# Clinical opinion - modern dental anaesthesia

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Working full-time in clinical endodontics I would estimate that approximately 9 out of 10 cases I treat are non-vital teeth, the remainder being the dreaded so-called 'hot pulps' of irreversible pulpitis. The differences between these two types of case in terms of the requisite local anaesthesia (LA) for access cavity preparation could not be more different. In fact the owners of the necrotic pulps often ask me what "that machine" (the Electronic Apex Locator) beeping in the background does, implying that their dentist skip LA injections for root-treatments; an "ouch" from the patient in response to a file tip boring into the alveolus seemingly indicates canal patency and working length! I don't follow this practice and advocate effective pre-operative local anaesthesia for all endodontic procedures to minimise post-operative pain long after the pharmacologic effect of the drug has worn off.[1] As for the hot pulps - I am normally asked to manage these because of the "ouch" persisting despite concerted attempts at LA; the dreaded missed inferior alveolar dental nerve (IADN) block.

Failing to achieve sufficiently profound local anaesthesia can be dispiriting, but is not particularly rare. In 1984 Kaufman et al[2] reported over a 5-day period that 13% of general dental practitioners experienced a failure of local anaesthesia meaning that 10% of treatments had to be abandoned. The most commonly reported 'miss' being the failed IADN blocks. Failed IADN (lidocaine) blocks in patients with irreversible pulpitis were even more common (32%) as reported in a more recent UK study.[3]

When considering local anaesthesia, like all clinicians, I will select an anaesthetic agent and injection technique.

## Anaesthetic agent

My own preferred agent is an articaine 4% preparation with adrenaline 1:100,000, having recently left behind my previous standard: lidocaine 2% preparation with adrenaline 1:80,000. I say "preferred" because whilst I do not cancel patients if we have run out, I will always reach for the gold ampoules given the choice. This preference is based on a mixture of my past experiences and the available evidence. Whilst it would be difficult to effectively share my past clinical experiences in any meaningful way here, I shall try to distil some of the recently published evidence.

When confronted with any new evidence from the dental literature it is necessary to consider its provenance. The methodology of any study can influence its quality and so it is worth bearing in mind the likely strength of the evidence[4], for example results from a well-designed Randomised Controlled Trial (RCT) can be a more robust method for determining true effect than authors' opinions following case-reports. Where possible it is appropriate to base clinical decision making on the highest quality evidence possible but without blindly overemphasising methodology to the exclusion of all evidence not derived from RCTs.[5] This is a concept that will be revisited to help inform the argument on the safety of articaine use in dentistry.

Articaine preparations for dental use were first introduced in Germany in 1976, the United Kingdom in 1998 and the United States in 2003. An excellent detailed review on articaine was published in the BDJ in 2011 by Yapp[6] which concluded articaine to be "a safe and effective local anaesthetic drug to use in all aspects of clinical dentistry for patients of all ages, with properties comparable to other common local

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anaesthetic agents."

A 2010 systematic review[7] on the efficacy and safety of articaine in dental use yielded a meta-analysis - a powerful statistical tool for distilling evidence - and the pooled data from nine separate clinical trials concluded that articaine was superior to lignocaine in anaesthetic efficacy in the first molar region and just as safe a drug. Dr John Meechan, the UK Chairman of the Dental Directorate Drug and Therapeutics committee, commented on this analysis urging caution that the lack of a universally accepted outcome measure adopted among these nine studies to indicate 'successful local anaesthesia' will have affected the robustness of the findings on the efficacy (but not safety) of articaine.[8]

A quick Pub Med search of the literature shows that the purported safety issue regarding dental use of articaine, in which articaine has been suggested to be neurotoxic, has been raised in some occasional dental case reports authored or co-authored by Haas.[9-14] Yet in the fields of ophthalmological surgery and surgery of the hand and foot, where articaine use is widespread and long-standing, there is not a single reported case of paraesthesia. The sporadic dental publications suggest an increased risk of paraesthesia of the lingual nerve following articaine use for IDN blocks but do not explain why - if the drug were neurotoxic - does it not affect all nerves equally? It seems that the lingual nerve, structurally similar to other peripheral nerves throughout the body, is most often affected by articaine and only during the IANB approach. It is difficult to accept that articaine per se is harmful when there is a worldwide scarcity of reports linking paraesthesia with articaine use in Gow-Gates mandibular nerve block, incisive/mental nerve block, or maxillary injections, be they infiltration or nerve blocks.[15]

The retrospective studies suggesting an increased risk of neurotoxicity with articaine are biased from a patient recruitment perspective terms and not the high levels of evidence preferred when making definitive clinical recommendations. Mere correlation doesn't prove effect and whilst Yapp[6] called for further RCTs on articaines to determine whether any increase in paraesthesia is attributable to articaine, Haas[11] concedes that "it would take an unrealistically large trial or cohort to detect statistically significant differences for an event as rare as nonsurgical paraesthesia".

Since it is unlikely that any strong evidence will be forthcoming soon, or ever, linking articaine use in dentistry with any negative effects, I expect that articaine 4% will continue to be chosen and used without any side effects over and above those realistically expected from use of any alternative local anaesthetic agent or preparation to great effect by many clinicians.

Leaving safety aside and considering instead the publications on the efficacy of articaine injection techniques, there is a weight of evidence from well-designed studies demonstrating articaine's benefits - particularly in instances when a lidocaine IADN block has failed.

## Injection technique

The common local infiltration and regional block injections, familiar to all Dentists, work in the majority of instances but, as mentioned earlier, the IADN can fail to anesthetise clinically normal pulps and this rate of failure is around 8 times higher with inflamed pulps[16]. Detailed explanations as to why inflamed pulps are more resistant to local anaesthetic are beyond the scope of this article but in brief

- Once deposited, the LA drug in solution establishes equilibrium between positively charged (dissociated) ionic form and uncharged molecular form. Inflammation reduces tissue pH, maintaining a greater proportion of LA in the dissociated form, unable to cross the lipid nerve membrane to exert its effect in the way the molecular form can.
- The increased blood flow through inflamed tissues clear the deposited drug from point of need more quickly.
- LA binds to sodium channels on pain nerve (nociceptors) membranes; inactivating them. These 'paralysed' nerves cannot initiate or propagate nerve firing = anaesthesia. When tissues are inflamed, nociceptor membranes preferentially express slightly different sodium channels that require more lidocaine to be rendered inactive.
- Some of the chemicals released in inflamed tissues cause a reduction in the threshold necessary for nociceptor firing meaning more nerves in a greater area require blocking.

Once a block has failed one has the choice to abandon treatment (as per Kaufman, 1984 2) or to make further attempts at achieving LA. This can be another attempt at the (missed) IADN block or by one of the supplementary routes to local anaesthesia described by Meechan[17]. The most prevalent of these being an intra-osseous injection or intra-ligamentary injection. A recent study has looked at the efficacy of these choices, as well as a buccal infiltration of articaine, in just this situation[3]. Clinicians familiar with Albert Einstein's definition of insanity ("Insanity: doing the same thing over and over again and expecting different results.") won't be surprised to hear that the most effective LA strategy following a missed lidocaine IADN block is not another attempt at a lidocaine IADN block. This option performed

poorest rendering only 32% of symptomatic pulps numb. The best option was the buccal infiltration of articaine which rescued the situation in 82% of cases, outperforming intra-osseous (68%) and intra-ligamentary (48%) approaches. This ability of articaine, infiltrated buccal to an irreversibly pulpitic tooth, in allowing continuation of endodontic access cavity preparation in most cases where a lidocaine IADN block has failed was also shown by Matthews.[18]

I am not aware that this practice (of infiltrating articaine buccal to mandibular teeth) is widespread but its performance in recent well-designed studies seems set to change that. A buccal infiltration of articaine alone performed as well as IADN blocks with lidocaine[19] and IADN blocks with articaine[20] in achieving pulpal anesthesia in healthy volunteers. Separate studies, also in healthy volunteers, demonstrated that lidocaine IANB injections supplemented with buccal infiltrations of articaine were significantly more successful than the IANB alone[21] or when supplemented instead with buccal lidocaine for pulpal anaesthesia in mandibular teeth.[22]

When all else has failed, another supplementary route to local anaesthesia that I find useful is the intra-pulpal injection. In the absence of profound anaesthesia, if the patient is able to tolerate access cavity preparation until such a time as a small hole into the pulp chamber can be made - pressurised deposition of local anaesthetic into the pulp chamber brings about almost instantaneous anaesthesia. It is interesting to note that this effect seems to be more mechanical than pharmacological since saline performed equally as well as lidocaine.[23]

## Conclusion

Simply loading a 4% articaine cartridge into a syringe does not guarantee profound anaesthesia but it is a genuinely different agent to other amide LA (lignocaine, prilocaine). I use it routinely but find it invaluable in certain clinical situations such as 'hot pulps' where a greater lipid solubility means more of the administered dose can enter neurons[24] by virtue of its molecular structure and a lower systemic toxicity of the drug allows articaine use in concentrations higher than other amide LAs.[25]

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