Review

Does buccal infiltration efficacy change with articaine or lidocaine use in posterior teeth?

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Abstract

Aims Lidocaine is the local anaesthetic (LA) solution most used in the UK. Debates that articaine is safer and a more effective alternative are ongoing. This review aims to assess whether adults undergoing posterior buccal infiltrations with either 4% articaine 1:100,000 adrenaline or 2% lidocaine 1:100,000 adrenaline experience greater anaesthetic efficacy.

Methods Medline, Cochrane and Web of Science databases were searched, using key terms including lidocaine, lignocaine, articaine, carticaine, compare, versus and infiltration to collect papers for the inclusion criteria. Both authors (RP and SK) evaluated the eligibility of each trial separately before assessing risk of bias.

Results Eight randomised control trials were included. Of these, seven trials were assessed to have high risk of bias and one was deemed unclear. Consequently, the data provided weak evidence to validate the hypothesis that adults undergoing posterior buccal infiltrations with 4% articaine 1:100,000 adrenaline experience greater anaesthetic efficacy than with 2% lidocaine 1:100,000 adrenaline.

Conclusions Current studies are too ambiguous to comprehensively conclude whether articaine or lidocaine solution provides greater anaesthetic efficacy, during posterior buccal infiltrations. Stronger evidence is required, dentists should remain aware of the limitations of different anaesthetics for a patient's safety and comfort.

Abbreviations

BDJ – British Dental Journal
EPT – Electric pulp tester
GDC – General Dental Council
LA – Local anaesthetic
PICO – Participant, intervention, comparison, outcome
RCT – Randomised controlled trial
ROBVIS – Risk of bias visual
VAS – Visual analogue scale

Introduction

Both articaine and lidocaine can be delivered by buccal infiltration, a commonly used technique for most clinical scenarios. Buccal infiltrations are advantageous as they are less technique sensitive for the operator and more comfortable for the patient. Fewer complications, e.g., nerve injuries are reported when administering buccal infiltrations compared to direct nerve blocks.[1]

When choosing between local anaesthetics (LA), certain characteristics need to be accounted for in order to choose the appropriate solution to administer on a case-by-case basis. Lidocaine is comprised of an amide group that is metabolised in the liver and has a half-life of ~2 hours so is preferable for patients undergoing longer procedures. Articaine has both an amide and an ester group which allows the LA to be metabolised by plasma cholinesterase in the blood, which decreases the half-life to ~0.5 hours.[2] The shortened half-life decreases the duration of action and so is beneficial for shorter procedures. This added medium for metabolisation also decreases the toxicity of articaine, though potential nerve paraesthesia should still be carefully accounted for.[3]

However, the wide availability of LA solutions makes it challenging for dental practitioners, when deciding which anaesthetic will be most efficacious. Efficacy summarises a local anaesthetic's performance by measuring properties that indicate anaesthetic success. These include

the number of patients achieving successful anaesthesia, pain during treatment and other secondary outcomes like pain on injection and onset of anaesthesia. Pain can be qualitatively evaluated by a visual analogue scale (VAS) where patients evaluate their own pain on a linear scale or by an electric pulp tester (EPT) where patients report any sensation felt from an electric stimulus applied to a single tooth.

The earliest review comparing articaine and lidocaine indorsed 4% articaine for simple dental procedures due to greater anaesthetic success and a comparable safety profile to lignocaine.[4] This recommendation was made despite finding that articaine may marginally cause greater post-injection pain.

More recent reviews have identified that anatomical differences could influence anaesthetic selection, when infiltrating posterior teeth, as both jaws are surrounded by dense cortical bone that could impede a local anaesthetic's diffusion.[5] Therefore, an ideal property of a local anaesthetic solution would be the ability to overcome this and provide a safe, reliable numbing effect.

There was a publication in the British Dental Journal (BDJ) in September 2020[6] indicating the need for this article. The current review aims to provide strong evidence as only randomised control trials will be used and a risk of bias will be generated for all included studies.

> *This systematic review aims to assimilate findings to advance best practice and answer the Participant, Intervention, Comparison, Outcome (PICO) question, 'In posterior buccal infiltrations, does 4% articaine or 2% lidocaine have greater anaesthetic efficacy?' (**Figure 1**).*

P Participant	Adult dental patients undergoing Buccal infiltrations in posterior teeth
I Intervention	4% articaine with 1:100,000 adrenaline
C Comparison	2% lidocaine with 1:100,000 adrenaline
O Outcome	Anaesthesia efficacy

Figure 1. The PICO question answered in this review.

Methods

Three databases were searched on the 17th of June 2020, including Medline (on OvidSP), Cochrane Library and Web of Science: Core Collection. These databases evaluated material from the following dates: 1946-present (Medline on Ovid), 1900 to present (Web of Science).

The following inclusion criteria were applied:

- Published in English.
- In adult populations (17+ years old, all genders, all ethnicities).
- On molars or premolars.
- On mandibular or maxillary teeth.
- Studies comparing 4% articaine vs 2% lidocaine (with 1:100,000 adrenaline).
- Studies using buccal infiltration as the only dental local anaesthetic technique.
- Studies undertaken for extraction, endodontic treatment, or simulated restorations.
- Randomised control trials (RCTs) and meta-analysis of RCTs were prioritised for review over observational or non-randomised studies. RCTs remain the 'gold standard' for establishing causality because they provide high-level evidence and reduced risk of bias if well conducted.

Two assessors (RP and SK) carried out the literature search, independently reviewed the inclusion criteria for papers using pre-determined data extraction tables (**Figure 2**). If discrepancies occurred, assessors would discuss until they both agreed to include or exclude the paper in question. If no agreement was reached, a project supervisor was consulted. Risk of bias was assessed in all included studies as high, some concerns or low, using the Cochrane Risk of Bias (ROBVIS) tool.[7]

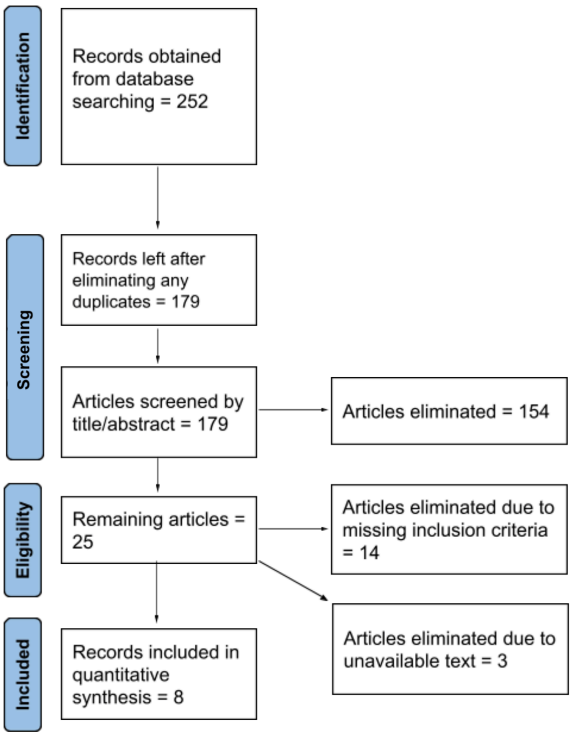

Figure 2. Search strategy PRISMA flowchart.

Results

Eight RCTs comparing the anaesthetic efficacy of articaine and lidocaine were included.[8-15] Bias detected included failure to blind study personnel, incomplete outcome data and selective reporting (**Figure 3**). All studies examined the proportion of patients experiencing sufficient analgesia in both lidocaine and articaine groups, which was performed using electric pulp testing, pinprick test or pain during procedure. Despite consistent methodology, no EPT output or pressure on pinprick test was replicated by other studies as not all studies stated the EPT output used or the force applied when administering the pinprick test. Six studies showed that articaine successfully anaesthetised more patients than lidocaine. Whilst articaine's trend of performing better in these primary outcomes is visible, the difference in effectiveness between LAs and the number of participants used in each individual study does not correlate, making the evidence disreputable.

Other secondary outcomes were also reported, with five studies assessing pain on injection and four studies considering the time to onset of anaesthesia. Pain on injection and pain during extraction was assessed using a visual analogue scale (VAS) by asking the patients to

rank their pain on a scale of 0-100mm[8,10-12] or 0-170mm.[9,14] The onset for articaine anaesthesia is between 36 seconds to 14 minutes, whilst lidocaine becomes effective within 18 seconds to 20.5 minutes. The buccal infiltrations showed no significant difference in the amount of injection pain or onset of anaesthesia, indicating that articaine and lidocaine provide a similar level of efficacy.[8-12,14] Therefore, discomfort is unlikely to play as large a factor as primary outcomes when choosing a local anaesthetic.

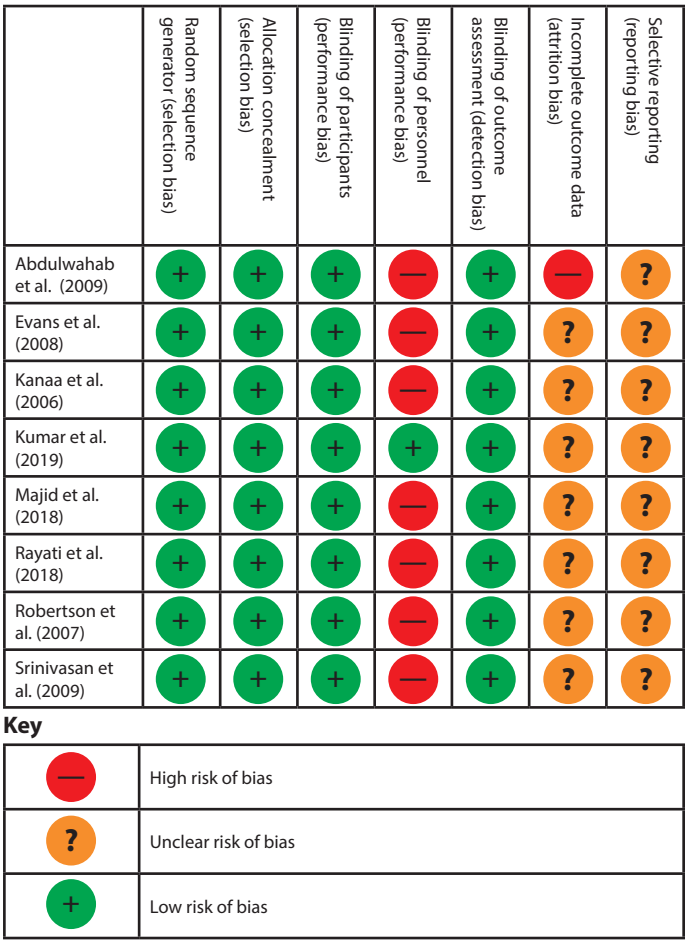

Figure 3. Risk of bias table based on Cochrane risk of bias (ROBVIS).[4]

There were heterogeneous results for pain during dental extraction and electric pulp testing with six studies showing a trend of better anaesthetisation with articaine[8,10-11,13-15] and two studies showing a similar proportion of patients successfully numb from both LAs assessed.[9,12] Two results from the VAS scale for extracting posterior teeth were also shown to be heterogeneous,[11,12] however results from VAS on injecting were shown to be more homogenous in the studies reviewed.[8-10,12,14] Therefore, no conclusions could be made as to the anaesthetic efficacy in any of these studies (**Table 1**). Injections are technique sensitive, and results varied greatly between the studies. The percentage of patients receiving successful anaesthesia with articaine ranged between 25-100% and 2-86% with lidocaine. These large, overlapping data spans (mainly without p values or confidence intervals) indicate that current studies do not corroborate, and the discrepancy is too great to form an absolute conclusion on efficacy.

Discussion

> *Regardless of clear methodology, injection technique varies between practitioners and the observed studies are unlikely to be generalisable to the wider population because of this.*

Furthermore, the clinical trials in this review reported small sample sizes and therefore may not be representative and could be underpowered, particularly for secondary outcomes. The age of participants in the studies ranged from 17-65 years old. Despite this broad age range, it is impossible to assess the efficacy for that of the elderly or paediatric population from this review. A search for available literature yielded no reviews on efficacy investigated across an extreme range of ages and therefore there is need for further study on this complex subject. If studies choose to investigate the effect of age on local anaesthetic efficacy, they will likely have to consider polypharmacy, comorbidities and the porosity, density, and maturity of bone.

One study used topical anaesthetic gel with each injection. While this may reduce pain and improve patient experience, it could confound effects seen from injectable solutions alone. Dentists may consider using topical LA for patient comfort which is paramount in the GDC's standards (principle 1.2.4.). All dentists should manage patients' dental pain and anxiety appropriately. Whilst not always required for operative procedures, this individual study applying topical anaesthetic complicates the debate. The results due to the inclusion of topical anaesthetic may conflict with those of the other reviewed studies. The data from this will not give sufficient evidence towards the effect of topical LA compared to not using topical LA. The changes to VAS, efficacy, onset, or successful anaesthesia cannot be determined due to this limited evidence.

As the eight RCTs used different methods for measuring anaesthetic efficacy (e.g., electric pulp testing versus VAS), comparison between studies was difficult and could account for the huge variability in results. Two VAS scales were used which ranged from 0-100mm and 0-170mm, which makes comparisons between these scales difficult. Results depend on the patients' perception of pain and understanding of the scale, so patients' responses to the pain cannot be calibrated and are difficult to reliably compare. In contrast EPT and pinprick pressure results could be standardised by having the same output and pressure applied respectively on each patient to assess sensitivity in the pulp. Nonetheless, direct comparisons between the solutions were formed within each study. From the limited evidence available, it appears that articaine and lidocaine perform similarly for most efficacy-based outcomes, however all included studies were deemed to be at risk of bias (**Figure 3**).

Conclusion In conclusion, this review closes the gap on recent evidence and largely agrees with existing literature.

> *Insufficient evidence exists to conclusively answer the question of whether 4% articaine (1:100 000 adrenaline) or 2% lidocaine (1:100000 adrenaline) provides greater efficacy during dental treatment in posterior teeth.*

Therefore, this review cannot recommend either solution and further research is required. Ideally this would involve larger RCTs with better external validity or perhaps split mouth trials (which are unique to dentistry), where articaine and lidocaine would be randomly assigned to the right or left side of the same patient's mouth mitigating against confounding factors. Furthermore, trials should aim to use similar outcome measurements to improve the homogeneity of data for meta-analysis.

Table 1. Summary table of included publications (and results).

Study no.	Author	Country	Design	Intervention	Vol. of solutions	Purpose	Site	Population observed	Method of assessing anaesthesia	Onset of anaesthesia (mins)	No. achieving successful anaesthesia:	VAS inject (Mean)	VAS during XLA (Mean)
1	Abdulwahab et al.[8]	USA	Randomised, doubled blinded crossover study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	0.9ml articaine/lidocaine	Pulp anaesthesia	Mandibular 1st molars	n = 18 (18 articaine/lidocaine) range of 18-53 years	EPT	14 = articaine, 8 = lidocaine (to peak anaesthesia)	7/18 = articaine, 3/18 = lidocaine	26.2mm = articaine, 27.6mm = lidocaine	
2	Evans et al.[9]	USA	Randomised, double blinded crossover study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.76ml articaine/lidocaine	Pulp anaesthesia	Maxillary 1st molars (20 left, 20 right)	n = 40 (40 articaine, 40 lidocaine) range of 18-65 years	EPT	3.3 +/- 2.35 = articaine, 3.7 +/- 2.29 = lidocaine	31/40 = articaine, 29/40 = lidocaine	44+/-29mm = articaine, 36+/-26mm = lidocaine	
3	Kanaa et al.[10]	UK	Randomised, double blinded crossover study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.8ml articaine/lidocaine	Pulp anaesthesia	Mandibular molars	n = 31 (31 articaine/lidocaine) range 20-30 years	EPT		20/31 = articaine, 12/31 = lidocaine	20.9+/-17.9mm = articaine, 17.8+/-14.9mm = lidocaine	
4	Kumar et al.[11]	India	Randomised, triple blinded parallel study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.8ml articaine/lidocaine	XLA	Maxillary 1st molars	n = 100 (50 articaine/lidocaine) range 18-60 years	Rescue injections if unanaesthetised	<5 for buccal, <5 for palatal in 44/50 = articaine, 21/50 = lidocaine	44/50 = articaine, 21/50 = lidocaine (Required no additional injections)		35.23mm = articaine, 65.77mm = lidocaine
5	Majid et al.[12]	Iraq	Randomised, double blinded parallel study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.8ml articaine, 3.6ml lidocaine	XLA	Maxillary molars	n = 84 (28 articaine/lidocaine) range of 17-60 years	Pinprick Test		24/28 = articaine, 24/28 = lidocaine	35 +/- 11mm = articaine, 36+/-10mm = lidocaine	18 +/- 7mm = articaine, 22+/- 10mm = lidocaine
6	Rayati et al.[13]	Iran	Randomised, double blinded parallel study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.8ml articaine/lidocaine	XLA	Mandibular molars	n = 133 (72 articaine, 61 lidocaine) range of 20-60 years	Pinprick Test followed by soft tissue dissection		18/72 = articaine, 1/61 = lidocaine		
7	Robertson et al. [14]	USA	Randomised, double blinded crossover study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.76ml articaine/lidocaine	Pulp anaesthesia	Mandibular molars and premolars	n = 60 (60 articaine/lidocaine) range of 18-60 years	EPT	1st premolar 4.7 +/- 2.4, 2nd premolar 4.3 +/- 2.3, 1st molar 4.2 +/- 3.1, 2nd molar 4.6 +/- 4.0 = articaine, 1st premolar 6.1 +/- 3.1, 2nd premolar 6.9 +/- 6.6, 1st molar 7.7 +/- 4.3, 2nd molar 11.1 +/- 9.5 = lidocaine	1st premolar 49/57, 2nd premolar 55/60, 1st molar 52/60, 2nd molar 45/60 = articaine 1st premolar 35/57, 2nd premolar 40/60, 1st molar 34/60, 2nd molar 27/60 = lidocaine	36+/-30mm = articaine, 37+/-36mm = lidocaine	
8	Srinivasan et al.[15]	India	Randomised, double blinded parallel study	4% articaine, 2% lidocaine (1:100,000 adrenaline)	1.7ml articaine/lidocaine	Endodontic access	Maxillary 1st molars and premolars	n = 40 (20 articaine/lidocaine) range of 18-40 years	Pain from access cavity		1st premolar 10/10, 1st molar 10/10 = articaine, 1st premolar 8/10, 1st molar 3/10 = lidocaine		

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