

# Comparison of Efficacy and Patient Response between 2% Lidocaine and 4% Articaine during Routine Dental Extractions

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## ABSTRACT

**Introduction:** Local Anaesthetic (LA) agents are chemicals that reversibly block the transmission of action potential of nerve membrane. Lidocaine has established itself as the gold-standard owing to its excellent clinical properties with minimal side effects. Articaine, a relatively newer LA agent is reported to have better clinical properties than lidocaine.

**Aim:** To compare and evaluate the differences in total volume of LA agent used, onset of subjective symptoms and objective signs, total duration of anaesthesia achieved and postoperative pain assessment with 2% lidocaine and 4% articaine during routine dental extractions.

**Materials and Methods:** This randomised clinical study was conducted by the Department of Dentistry, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India, from October 2020 to February 2021. A total of 200 patients (107 females and 93 males) requiring mandibular molar extraction were included in the study. The patients were randomly divided into two study groups. Group-I patients were administered with 2% lidocaine while group-II patients were administered with 4% articaine. Complete demographic and clinical details of all the patients were recorded.

The volume of LA agent used, onset time for subjective symptoms and objective signs and total duration of anaesthesia was recorded. Postoperative pain was recorded on Visual Analogue Scale (VAS) on a scale of 0 to 10. All the variables were recorded in Microsoft excel sheet and were analysed by Statistical Package for the Social Sciences (SPSS) version 21 software. A two-tailed p-value less than 0.05 ( $p < 0.05$ ) was considered statistically significant.

**Results:** A total of 200 patients participated in the study, where group-I patients (49 males and 51 females) had a mean age of  $34.79 \pm 10.43$  years and group-II patients (44 males and 56 females) had a mean age of  $35.41 \pm 11.39$  years. Statistically insignificant differences ( $p > 0.05$ ) were obtained for the following parameters- volume of LA agent used, onset time of subjective symptoms, onset time of objective signs and postoperative VAS scores. A statistically significant difference ( $p < 0.05$ ) was observed for total duration of anaesthesia.

**Conclusion:** Both 2% lignocaine and 4% articaine are equally effective LA agents in patients undergoing mandibular molar extractions. However, 2% articaine exhibited significantly higher duration of total anaesthesia when compared to 2% lidocaine.

**Keywords:** Inferior alveolar nerve block, Local anaesthetic agents, Mandibular first molar extraction, Visual analogue scale

## INTRODUCTION

Local anaesthesia has been defined as a loss in sensation in a circumscribed area of the body caused by depression of excitation in nerve endings or inhibition of the conduction process in peripheral nerves [1]. Lidocaine (lignocaine) was the first amide linked LA agent synthesised in 1943 and has extensively been evaluated and documented for its effectiveness and safety profile. It is the most widely used LA agent and is considered as the gold standard. It is available as plain or in combination of varying concentration of vasoconstrictors that offers many clinical advantages [2,3].

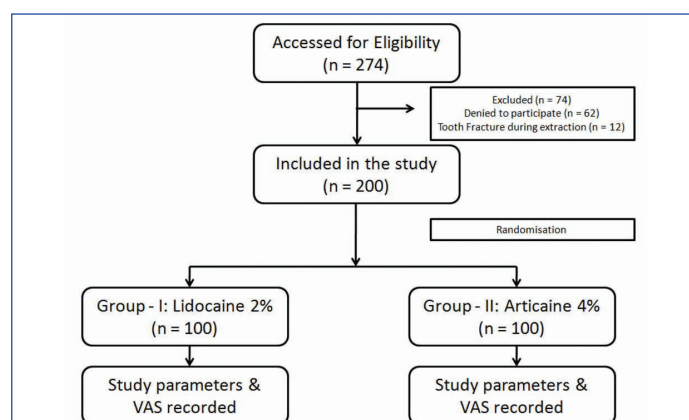
Another amide linked LA agent, articaine was first synthesised in 1969 and is being used worldwide safely with well documented studies [2,4,5]. The molecular structure of articaine has a linked ester group, which facilitates its metabolism by plasma esterases as well as liver microsomal enzymes. Though, classified as short acting LA, it offers prolonged anaesthetic duration only to be surpassed by ultra-long acting agent such as bupivacaine [5]. It is also reported to have superior diffusability through hard tissues [6]. Though, many studies have been carried out in the past to compare both the LA agents, there is scant number of published data available for the local population of Bihar [4,5]. Therefore, the present study was designed to assess the efficacy and patient response to these two LA agents in patients undergoing routine dental extraction procedures.

## MATERIALS AND METHODS

This randomised clinical study was conducted at Department of Dentistry, Sri Krishna Medical College and Hospital, Muzaffarpur,

Bihar, India, from October 2020 to March 2021 in accordance with revised Helsinki Declaration of 1975 after obtaining approval from the Institutional Ethical Committee vide letter number 25/20 (IEC, SKMCH).

**Sample size calculation:** The formula used to calculate the sample size required for this study at 95% confidence interval and 80% power of study was:  $n = 2(Z_{\alpha/2} + Z_{\beta})^2 \cdot \sigma^2 / d^2$  where,  $Z_{\alpha/2} = 1.96$  for a confidence level ( $\alpha$ ) of 95%,  $Z_{\beta} = 0.84$  for power of 80%,  $\sigma$  = standard deviation and  $d$  = size of the effect clinically worthwhile to detect [7]. Using the above formula, a sample size of 96 patients per group was calculated and it was increased to nearest 100 to include 200 patients in the study [Table/Fig-1].



[Table/Fig-1]: Flow diagram of the study.

**Inclusion criteria:** Systemically healthy patients aged 18-60 years without any co-morbidity who needed extraction of carious mandibular molars were included in the study.

**Exclusion criteria:** Individuals with grossly decayed teeth, teeth with periodontal problems/bone loss, presence of periapical pathology/sinus opening, impacted teeth and root stumps were excluded from the study.

A total of 200 such patients (107 females and 93 males) were selected from the outpatient pool and were randomly divided into two groups with 100 patients in each group:

**Group-I:** 100 patients underwent dental extraction under 2% lidocaine (Lignospan™, 2% lidocaine hydrochloride and epinephrine 1:1,00,000, Septodont, Canada)

**Group-II:** 100 patients underwent dental extraction under 4% Articaine (Septanest™, 4% articaine hydrochloride and epinephrine 1:1,00,000, Septodont, France)

## Study Procedure

In this single blinded study, complete demographic profile and clinical details of all the patients were recorded. Local anaesthesia was achieved by Inferior Alveolar Nerve Block (IANB), Lingual Nerve Block and Long Buccal Nerve Block by a single operator. The mean duration of onset of subjective symptoms and objective signs were recorded and the mean amount of anaesthetic solution used was recorded. After the onset of objective signs, the tooth was extracted using least traumatic approach by a single operator. Postoperative instructions were explained to the patients and five days medication (amoxicillin 500 mg TDS and aceclofenac 100 mg BD) was prescribed.

Pain was recorded on VAS on a scale of 0 to 10 with 0 indicating no pain and 10 indicating worse pain after the completion of procedure [6]. The patients were made to wait in the waiting area for postoperative follow-up and to access the duration of action of each LA agent.

## STATISTICAL ANALYSIS

All the results were recorded in Microsoft Excel Sheet and were analysed by Statistical Package for the Social Sciences (SPSS) version 21 (IBM Corp., Chicago, Illinois, USA). Student t-test was used for evaluation of level of significance. A two-tailed p-value less than 0.05 ( $p < 0.05$ ) was considered statistically significant.

## RESULTS

The comparative demographic characteristics (age and sex) for both the groups has been summarised in [Table/Fig-2]. The mean age of the group-I patients was  $34.79 \pm 10.43$  years while that for group-II patients was  $35.41 \pm 11.39$  years. The onset of subjective symptoms in group-I and group-II patients was found to be  $85.07 \pm 16.84$  seconds and  $83.76 \pm 13.79$  seconds respectively while that for objective signs was found to be  $180.84 \pm 14.57$  seconds and  $182.22 \pm 14.53$  seconds, respectively. Intergroup comparison for these parameters yielded non-significant results  $p = 0.54$  and  $p = 0.50$ , respectively as shown in [Table/Fig-3].

Parameters		Group-I (n=100)	Group-II (n=100)
Age group (years)	Mean age $\pm$ SD	$34.79 \pm 10.43$	$35.41 \pm 11.39$
Gender	Males	49	44
	Females	51	56

[Table/Fig-2]: Demographic profile of the patients.

Parameters		Group-I	Group-II	p-value*
Mean time of onset (seconds)	Subjective symptoms	$85.07 \pm 16.84$	$83.76 \pm 13.79$	0.54
	Objective signs	$180.84 \pm 14.57$	$182.22 \pm 14.53$	0.50
Duration of anaesthesia (minutes)		$191.46 \pm 6.88$	$194.70 \pm 9.16$	0.0052*
Amount of LA used (mL)		$2.21 \pm 0.41$	$2.14 \pm 0.38$	0.23

[Table/Fig-3]: Comparison of efficacy of the two anaesthetic agents. (student t-test, \* - statistically significant)

The average duration of anaesthesia for group-I and group-II patients came around  $191.46 \pm 6.88$  minutes and  $194.70 \pm 9.16$  minutes respectively which was significantly higher ( $p = 0.0052$ ) for group-II patients [Table/Fig-3]. The average amount of LA agent used for both the groups was  $2.21 \pm 0.41$  mL for group-I and  $2.14 \pm 0.38$  mL for group-II patients. Statistically insignificant ( $p > 0.05$ ) difference was evidenced in the mean amount of anaesthetic solution used for both the groups [Table/Fig-3].

The mean postoperative VAS for group-I patients was  $2.59 \pm 1.33$  while that for group-II patients was  $2.42 \pm 1.28$ . Non-significant ( $p > 0.05$ ) differences were obtained while comparing the mean VAS for both the study groups [Table/Fig-4].

Parameter	Group-I	Group-II	p-value*
Mean VAS	$2.59 \pm 1.33$	$2.42 \pm 1.28$	0.35

[Table/Fig-4]: Comparison of postoperative mean VAS.

(\*student t-test)

## DISCUSSION

Establishment of good LA effect is one of the important prerequisite before carrying out any invasive dental procedure. For a mandibular molar extraction, IANB technique is used with a suitable anaesthetic agent. However, the possibility of failure of IANB even with experienced operators ranges from 31-41% for mandibular first and second molars [8]. In general, surgical anaesthesia requires the use of higher concentrations and doses. When a less intense block is demanded, the use of a lower concentration is intimated. The volume and concentration of the drug used for anaesthetic effect will affect the spread and extent of anaesthesia [6,9,10]. The present study was undertaken to measure the efficacy of two different LA solutions and patient's response in persons undergoing mandibular molar extraction procedures.

The present study reported a mean onset time of subjective symptoms in group-I (lidocaine 2%) and group-II (articaine 4%) patients to be  $85.07 \pm 16.84$  seconds and  $83.76 \pm 13.79$  seconds, respectively, while the objective signs were elicited by  $180.84 \pm 14.57$  seconds and  $182.22 \pm 14.53$  seconds, respectively. Another split-mouth study reported onset of subjective symptoms at 1.40 minutes and 1.35 minutes and objective signs after 2.15 minutes and 2.12 minutes for 2% lidocaine and 4% articaine groups, respectively [11].

The duration of anaesthetic effect is directly proportional to the degree of protein binding of the LA agent. It is also determined by the accuracy of nerve block technique and the concentration of vasoconstrictor present [11]. The mean duration of anaesthesia achieved in the 2% lidocaine group and 4% articaine group was recorded to be  $191.46 \pm 6.88$  minutes and  $194.70 \pm 9.16$  minutes, respectively with significantly higher duration of action for articaine group. Boonsiriseth K et al., reported a mean duration of 258.82 minutes and 287.55 minutes for 4% lidocaine and 4% articaine [12], where the statistical differences between the study groups were insignificant. Other studies however claimed significantly longer duration of anaesthesia with 4% articaine as compared to 2% lidocaine [13,14], which is in accordance to the findings of the present study. This could be attributed to the fact that articaine is concentrated by 100 times on the alveolus compared to systemic circulation; thereby offering prolonged duration of anaesthesia [5].

In the present study, the mean amount of LA used for lidocaine group and articaine group was  $2.21 \pm 0.41$  mL and  $2.14 \pm 0.38$  mL, respectively. Though, the amount of articaine used was less compared to lignocaine, it was statistically insignificant. Similarly, in the study by Kambalimath DH et al., the mean amount of LA used for IANB was 1.86 mL and 1.73 mL for lignocaine and articaine with statistically insignificant difference [11]. In the present study, apart from IANB, lingual and long buccal nerve blocks were also administered.

Pain has been defined as an unpleasant emotional experience usually incited by a noxious stimulus and transmitted over a specialised neural network to the central nervous system where it is interpreted as such [15]. The present study reported a mean postoperative VAS score of  $2.59 \pm 1.33$  and  $2.42 \pm 1.28$  in lidocaine group and articaine group respectively with statistically insignificant differences. While Jain NK et al., reported significantly lower postoperative VAS for articaine group compared to lidocaine group for impacted mandibular 3<sup>rd</sup> molars [13], Kambalimath DH et al., reported non significant differences in VAS for both the groups following IANB [11]. Ghazalgoo A et al., reported significantly lesser postoperative pain in articaine group compared to lignocaine group after endodontic treatment of mandibular 1<sup>st</sup> molars at 4 hours, 6 hours, 12 hours and 18 hours [16]. Tortamano IP et al., reported a greater degree of pain absence during pulpectomy of mandibular posterior teeth with articaine compared to lidocaine [17].

Zhang A et al., in a meta-analysis reported insignificant difference in intraoperative pain between the two groups [14].

Various researchers who compared the efficacy of 2% lidocaine/lignocaine with 4% articaine for extraction of teeth using nerve block or infiltration technique eventually concluded that articaine might provide faster onset and increased duration of anaesthesia, however no significant differences in patient's pain score was present between the group [Table/Fig-5] [12,13,18-30].

Though, lidocaine has a well established safety profile documented over years, articaine on the other has few concerns pertaining to development of Methemoglobinemia, neuropathy, paresthesia and allergic reactions [11]. Malamed SF et al., reported incidence of 22% and 20% adverse events in articaine group and lignocaine group and concluded that articaine is safe and effective LA agent for use

S. No.	Authors	Agents used	Procedure	Sample size	Technique	Result	Place	Year
1.	Kumar K et al., [18]	2% Lignocaine vs 4% Articaine	Extraction of mandibular molars	120	Inferior alveolar nerve block, lingual nerve block and buccal nerve block	Articaine is more effective compared to Lignocaine	India	2020
2.	Phyo HE et al., [19]	4% Lignocaine vs 4% Articaine	Extraction of bilaterally impacted maxillary 3 <sup>rd</sup> molars	30	Buccal infiltration	Non significant differences in success, pain score and patient satisfaction	Thailand	2020
3.	Deshpande N et al., [20]	2% Lidocaine vs 4% Articaine	Extraction of maxillary molars for orthodontic purpose	60	Buccal infiltration	Articaine showed a faster time of onset and longer duration of analgesia than lidocaine. Insignificant differences in intraoperative discomfort and hemodynamic parameters	India	2020
4.	Kumar BP et al., [21]	2% Lidocaine vs 4% Articaine	Anaesthetic efficacy of the two LA agents in irreversible pulpitis during endodontic therapy	25	Inferior Alveolar nerve block and buccal infiltration	There was no significant difference in the proportions of the overall success rate between the two groups	India	2020
5.	Saralaya S et al., [22]	2% Lignocaine vs 4% Articaine	Extraction of impacted mandibular 3 <sup>rd</sup> molars	50	Inferior alveolar nerve block, lingual nerve block and buccal nerve block	Articaine group experienced statistically significant longer period of analgesia and duration of action however no difference in pain score was noted between the groups	India	2019
6.	Kumar PD et al., [23]	4% Articaine vs 2% Lignocaine	Maxillary 1 <sup>st</sup> molar extraction	100	Buccal infiltration	The efficacy of single buccal injection of articaine is comparable to buccal and palatal injection of lignocaine.	India	2019
7.	Rayati F et al., [24]	2% Lidocaine vs 4% Articaine	Extraction of mandibular molars	133	Buccal infiltration	Articaine is more successful in providing adequate depth of anaesthesia, but its efficacy was not sufficient to replace an inferior alveolar nerve block for extraction of mandibular molars	Iran	2018
8.	Mittal J et al., [25]	2% Lidocaine vs 4% Articaine	Extraction of bilaterally impacted mandibular 3 <sup>rd</sup> molars	20	Inferior alveolar nerve block and lingual nerve block	4% articaine was found to have a significantly shorter onset of action and longer duration of action than 2% lidocaine while no significant difference was found in other parameters.	India	2018
9.	Bansal SK et al., [26]	4% Articaine vs 2% Lignocaine	Extraction of maxillary molars for orthodontic purpose	50	Local infiltration	The present study asserted that articaine HCl has shorter onset time, longer duration of action, and similar efficacy to lignocaine HCl and thus can also be used.	India	2018
10.	Boonsirisetth K et al., [12]	4% Lidocaine vs 4% Articaine	Extraction of bilaterally impacted mandibular 3 <sup>rd</sup> molars	22	Inferior alveolar nerve block and buccal nerve block	The use of 4% articaine for the inferior alveolar nerve block was clinically more effective in the onset of subjective and objective anaesthesia as compared with the use of 4% lidocaine however no significant differences in pain score was evident between the groups.	Thailand	2017
11.	Kaur H and Kataria R [27]	2% Lidocaine vs 4% Articaine	Extraction of impacted mandibular 3 <sup>rd</sup> molar	30	Not specified	Articaine had a significant faster onset of action and longer duration of action when compared to lignocaine.	India	2017
12.	Jain NK et al., [13]	2% Lignocaine vs 4% Articaine	Impacted mandibular 3 <sup>rd</sup> molars	70	Inferior alveolar nerve block and additional infiltration (if required)	Articaine had a significant faster onset of action and longer duration of action when compared to lignocaine	India	2016
13.	Shruthi R et al., [28]	2% Lignocaine vs 4% Articaine	Impacted mandibular 3 <sup>rd</sup> molars	50	inferior alveolar nerve block and buccal nerve block	Articaine has similar efficacy as that of lignocaine with slightly longer duration	India	2013
14.	Silva LC et al., [29]	2% Lidocaine vs 4% Articaine	Extraction of bilaterally impacted mandibular 3 <sup>rd</sup> molars	20	Inferior alveolar nerve block and buccal nerve block	No significant differences were observed between lidocaine and articaine in the control of postoperative pain.	Brazil	2012
15.	Martínez-Rodríguez N et al., [30]	2% Lignocaine vs 4% Articaine	Extraction of mandibular 3 <sup>rd</sup> molar	96	Inferior alveolar nerve block, lingual nerve block and buccal nerve block	Both the latency period and the duration of anaesthetic effect were greater for articaine, although the differences were not statistically significant.	Spain	2012

[Table/Fig-5]: Previous similar studies comparing the anaesthetic agents. [12,13,18-30].

in clinical dentistry [31]. In the present study, none of the patients reported any incidence of adverse events for both the groups.

### Limitation(s)

The limitations of the present study include only the use of mandibular nerve block technique in adult patients. The study could have been more insightful if it were used in split-mouth design. Also, the effects of both anaesthetic agents were not evaluated for the maxillary nerve blocks.

### CONCLUSION(S)

Within the limits of the present study, no significant differences were evident for both the study groups with respect to the total amount of anaesthetic agent used, onset of subjective symptoms and objective signs in the existing patient pool. However, 4% articaine exhibited significantly higher duration of total anaesthesia when compared to 2% lidocaine. No adverse events were reported for both the groups. The authors concluded that both 2% lignocaine and 4% articaine anaesthetic solutions are equally effective in clinical dental practice.

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