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## Research Article

# COMPARISON OF THE ANAESTHETIC EFFICACY OF INCREASED VOLUME OF ARTICAINE, PRE-OPKETOROLAC AND MAGNESIUM SULFATE IN PULPITIS

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Articaine, Magnesium Sulfate, Pre-operative Ketorolac.

### ABSTRACT

**Objective:** The purpose of this study is to determine the best possible combination of anaesthesia with articaine for achieving anaesthesia in mandibular molar teeth with symptomatic irreversible pulpitis.

**Materials and methods:** A total of 18 patients with moderate to severe pain diagnosed with symptomatic irreversible pulpitis of mandibular posterior teeth were selected. They were randomly assigned to one of the groups and received either an increased volume of articaine during procedure or 10mg of oral ketorolac one hour before the administration of IANB or 1ml of magnesium sulphate 50% IP one hour before the administration of IANB. The pain values were noted in Heft-Parker Visual analog scale before the procedure and during the access cavity preparation and the VAS scores were compared.

**Results:** Inter group analysis was made using one way ANOVA test for the initial pain values and for the pain values during access cavity preparation. There was statistically significant difference in the pain value during access cavity preparation for the three groups ( $p=0.0365$ ) with the least pain value for oral ketorolac group.

**Conclusion:** Under the conditions of this study it can be concluded that, combination of articaine with pre-operative oral ketorolac provided significant decrease in pain during endodontic procedure followed by combination with pre-operative magnesium sulphate and increased volume of articaine.

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### INTRODUCTION

Pain management in endodontics often difficult because of the lack of profound anaesthesia<sup>1</sup>. Achieving such anaesthesia poses a major concern for the dentist especially in case of irreversible pulpitis.

Inferior alveolar nerve block is the most commonly used technique to achieve anaesthesia in mandibular teeth<sup>2,3</sup>. It is considered the most technique sensitive and it is clinically adequate in 85-90% of the cases. But in case of irreversible pulpitis, its efficacy is reduced by 20%. Failure of anaesthesia in inferior alveolar nerve block (IANB) is reported to be 44-81%<sup>4</sup>. The high rate of failure may be due to accessory innervations, inaccurate injection technique, needle deflection and cross innervations<sup>5</sup>.

In case of symptomatic irreversible pulpitis, the lowered pH of the tissues reduces the amount of base form of anaesthesia that is available to penetrate the nerve membrane. The inflammatory process is mediated by prostaglandins, which act

by sensitizing the nerve endings to bradykinins and histamines thereby activating the nociceptors and decreasing the pain threshold<sup>6,7</sup>.

Traditionally lidocaine solution has been administered for the IANB. Articaine introduced in the year 1969, is found to be as a potent local anaesthetic agent as lidocaine. It is the only amide group of local anaesthetic with the ester group (thiophene ring) in its molecular structure that allows for its metabolism by both plasma esterases and liver microsomal enzymes. The clinical advantage of articaine is its superior bone diffusibility. It is also found to have better cardiac stability, increased duration of action and shorter onset of action when compared to lidocaine<sup>8</sup>.

Determining the success of the IANB by the subjective signs of lip and tongue numbness is not always reliable. Successful soft tissue anaesthesia only indicates that the anaesthesia is delivered at the correct site and does not guarantee pulpal anaesthesia. Successful pulpal anaesthesia is achieved only

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when patient reports no pain during access cavity preparation and during canal instrumentation.

One of the ways to increase the success of anaesthesia after the administration of IANB is to increase the volume of anaesthetic solution administered. Most of the previous studies which have investigated the effect of increased volume of anaesthesia on the success of IANB have reported no significant difference in the success. But all these studies were done with lidocaine. Abazarpoor *et al* in the year 2015 evaluated the efficiency of increased volume of 3.6ml articaine for IANB and showed higher success rate than 1.8ml of articaine<sup>9</sup>.

Previous studies have also reported that the use of pre-operative medication increases the success rate of IANB in symptomatic irreversible pulpitis<sup>10,11</sup>. Inflammation is a result of inflammatory mediators like prostaglandins. Ketorolac which is a pyrolo-pyrole derivative inhibits the enzyme cyclooxygenase thereby decreasing pain and inflammation<sup>12</sup>.

Magnesium sulphate is used in the field of anaesthesia to increase the quality of anaesthesia<sup>13</sup>. Local anaesthetics inhibit the phospholipid facilitated calcium transport in order to achieve anaesthesia. Magnesium reversibly binds to phospholipid molecules and acts in a synergistic effect with the local anaesthetic solution, thereby improving the quality of anaesthesia<sup>14</sup>.

Hence the aim of this in-vivo study was to compare the anaesthetic efficacy of increased volume of articaine, articaine with pre-operative ketorolac and articaine with pre-operative magnesium sulphate 50% IP in symptomatic irreversible pulpitis.

## MATERIALS AND METHODOLOGY

18 patients in the age group of 18-65 were included in the study. Patients with pain in the mandibular molar teeth (mandibular first and second molar) with moderate to severe intensity, absence of any periapical radiolucency in radiographs except for widening of the periodontal ligament space, a positive response to EPT and an ability to understand pain scales 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.

Each patient rated his/her pain on a Heft-Parker visual analogue scale. This scale has markings ranging from 0-170mm. No pain was indicated by 0mm, mild pain by 1-54mm, moderate pain by 53-113mm, severe pain by 114-170mm.

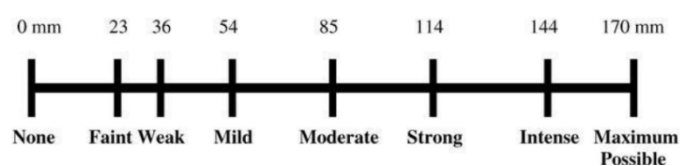
Patients having moderate to severe pain were randomly assigned to one of the three groups. Group I(n=6) patients received two cartridges of articaine (Septanest with adrenaline 1/100,000, Septodont, France) for IANB. Group II(n=6) patients were given 10mg oral ketorolac tablet(Ketoroldt, Dr.Reddy's laboratories Ltd, India) one hour before the procedure and standard IANB was administered prior to endodontic procedure. Group III(n=6) patients received 1ml of magnesium sulphate 50% IP(Magneon, Neon laboratories Ltd,

India) at the injection site one hour prior to the procedure and standard IANB was administered before the endodontic procedure.

IANB was administered by a single operator using a 2ml syringe and 26gauge 31mm long needle. Ten minutes after the injection, the patients were asked for lip numbness and patients without lip numbness were considered unsuccessful anaesthesia and were excluded from the study.

The patients were asked to rate their pain on the Heft-Parker Visual analog scale before the procedure and during access cavity preparation.

Place a mark on the line below to show the amount of pain that you feel.



Patients who reported moderate to severe pain were administered supplemental intra-pulpal injection to complete the procedure.

## RESULTS

Table 1 shows the initial pain values and pain values during access cavity preparation. Inter-group analysis was made using one way ANOVA test for the initial pain values and for the pain values during access cavity preparation.

All the patients reported moderate to severe pain before administration of anaesthesia and the results indicate that there is statistically no significant difference ( $p = 0.641$ ) in the initial pain values in all the three groups.

There was statistically significant difference in the pain value ( $p=0.0365$ ) during access cavity preparation in all the three groups with the least pain value for group II (pre-operative oral ketorolac) followed by group III (pre-operative magnesium sulphate) and group I (increased volume of local anaesthetic).

Table 1 Pain values Mean± SD

Groups	Before anaesthesia	During access cavity preparation
Group I	98.5±10.57 <sup>a</sup>	84.6±25.6 <sup>a</sup>
Group II	104.6±17.70 <sup>a</sup>	54.5±12.58 <sup>b</sup>
Group III	105.3±13.75 <sup>a</sup>	66.25±13.48 <sup>c</sup>

Groups with different superscript letter are statistically significant at  $p=0.05$ .

## 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<sup>1</sup>.

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*<sup>15</sup>, Kanaa *et al* and Poorni *et al*<sup>16</sup> reported a higher success rate of articaine when compared with lidocaine. Articaine is 4-methyl-3-(2-[propylamino] propionamido)-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<sup>17</sup>.

Our study aimed at determining the best possible anaesthetic combination with articaine in achieving anaesthesia in teeth with symptomatic irreversible pulpitis.

Varying results have been proposed regarding the usage of increased volume of anaesthetic agent for successful anaesthesia in symptomatic irreversible pulpitis. Abazarpour *et al* proposed a significantly higher success rate with 3.6ml of lidocaine when compared to 1.8ml of lidocaine<sup>9</sup>. He proposed that the higher success rate of increased volume could be due to the increased volume of the solution in the pterygomandibular space and the greater length of the nerve being exposed to the anaesthetic solution. However Nusstein *et al*<sup>18</sup> and Pfeil *et al*<sup>19</sup> proposed that there was no significant difference in the anaesthetic efficiency between 1.8ml and 3.6ml of lidocaine. In this study also there was no significant difference in the mean pain values of group I.

The inflammatory process is mediated via prostaglandins that alter the kinetics of voltage gated sodium channels, resulting in increased depolarization. This causes enhanced pain by decreasing the threshold for pain. Therefore, decreasing the amount of prostaglandins can help increase the efficacy of the local anaesthetic agent in the inflamed tissue.

Ketorolac or Ketorolac tri-methamine is a pyrrole-pyrrole derivative that has been found to be as effective as morphine or mepiridine for pain relief. Ketorolac activates the Nitric oxide - cyclic Guanosine Monophosphate (GMP) pathway that could induce antinociceptive action at the peripheral primary afferent nerve endings by opening up the K<sup>+</sup> channels. This action of ketorolac could be the primary reason for their role in increasing the success rate of IANB. In this study also there was significant decrease in the mean pain values of group II compared to the other groups. This is in accordance with the study done by MeetuYadav *et al*<sup>20</sup> who proposed a significant increase in the success rate of IANB when a pre-operative ketorolac medication was given.

Hargreaves and Keiser have proposed several hypotheses to explain local anesthetic failure including effect of inflammation on central sensitization. Central sensitization is due to up-regulation of N-methyl-D-aspartate (NMDA) receptors<sup>21</sup>. Magnesium sulphate interfere with these NMDA receptors and prevent the induction of central sensitization due to peripheral nociceptor stimulation and eliminate the hypersensitivity.

In 1964, Feinstein described the mechanism of action of magnesium, calcium and local anaesthetic<sup>22</sup>. Local anaesthetic agent acts by inhibiting the phospholipid facilitated calcium transport. Magnesium reversibly binds to the phospholipid molecules and thereby enhances the action of the local anaesthetic agent.

In the practise of anaesthesia, the amount of magnesium sulphate used is 2-2.5g (16-20mEq/ml)<sup>23</sup>. The use of such large amount of magnesium sulphate requires precaution as it can cause sudden drop in blood pressure, cardiac and central nervous system depression, and respiratory paralysis<sup>24</sup>. Side effects of magnesium sulphate start to appear when the plasma concentration of magnesium cross 6-7 mEq/ml<sup>25</sup>. The total amount of magnesium sulphate used in this study is 4.06mEq/ml. This would eliminate the need for any precautions for the use of magnesium sulphate.

In a study done by Krishna Prasad Shetty *et al*<sup>26</sup>, 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

Within the limitations of this study, it can be concluded that, the combination of preoperative Ketorolac with articaine produced significant decrease in pain during endodontic procedure followed by combination with preoperative magnesium sulphate 50% IP with articaine and increased volume of articaine respectively.

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