.15				
Total	Initial pain score	14	114.00	30.14	68.21	-59.83	10.372	P<.05
	Pain score during access opening	14	45.79	19.23				

Statistical analysis: Paired t test. S: statistically significant at the 0.05 level. NS: Not significant.

Table 2. Intra group comparison of pain score in Group 2 (50% magnesium sulfate)

Gender	Time	N	Mean	SD	Mean difference	% of mean change	t value	P value
Male	Initial pain score	8	116.50	25.35	80.34	-68.96	7.6000	P<0.05
	Pain score during access opening	8	36.16	22.41				
Female	Initial pain score	6	122.50	34.56	92.50	-75.51	8.788	P<.05
	Pain score during access opening	6	30.00	19.15				
Total	Initial pain score	14	119.07	28.55	85.57	-71.87	11.492	P<0.05
	Pain score during access opening	14	33.50	20.53				

Statistical analysis: Paired t test. S: statistically significant at the 0.05 level. NS: Not significant

Table 3. Intra group comparison of pain score in Group 3 (ketorolac)

Gender	Time	N	Mean	SD	Mean difference	% of mean change	t value	P value
Male	Initial pain score	9	112.00	39.79	85.33	-76.19	7.099	P<0.05
	Pain score during access opening	9	26.67	19.29				
Female	Initial pain score	5	123.60	25.82	107.00	-86.57	8.149	P<.05
	Pain score during access opening	5	16.60	19.15				
Total	Initial pain score	14	116.14	34.82	93.07	-80.14	10.131	P<.05
	Pain score during access opening	14	23.07	19.15				

Statistical analysis: Paired t test. S: statistically significant at the 0.05 level. NS: Not significant

Table 4. Intra group comparison of pain score in control group - Group 4 (normal saline)

Gender	Time	N	Mean	SD	Mean difference	% of mean change	t value	P value
Male	Initial pain score	6	138.00	32.91	51.33	-37.20	9.945	0.000
	Pain score during access opening	6	86.67	23.42				S
Female	Initial pain score	8	121.38	25.20	33.88	-27.91	5.237	0.001
	Pain score during access opening	8	87.50	20.98				S
Total	Initial pain score	14	128.50	28.84	41.36	-32.19	8.622	0.000
	Pain score during access opening	14	87.14	21.17				S

Statistical analysis: Paired t test. S: statistically significant at the 0.05 level. NS: Not significant

Table 5. Inter-group comparison of Pain score during access opening among Group 1, Group2, Group 3 and Group 4

Groups	N	Mean	Std. Deviation	F value	P value
Group 1	14	45.79	19.23	27.508	<.05
Group 2	14	33.50	20.53		
Group 3	14	23.07	19.15		
Group 4	14	87.14	21.17		

Statistical analysis: ANOVA one way test. S: statistically significant at the 0.05 level. NS: Not significant

Table 6. Inter-group comparison of Pain score during access opening among Group 1, Group2, Group 3 and Group 4

Groups	Mean	Std. Deviation	Mean difference	t value	P value
Group 1	45.79	19.23	12.29	1.634	0.114
Group 2	33.50	20.53			NS
Group 1	45.79	19.23	22.72	3.131	0.004
Group 3	23.07	19.15			S
Group 1	45.79	19.23	41.35	5.410	0.000
Group 4	87.14	21.17			S
Group 2	33.50	20.53	10.43	1.390	0.176
Group 3	23.07	19.15			NS
Group 2	33.50	20.53	53.64	6.806	0.000
Group 4	87.14	21.17			S
Group 3	23.07	19.15	64.07	8.398	0.000
Group 4	87.14	21.17			S

Statistical analysis: Independent sample t test. S: statistically significant at the 0.05 level. NS: Not significant

Table 7. Gender Distribution

Gender	Group 1 [N=14]		Group 2 [N=14]		Group 3 [N=14]		Group 4 [N=14]		Chi-square value	P value
	n	%	n	%	n	%	n	%		
Male	7	50.0	8	57.1	9	64.3	6	42.9	1.436	0.697
Female	7	50.0	6	42.9	5	35.7	8	57.1		NS

Statistical Analysis: Chi-square test. S: statistically significant at the 0.05 level. NS: Not significant

Table 8. Mean and SD age of the study participants

Groups	N	Mean	Std. Deviation	F value	P value
Group 1	14	32.57	14.89	1.420	0.248
Group 2	14	29.14	13.27		NS
Group 3	14	38.29	9.34		
Group 4	14	37.14	14.80		

Statistical analysis: ANOVA one way test. S: statistically significant at the 0.05 level.
NS: Not significant

DISCUSSION

In this study 1 ml of 20%, 50% concentration of magnesium sulfate and ketorolac was administered at the site of injection prior to inferior alveolar nerve block in patients with symptoms of irreversible pulpitis. In the present study all the teeth were included that were responsive to cold test. In order to confirm the diagnosis electric pulp testing was also done. Pain experienced by the patients was recorded on Heft Parker visual analogue scale and those exhibiting moderate to severe pain were included. All the patients were then divided into 4 groups. Nusstein *et al*, tortamano *et al* have reported 30-81% failure rates for inferior alveolar nerve block in molars with irreversible pulpitis.[12] it may be due to needle deflection, inaccurate injection technique, crossinnervations; technical failure in delivering the anesthetic solution to the target area that is the pterygomandibular space where the inferior alveolar nerve enters the mandibular foramen. According to Webster *et al* it can also be due to local causes such as inflammation in patients with irreversible pulpitis. According to chaudhary *et al*, inflammation results in activation of the capsasin- sensitive transient receptor that is potential vanilloid type 1 and also tetrodotoxin- resistant receptors. Activation of these receptors is known to reduce the efficacy of commonly used anesthetic agents[13]. Also in inflamed tissue, because of the lower ph of the tissue a major portion of the local anesthesia is trapped in its charged form. This results in further failure of the action of local anesthetics. Prostaglandins also play a major role in the inflammatory process. Prostaglandins when released during inflammation results in increased depolarization by altering the kinetics of voltage gated sodium channels. All these results in decrease threshold for pain and the patients will experience enhanced pain. Therefore, efficacy of the local anesthesia can also be increased by decreasing the level of prostaglandins in inflamed tissue. Many alternative agents were used in order to improve the efficacy of inferior alveolar nerve block and produce pulpal anesthesia. Magnesium sulfate and ketorolac are some of the adjuvants used in these attempted strategies. Ketorolac is a non steroidal anti inflammatory drug and belongs to pyrrole-pyrrole group and it is as effective as morphine or meperidine for pain relief[14,15]. Ketorolac is a non-selective inhibitor of both cox-1 and cox-2 enzymes and inhibits the key pathways in prostaglandins synthesis. After oral administration oral ketoralac is rapidly absorbed and Cmax is obtained around 30-40 minutes and after IM administration it takes about 45-60 minutes to reach maximal plasma concentration[16]. That is why ketorolac was administered one hour before inferior alveolar nerve block in our study. Central sensitization is a common component of both inflammatory and neuropathic pain. N- Methyl-D- aspartic acid glutanergic receptors are mainly responsible for central sensitization. Magnesium sulfate blocks these NMDA receptors, preventing central sensitization from peripheral nociceptor stimulation and thus abolishes hypersensitivity. This is the first mechanism through which magnesium sulfate work. In 1964 Feinstein[17] described the mechanism of action of magnesium, calcium, and local anesthetic. The local anesthetic prevents calcium transport through the cell membrane that is facilitated by phospholipids. Magnesium reversibly binds to phospholipids molecules thus inhibiting calcium transport. This is the second mechanism through which magnesium sulfate work. Magnesium sulfate USP 50% through intramuscular route reaches peak plasma concentration in 60 minutes therefore it was administered 1 hour prior to inferior alveolar nerve block in our study. The concentration of 50% magnesium sulfate USP used in the study was based on previous established studies. Krishna Prasad shetty *et al* and Priyadharshini T *et al* conducted studies on using 50% magnesium sulfate. Since most commonly used formulations of magnesium sulfate are 50% and 20% in the clinical practice and there were no prior studies conducted on the comparison of different doses so these formulations were chosen.

In our study baselines variables such as age, genders were not significantly different between the four groups. In the present study the mean pain scores were compared between the four groups – 20% magnesium sulfate, 50% magnesium sulfate, ketorolac and normal saline. The mean initial pain rating of 114.00±30.14 for 20% magnesium sulfate, 119.07±28.55 for 50% magnesium sulfate, 116.14±34.82 for ketorolac group and 128.50±28.84 for normal saline or control group indicated severe pain on the HP-VAS and were almost similar. During access cavity preparation and initial instrumentation the mean score between the groups was statistically significant. All the three groups show significant reduction in the mean pain score during access cavity preparation and initial instrumentation and the mean pain reduction in group 3 (ketorolac) is slightly more as compared to 50% magnesium sulfate followed by 20% magnesium sulfate. The results of this trial are in accordance with the studies conducted by shetty *et al* (2015) which demonstrated that 50% magnesium sulfate can increase the efficacy of inferior alveolar nerve block and priyadharshini *et al* (2018) which demonstrated that ketorolac with articaine results in significant decrease in pain followed by

50%magnesium sulfate during endodontic procedure. So, it can be assumed that ketorolac 1 ml prior to inferior alveolar nerve block produce significant decrease in pain during endodontic procedure followed by 50 % magnesium sulfate and 20 % magnesium sulfate respectively.

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