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Can single buccal infiltration with 4% articaine induce sufficient analgesia for the extraction of primary molars in children: a systematic literature review

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This systematic review aims to determine if a single buccal infiltration (without palatal infiltration in the maxilla and Inferior Alveolar Nerve Block in the mandible) with 4% articaine can induce adequate analgesia for the extraction of primary molars (Maxillary and Mandibular) in children. PubMed, Ovid SP, and Embase were searched for studies published between January 1990 and March 2020 with the relevant MeSH terms. Titles and abstracts were screened preliminarily, followed by the full-texts of the included studies. Five articles were included for this systematic review. The outcome investigated was "Procedural pain during the extraction of primary molars after injection with single buccal infiltration of 4% articaine in comparison to single buccal infiltration, double infiltration (buccal and palatal/lingual), and inferior alveolar nerve block with 2% lignocaine." Of the five studies that evaluated subjective pain during extraction, two reported no significant difference between the articaine and lignocaine groups, and the remaining three reported lower subjective pain during extraction in the articaine group. Only two studies evaluated objective pain scores during extraction, and both studies reported lower pain scores in the articaine group. There is insufficient evidence to justify the statement that a single buccal infiltration of 4% articaine alone is sufficient for the extraction of primary molars. Further evidence is required to justify the claim that palatal infiltrations and IANB can be replaced with the use of 4% articaine single buccal infiltration for the extraction of primary molars in children.

Keywords: Articaine; Buccal Administration; Children; Inferior Alveolar Nerve; Lignocaine; Tooth Extraction.

INTRODUCTION

The extraction of primary molars is one of the most feared dental procedures in children. To achieve atraumatic extraction of primary molars, local anesthesia is mandatory. Local anesthesia can provoke pain and anxiety in young children, which adds more difficulty for the operating dentist. Delivering less painful local anesthesia is very beneficial as it prevents the further need for operating under general anesthesia.

Among all the injections, palatal injections and inferior alveolar nerve blocks (IANBs) are more painful, and they can immediately evoke anxiety and pain-induced negative behavior in the child. The palatal mucosa is firmly attached to the underlying bone; hence, positive pressure should be applied during administration, which can result in pain. IANB, on the other hand, is technique sensitive owing to the age-based anatomical variations, thereby affecting the success rate. Therefore, avoiding these painful injections (palatal and IANB) while achieving adequate analgesia for carrying out invasive procedures

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Table 1. Excluded studies with reasons

No	Excluded articles	Reasons for exclusion
1.	Arrow, 2012	Study was carried out in children, but pain during restorative procedures, and not extractions, was evaluated.
2.	Maruthingal, 2015	Study was carried out in adults
3.	Zain, 2016	Study was carried out in adults
4.	Majid, 2018	Study was carried out in adults
5.	Bataineh, 2019	Study was carried out in adults
6.	Kumar, 2019	Study was carried out in adults
7.	Sandilya, 2019	Study was carried out in adults
8.	Jorgenson, 2019	Study was conducted on permanent molars in children

atraumatically can be beneficial to the children and the dentist.

Since its adoption into dentistry, articaine has been claimed to have superior diffusion due to the presence of the thiopentene ring, which improves lipid solubility. Several studies involving adult subjects have reported lower procedural pain during the extraction of maxillary molars using a single buccal infiltration of 4% articaine without the need for additional palatal injection [1-9]. Other studies involving adult subjects have also reported that a single buccal infiltration of 4% articaine is equipotent to IANB with 2% lignocaine in reducing procedural pain during the extraction of permanent mandibular molars [10,11].

To the best of our knowledge, no systematic review has evaluated the efficacy of a single buccal infiltration of 4% articaine for reducing procedural pain during the extraction of primary molars (maxillary and mandibular) in children. The current systematic review aims to determine whether the exclusion of palatal injections and IANBs is possible with a single buccal infiltration of 4% articaine for the extraction of primary molars (maxillary and mandibular) in children.

METHODS

Protocol: The current systematic review is registered under PROSPERO (Acknowledgment ID: 198994), and it followed the PRISMA guidelines for reporting. ***Eligibility criteria:*** The search strategy was based on the Population Intervention Comparison Outcome (PICO) framework to address the following question ***"Can a single buccal infiltration with articaine provide sufficient analgesia for the extraction of primary molars in children".*** The PICO search strategy of the systematic review can be broken down as follows: [P] population: children; [I] intervention: buccal infiltration of articaine; [C] comparison: buccal infiltration of lignocaine, buccal and palatal infiltration of lignocaine, buccal and lingual infiltration of lignocaine, IANB with lignocaine; [O] outcome of interest: sufficiency of analgesia for carrying out the extraction of primary molars.

An electronic search was performed on three databases: PubMed, Ovid SP, and Cochrane. Studies published between 1990 and 2020 were included in the search. The last search was performed on 10 May 2020. Articles published in English are only included. The search was based on the pre-specified question using relevant MeSH terms: ((buccal) AND (articaine)) AND (dental).

Eligibility criteria: Clinical trials that compared a single buccal infiltration of articaine with that of lignocaine or buccal and palatal infiltration of lignocaine or buccal and lingual infiltration of lignocaine or IANB with lignocaine for inducing adequate anesthesia to facilitate the extraction of primary molars in children were evaluated. Comparative studies, technical notes, case reports, narrative reviews, and systematic reviews and articles that could not be translated into English were excluded. Initially, studies retrieved after a comprehensive search using MeSH terms were imported to Zotero (www.zotero.org) from all the databases, and the exclusion of duplicates was performed followed by the screening of titles and abstracts. Potential articles were

Table 2. Characteristics of Included studies

No	Author-year	Study design	Sample characte-ristics	Intervention	Comparison	Topical anesthesia & needle gauge	Extraction	Subjective pain reported during extraction of primary molars	Objective pain reported during extraction of primary molars	Other physiological parameters evaluated
1.	Mittal et al. 2015 [20]	Rando-mized double-blind design.	102 children 5-12 years Divided into two groups of 51 each	Single buccal infiltration with 1.7 ml of 4% articaine + epinephrine 1:100,000	Buccal infiltration using 1.8 ml of 2% lidocaine + epinephrine 1:80,000	30 gauge needle Topical Lignocaine spray was used.	Maxillary primary molars	The FPS values (mean ± standard deviation) were found to be higher in the lidocaine group versus the articaine group (1.88 ± 1.688 versus 1.31 ± 1.13), but the difference was not statistically significant. (P > 0.05).	Objective pain evaluated with the Modified Behavioural Pain Scale (MBPS). Using the MBPS for parameters such as eye squeezing, hand movement, leg movement, articaine presented significantly lower pain scores in comparison with lignocaine (P = 0.15; P = 0.03; P = 0.46). However, using the MBPS for parameters such as torso movement and crying, no significant difference between the articaine and lignocaine groups was observed (P = 0.135; P = 0.248).	Blood pressure was also evaluated in this study. There was no significant difference between the systolic and diastolic blood pressures of the articaine and lignocaine groups (P > 0.05).
2.	Kolli et al. 2017 [16]	Rando-mized control trial.	90 children 6-14 years Divided into three groups of 30 each	G1: single buccal infiltration of 1.7 ml of 4% articaine	G2: 1.7 ml of 2% lidocaine with adrenaline 1:80,000 buccally (1.5 ml) and palatally (0.2 ml) G3: single buccal infiltration of 1.7 ml of 2% lidocaine with adrenaline 1:80,000	27-gauge Needle Topical benzocaine spray.	Maxillary primary molars	The FPS values (mean ± standard deviation) were found to be significantly higher in the lidocaine single buccal infiltration group (2.67 ± 1.91) and conventional buccal + palatal group (1.20 ± 1.34) in comparison to articaine single buccal infiltration group (0.73 ± 1.1).	The FLACC values (mean ± standard deviation) were found to be significantly higher in the lidocaine single buccal infiltration group (2.17±1.46), and conventional buccal + palatal group (1.27 ± 1.28) in comparison to articaine single buccal infiltration group (0.80 ± 0.84).	Heart rate was evaluated before, during, and after extraction. There was no significant difference between the mean heart rates of the three groups. During extraction, heart rate values (mean±standard deviation) were (100.93 ± 14.5) for single buccal Infiltration of articaine, (93.57 ± 14.20) for buccal + palatal lignocaine (94.47 ± 12.74)
3.	Alzahrani 2018 [12]	Rando-mized control trial.	98 children 5-9 years old. Divided into two groups.	Single buccal infiltration with 2.2 ml of 4% articaine + epinephrine 1:100,000	Inferior alveolar nerve block with 2% lignocaine.	Not mentioned	Mandibular primary molars	During treatment, success was measured with the Wong-Baker Faces Pain Scale. No significant difference between the success rates was observed with the WB-FPS: 70.8% and 67.3% for articaine and lidocaine, respectively. P = 0.367	No subjective parameter was evaluated during treatment VAS (visual analog scale) was evaluated during injection, not during extraction.	Not evaluated
4.	Rathi 2019 [21]	Rando-mized control trial.	100 children 7-12 years divided into two groups	Single buccal infiltration using 1.7-ml of 4% articaine with epinephrine 1:100,000	1.8-mL of 2% lignocaine with epinephrine 1:80,000 Buccal + palatal/lingual	30-gauge needle Benzocaine topical anesthesia was used	Both maxillary and mandibular primary molars	The FPS values (mean ± SD) were lower in the articaine single buccal infiltration group (1.52 ± 1.64) than in the lidocaine single buccal infiltration group (5.6 ± 1.8), and the difference was statistically significant (P < 0.05)	Not evaluated	The difference (mean ± SD) between the heart rate recorded before and during the intervention in the articaine group was (3.08 ± 6.12), while of the lidocaine group was (8.12 ± 19.21), and they were statistically significant (P ≤ 0.05)

5.	Massignan 2020 [19]	Randomized triple-blind control trial	43 children 6-10 years	Single buccal infiltration using 1.8 mL of 4% articaine with epinephrine 1:100,000	Single buccal infiltration of 1.8 ml of 2% lidocaine with adrenaline 1:100,000	30 Gauge needle Benzocaine topical anesthesia used.	Both maxillary and mandibular primary molars	Using the visual analog scale, the children rated their experience during the tooth extraction: 7.45 ± 4.23 in the lignocaine single buccal infiltration group and 6.07 ± 4.57 in the articaine single buccal infiltration group with no statistically significant difference (P = 0.20). During extraction, there was no significant difference between lignocaine single buccal infiltration group and articaine single buccal infiltration group (values not mentioned in Table). Injection pain was reported to be significantly higher for the articaine group than the lignocaine group	-	Not evaluated.

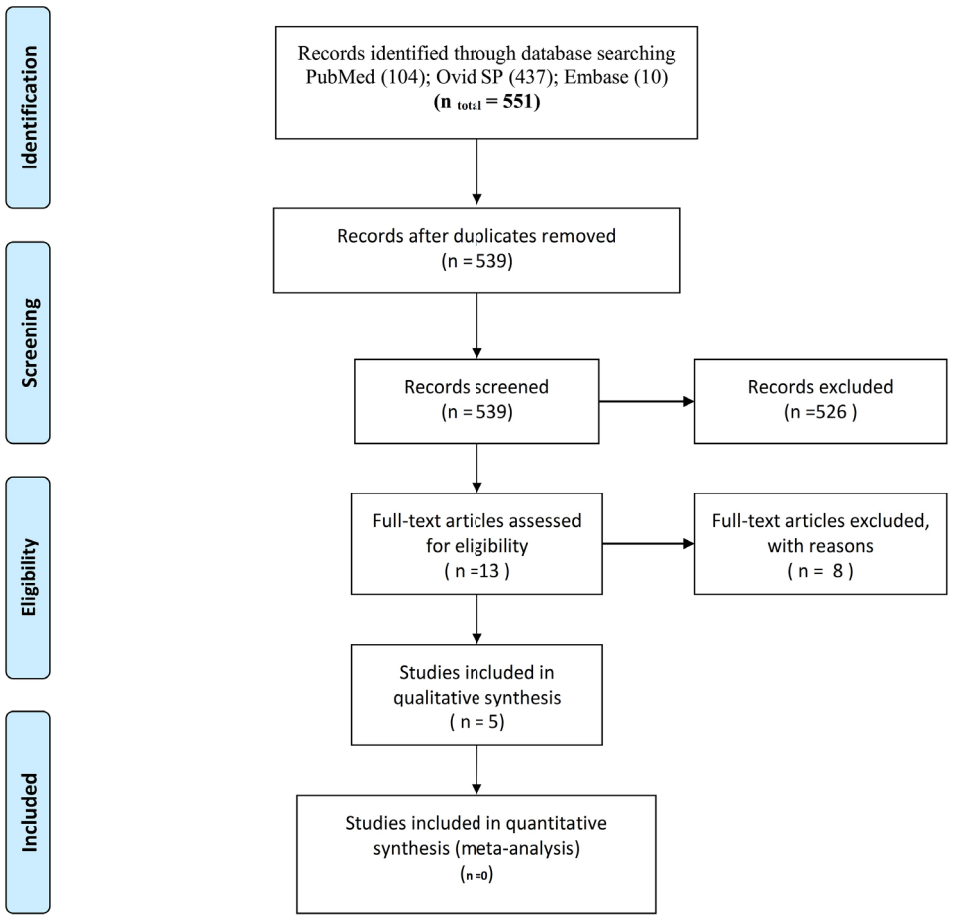

Fig. 1. PRISMA 2009 flow diagram

included for a full-text review.

The data were analyzed by two independent reviewers and recorded using excel. The data form had fields for the following information: author names and year of

publication, study design, number of participants, age, intervention, control, and outcome. The outcome sought was "pain during extraction between intervention and comparison groups." Only a qualitative data analysis was carried out.

Risk-of bias (RoB) assessment: Seven parameters, including random sequence generation, concealment of allocation, blinding of subjects (participants and personnel), blinding of the evaluator (person assessing the outcome), completeness of outcome data, selective reporting of outcomes, and bias due to other sources were evaluated independently by two review team members using the Cochrane Collaboration criteria. If one or more parameters had a high risk of bias for a given study, it was categorized as having a high overall risk of bias. Studies with low bias risks for all the seven mentioned parameters were marked as having low overall risks of bias. Each of the included studies was separately classified as having a low or high overall risk of bias by two reviewers, and a consensus was reached by comparing both reviewer scores.

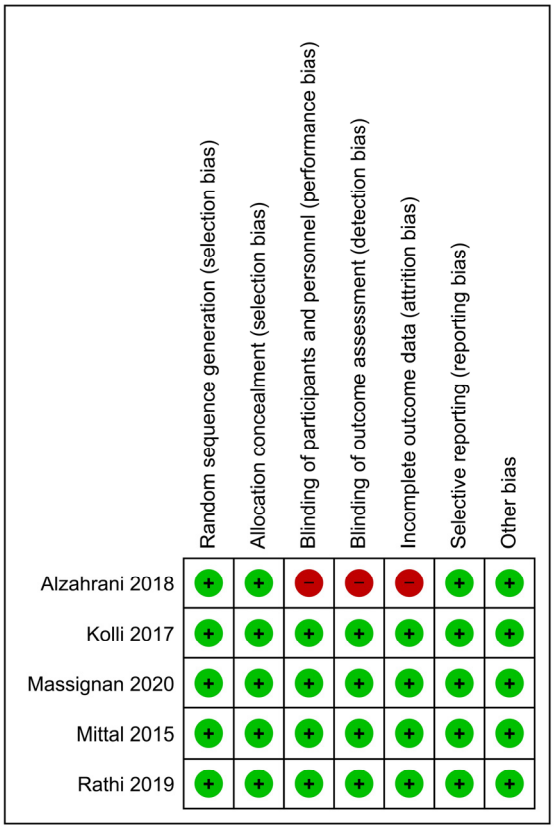

Fig. 2. Risk of bias summary

RESULTS

The initial search using the MeSH terms revealed 551 articles, of which 12 were duplicates. Screening of titles and abstracts was carried out on the remaining 539 articles (after the duplicate removal). The full texts of the 13 potentially relevant papers were evaluated [6,8, 12-22], and 8 of them were excluded [6,8,13-15,17,18, 22]; the reasons for exclusion are presented in Table 1. Therefore, five studies were included in this final systematic review [12,16,19-21] (Fig. 1).

Characteristics of included studies: Table 2 presents the characteristics of the included studies. The five included studies were published between 2015 and 2020. All the studies were randomized control trials, and they involved children. The ages of the children enrolled in the included studies ranged from 5 to 14 years.

Risk of Bias: The risk of bias (Fig. 2) of each study was evaluated following the Cochrane guidelines. Randomization and allocation concealment were carried out in all the five studies [12,16,19-21]. The blinding of participants, personnel, and observers were carried out in all the studies, except in the study by Alzahrani et al. [12]. Attrition bias was observed only in the study by Alzahrani et al. [12]; the remaining four studies were free of attrition bias [16,19-21]. Reporting bias was not observed in any of the included studies [12,16,19-21].

DISCUSSION

All the five included studies were randomized control trials, except the study by Alzahrani et al. [12], where only the patients were blinded. The studies by Rathi et al. [21] and Mittal et al. [20] followed the double-blind design. The triple-blind design was followed in the studies by Kolli et al. [16] and Massignan et al. [19].

The age of the children enrolled in the included studies ranged from 5 to 14 years.

This systematic review involved studies comparing the single buccal infiltration with 4% articaine to any of the following comparison groups: a) single buccal infiltration of 2% lignocaine; b) buccal and palatal/lingual infiltration of 2% lignocaine; c) IANB with 2% lignocaine. The outcome evaluated was procedural pain during the extraction of primary molars: maxillary [16,20], mandibular [12], or both [19,21].

Comparision-1: Single buccal infiltration of 4% articaine versus single buccal infiltration of 2% lignocaine for the extraction of primary molars in children: Three studies evaluated procedural pain during the extraction of primary molars for the above-mentioned comparison (Single buccal infiltration of 4% articaine versus single buccal infiltration of 2% lignocaine) [16,19,20]. Of these three studies, two (Mittal et al. [20] and Kolli et al. [16]) evaluated procedural pain during the extraction of primary maxillary molars only [16,20]. The study by Massignain et al. [19] evaluated procedural pain during the extraction of both mandibular and maxillary primary molars. Procedural pain during extraction (subjective score/child-reported): Child-reported scores of pain were evaluated during extractions in all the three above-entioned studies. The scales of measurement were the Faces Pain Scale (FPS) used in the studies by Mittal et al. [20] and Kolli et al. [16] and the Visual Analog Scale (VAS) in the study by Massignan et al. [19]. In the studies by Mittal et al. [20] and Massignain et al. [19], there was no significant difference in the self-reported pain scores of the children in both groups (single buccal infiltration of 4% articaine group, single buccal infiltration of 2% lignocaine group): Mittal et al. [20] FPS scores: articaine, 1.31 ± 1.13, lignocaine, 1.88 ± 1.68, $P > 0.05$; Massignain et al. [19] VAS score: articaine, 6.07 ± 4.57, lignocaine, 7.45 ± 4.23, $P = 0.20$ [19,20]. The study by Kolli et al. [16] reported significantly lower child-reported pain scores (FPS) for the single buccal infiltration of 4% articaine group than for the single buccal infiltration of 2% lignocaine group (Kolli et al. FPS score: articaine, 0.73 ± 1.1, lignocaine, 2.67 ± 1.91, $P > 0.05$) [16]. Procedural pain reaction during extraction (observer-reported pain response): of the three studies that compared the single buccal infiltration of 4% articaine with the single buccal infiltration of 2% lignocaine, only two evaluated objective pain scores [16,20]. Pain reaction in the study by Mittal et al. [20] was evaluated using the Modified Behaviour Pain Scale (MBPS) scores for parameters such as eye squeezing, hand movement, and leg movement. The articaine group had significantly lower pain scores than the lignocaine group ($P = 0.15$; $P = 0.03$; $P = 0.46$). However, for parameters such as torso movement and crying, there was no significant difference between the outcomes for articaine and lignocaine ($P = 0.135$; $P = 0.248$) [20]. The Face, Legs, Arms, Cry, Consolability (FLACC) scale was used in the study by Kolli et al. [16] to evaluate pain behavior during extraction. The FLACC values were significantly lower for the single buccal infiltration with 4% articaine (0.80 ± 0.84) than for the single buccal infiltration with 2% lignocaine (2.17 ± 1.46) ($P < 0.05$) [16].

Comparision-2: Single buccal infiltration of 4% articaine versus double (buccal and palatal/lingual) infiltration of 2% lignocaine for extraction of primary molars in children: Two studies evaluated procedural pain during the extraction of primary molars for the above-mentioned comparison (single buccal infiltration of 4% articaine versus double (buccal and palatal/lingual) infiltration of 2% lignocaine) [16,21]. Procedural pain during extraction (subjective score / child-reported): Both studies evaluated subjective pain during extraction using the FPS. In the study by Kolli et al. [16], only maxillary primary molars were extracted; both maxillary and mandibular primary molars were extracted in the study by Rathi et al. [21]. In both studies, the mean scores of procedural pain during extraction reported by the children were significantly lower in the single buccal infiltration of 4% articaine group than in the double infiltration of 2% lignocaine group (Kolli et al. [16] FPS score: articaine, 0.73 ± 1.1, lignocaine, 1.20 ± 1.34, $P > 0.05$; Rathi et al. [21] FPS score: articaine 1.52 ± 1.64,

lignocaine, 5.60 ± 1.80, P > 0.05) [16,21]. Procedural pain reaction during extraction (observer reported pain response): Only the study by Kolli et al. [16] evaluated the observer-reported pain scores using the FLACC scale for the above-mentioned comparison. The mean FLACC scores were significantly lower in the single buccal infiltration of 4% articaine group than in the double infiltration of 2% lignocaine group (Kolli et al. [16] FLACC score: articaine, 0.80 ± 0.84, lignocaine, 1.27 ± 1.28, P > 0.05) [16].

Comparision-3: Single buccal infiltration of 4% articaine versus inferior alveolar nerve block (IANB) with 2% lignocaine for the extraction of primary mandibular molars in children: Only the study by Alzahrani et al. [12] evaluated subjective pain for the above-mentioned comparison (single buccal infiltration of 4% articaine versus inferior alveolar nerve block (IANB) with 2% lignocaine for the extraction of primary mandibular molars in children). In this study, success or failure during extraction was measured based on the following criteria: success: FPS score of < 2; failure: FPS score of > 2. During extraction, no significant difference was observed between the success rates of the single buccal infiltration of 4% articaine and IANB with 2% lignocaine (70.8% versus 67.3%; P = 0.367) [12].

This review had limitations. The study by Alzahrani et al. [12], included in this review, has an overall high risk of bias. The treatments performed in this study were also pulp therapies and extractions, and only data related to extractions were included in the study. Instead of presenting the numerical values or scores (mean ± SD), the authors presented success and failure percentages based on their criteria (FPS ≥ 2 is Failure; FPS ≤ 2 is Success), which in our opinion may affect the validity of findings. During the extractions, observer-reported pain scores were expressed using the FRANKL behavior rating scale (which is primarily used to measure anxiety-related behavior in children); the authors could have used other valid scales, such as FLACC, Sound Eye Motor (SEM), and MBPS, for evaluation.

Even though most of the studies favor single buccal infiltration with 4% articaine for reducing procedural pain during extractions of primary molars, the evidence is insufficient to conclude on its superiority over the single buccal infiltration, double infiltration (Buccal and Palatal/Lingual), or IANB with 2% lignocaine. Further studies should be carried out in children to establish conclusions.

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AUTHOR CONTRIBUTIONS

Sunny Priyatham Tirupathi: Conceptualization, Data curation, Methodology, Resources, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing
Srinitya Rajasekhar: Writing - review & editing

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