

Effective anaesthesia of the acutely inflamed pulp: part 2. Clinical strategies

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VERIFIABLE CPD PAPER

IN BRIEF

- Discusses the success rates of conventional local anaesthetic techniques when applied to the acutely inflamed pulp.
- Outlines a staged approach that helps increase success rates of attaining pulpal anaesthesia in the acutely inflamed mandibular molar.
- Discusses key variables (ie solutions, techniques, volume etc) that influence anaesthetic efficacy.

Achieving profound pulpal anaesthesia in a mandibular molar diagnosed with irreversible pulpitis can be argued to be the most testing of dental anaesthetic challenges. Following discussion on the possible reasons for this occurrence in part 1, part 2 outlines the various local anaesthetic techniques that practitioners can use to overcome the acutely inflamed mandibular molar. They should then be able to apply these same principles to help anaesthetise any other tooth presenting with an acutely inflamed pulp. Techniques are discussed in detail along with key variables that have been associated with having an impact on the anaesthetic efficacy. This is to bring to light factors that can aid anaesthetic success as well as dispel common misnomers.

INTRODUCTION

Difficulties in effectively anaesthetising an acutely inflamed mandibular molar (AIMM) are well documented. Conventional local anaesthetic techniques have shown to be unpredictable and sometimes ineffective, with success rates ranging between 20-50%.¹⁻⁶ Part 1 outlined the clinical presentation and pathophysiology of an acutely inflamed pulp (AIP), defined what it meant to achieve pulpal anaesthesia and critically analysed theories as to why these teeth are more difficult to anaesthetise than their healthy counterparts. This section expands upon this by reviewing literature and drawing upon anecdotal experiences to outline a staged approach for attaining clinically acceptable pulpal anaesthesia in the AIMM (Fig. 1). Practitioners should then be able to apply these same principles to anaesthetising any other tooth presenting with an AIP.

STEP ONE

a) Inferior alveolar nerve block with lingual block

As the first point of anaesthesia, an inferior alveolar nerve block (IANB) should be

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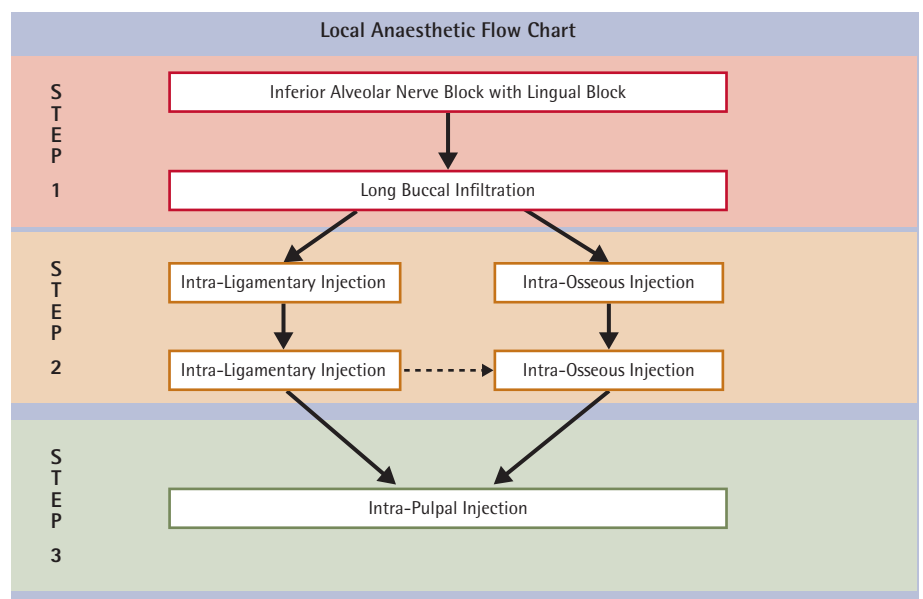


Fig. 1 Flow chart outlining a systematic approach for anaesthetising a acutely inflamed mandibular molar

administered as infiltration techniques alone do not provide a sufficient degree of anaesthesia.^{7,8} This dental block technique is the commonest, but arguably, the most difficult and it anaesthetises tissues receiving sensory innervation from the inferior alveolar nerve (IAN). These are ipsilateral to the side of administration and include all mandibular teeth up to the midline, the buccal mucosa anterior to the first molar, and the skin and mucosa of the lower lip and chin (Fig. 2).⁹

Technique

1. Outline anatomical landmarks

Use the thumb to intra-orally palpate the deepest portion of the coronoid notch on the

external oblique ridge (EOR). Simultaneously, place the index finger extra-orally in the indentation above the angle of the mandible. The maximum concavity of the coronoid notch corresponds to the height of the mandibular foramen and the distance between digits indicates its anteroposterior position.⁹ From this position, slide the thumb medially to palpate the internal oblique ridge (IOR) keeping a mental note of its position. Then slide it back to the coronoid notch on the EOR, stretching tissues taut and exposing the pterygomandibular depression (Fig. 3).

2. Insert needle

Direct the barrel across the occlusal plane of the contralateral premolars and insert a

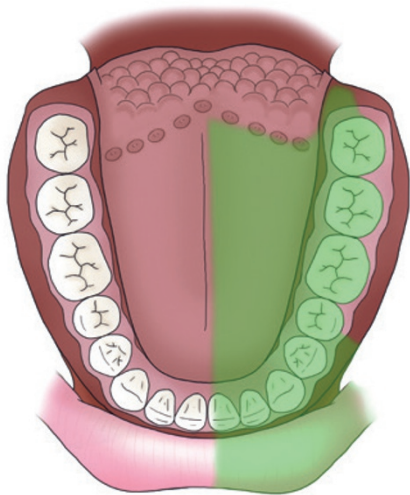


Fig. 2 Zone of anaesthesia achieved from an IANB with Lingual Block



Fig. 3 IANB: outline key anatomical landmarks. 1) pterygomandibular raphe, 2) external oblique ridge 3) coronoid notch



Fig. 4 IANB: needle entry point



Fig. 5 IANB: lingual block on withdrawal of needle

27 gauge long needle into the mucosa medial to the IOR and lateral to the pterygomandibular raphe (Fig. 4). The height should coincide with the midpoint of the thumb and the anteroposterior distance slightly more than half way posteriorly between the digits.⁹ After advancing 20-25 mm, the needle should contact mandibular bone behind the lingula and above the mandibular foramen. Premature contact warrants repositioning and similarly, if the needle is placed too far posteriorly repositioning is advised to avoid inducing transient facial nerve palsy.

3. Aspirate syringe

Aspirate after withdrawing a few millimetres and if positive (that is, blood is seen entering into syringe) the needle must be repositioned and re-aspirated until a negative result is attained.

4. Deposit anaesthetic solution

When the needle is at the correct depth, height and there is no blood on aspiration, the anaesthetic should be deposited over the course of 30-60 seconds into the pterygomandibular space. Continuing to inject and straightening the needle on withdrawal to make it parallel to the medial aspect of the ramus, will anaesthetise the lingual nerve which runs anterior and parallel to the IAN (Fig. 5).⁹ This results in further anaesthesia to the lingual mucosa, anterior two-thirds of the tongue and the floor of mouth.⁹

Key variables

• Anaesthetic solution

Numerous clinical trials have failed to demonstrate any clinical superiority in efficacy of articaine 4%, prilocaine 4% or mepivocaine 3% preparations, in healthy and AIMMs, over lidocaine 2% preparations when administered via an IANB.^{1,10-12} However, despite the controversy surrounding the safety of 4% anaesthetic solutions (that is, articaine 4% and prilocaine 4%), there is no conclusive scientific evidence to support that they exhibit any more neurotoxicity than lidocaine 2%.^{13,14} Therefore although safe, their use over lidocaine 2% would provide no clinical advantage for the IANB technique.¹⁴ Research has yet to detail the impact of different vasoconstrictor concentrations on IANB success rates.

• Volume

A recent systematic review, containing 319 patients, concluded there was no significant difference in success when administering 1.8 ml or 3.6 ml of lidocaine 2% to AIMMs.¹⁵ Neither provided an acceptable degree of pulpal anaesthesia, therefore, repeat injections would provide no benefit.¹⁵

• Technique

The limited evidence comparing the anaesthetic efficacy of alternative techniques, such as Gow-Gates and Vazirani-Akinosi

techniques, on AIMMs have demonstrated that although they may provide marginally higher success rates over the conventional method, clinically acceptable rates of pulpal anaesthesia are still not achieved.¹⁶⁻¹⁸ For further details on these techniques please refer to Netter's head and neck anatomy for dentistry.⁹

• Mandibular foramen position

The commonest position of the mandibular foramen has been reported to be within the third quadrant of the ramus in both anterior-posterior and superior-inferior planes.¹⁹⁻²² This location is more posterior-inferiorly in children and more superior-anteriorly in the elderly, indicating the respective changes in the entry point of the needle.^{9,22} Furthermore, an oral panoramic radiograph can be used to determine this position in patients that may have an atypical foramen location.²³

• Speed of administration

Studies have demonstrated IANBs lasting 60 seconds are more comfortable and have higher success rates in healthy mandibular molars when compared to those lasting 15 seconds.²⁴ However, for AIMMs, the literature is conflicting as it suggests slow administration has no impact, but is still more comfortable.²⁵

Summary

- Administer an IANB.
- Continue injecting on withdrawal for lingual block.
- Use lidocaine 2% anaesthetic with vasoconstrictor.
- Deposit 1.8 ml over 60 seconds.
- Repeat IANB if soft tissue anaesthesia has not been achieved – no lip numbness.
- When completed, proceed to administer a LBI.

b) Long buccal infiltration

Due to the poor success of conventional techniques, the long buccal infiltration (LBI) is recommended to supplement all IANBs to improve success rates from 20-50%, to 60-70%.^{1-6,10,26,27} It is relatively quick and simple and anaesthetises tissues receiving sensory innervation from the long buccal branch of the mandibular division of the trigeminal nerve.⁹ This includes the mandibular molars, skin of the cheek and the buccal muco-periosteum adjacent to the mandibular molars (Fig. 6).⁹ These tissues are not anaesthetised from an IANB.

Technique

1. Outline anatomical landmarks

Using a mirror, retract the cheek so the buccal mucosa adjacent to the molars is at 90 degrees to the mandible. This will keep the tissues taught and give a clear view of

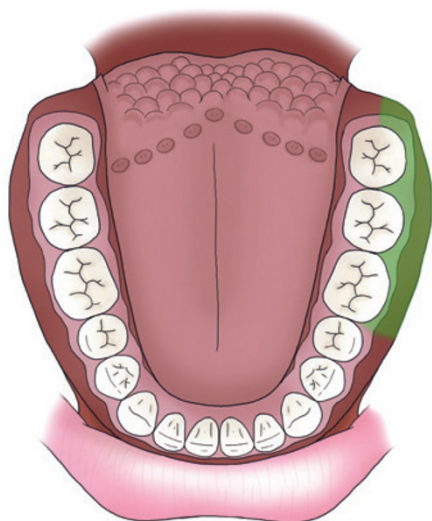


Fig. 6 Zone of anaesthesia achieved from an LBI



Fig. 7 LBI: outlining key anatomical landmarks – mucobuccal fold



Fig. 8 LBI: needle entry point

the mandibular molars and muco-buccal fold (Fig. 7).

2. Insert seedle

Insert a 2 gauge long needle into the mucosa at 45 degrees to the buccal cortical plate. The entry point should be below the muco-buccal fold and distal to the apices of the second mandibular molar at a depth of 2-4 mm in which bone should be contacted (Fig. 8). The use of topical anaesthetic before insertion is advised.

3. Aspirate syringe

Withdraw and aspirate and if blood is seen entering into the syringe, reposition needle and re-aspirate until negative results are attained.

4. Deposit anaesthetic solution

When at the correct site and there is no blood upon aspiration, inject 1-1.8 ml into the tissues. By depositing solution in this position, the long buccal nerve is anaesthetised as it crosses the anterior border of the mandibular ramus.⁹

Key variables

• Anaesthetic solution

In contrast to an IANB, clinical trials have demonstrated higher success rates of articaine 4% preparations (58-71%) over lidocaine 2% preparations (29-47%), when administering through a LBI to AIMMs.^{2,10,26,27} There is very little research that assesses the impact of varying vasoconstrictor concentrations on success rate.

• Volume

A recent randomised controlled trial found there was no statistically significant difference in the success rates between 1.8 ml and 3.6 ml of articaine 4% + adrenaline 1:100,000, suggesting increasing the volume past 1.8 ml would not improve success.²⁸

• Lingual infiltration

One may consider a lingual infiltration, in addition to the long buccal infiltration, to improve the success rates of pulpal anaesthesia. However, clinical trials have failed to demonstrate any clinical advantage that this technique may provide over a solitary LBI following a failed IANB.^{2,29}

Summary

- Administer LBI with all IANBs.
- Use articaine 4% anaesthetic with vasoconstrictor
- Deposit 1-1.8 ml over 10-20 seconds
- Objectively test the pulp and neighbouring teeth as outlined in part 1 and proceed cautiously if negative response attained
- Repeat LBI if soft tissue anaesthesia has not been achieved – no pain on probing.
- Proceed to next stage if presenting symptoms persist despite presence of soft tissue anaesthesia.

STEP TWO

Intra-ligamentary injection

After a failed LBI, it is recommended that the intra-ligamentary injection (ILI) is the next supplemental technique that should be employed in the absence of an intra-osseous injection (IOI) kit. The overall success rate for endodontic procedures in AIMMs ranges between 56-96%.^{4,30-32} The technique itself is simple and requires a small volume of anaesthetic to produce rapid single tooth anaesthesia (Fig. 9). However, one must

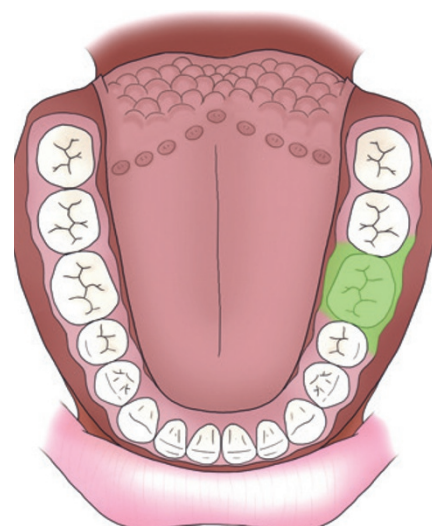


Fig. 9 Zone of anaesthesia achieved from an ILI / IOI



Fig. 10 ILI: tissue ischemia following successful solution deposition under backpressure

warn patients of the postoperative discomfort that can arise.³³

Although the name suggests the solution is distributed across the periodontal ligament, it is in fact forced laterally intraosseously into the bone marrow spaces, via cribiform plate, and systemically into the vasculature around the tooth.^{34,35} Conventional and high pressure syringes or computer controlled delivery systems (CCDS) are all modes of delivering an ILI.

Technique

1. Outline anatomical landmarks

Retract cheek so the buccal mucosa adjacent to the molars, is at almost 90 degrees to the mandible. This gives better access to the gingival sulcus of the mandibular molars.

2. Insert needle

Gently insert the tip of a 27 gauge short needle into the gingival sulcus of the mandibular molar at approximately 30 degrees. It should be then slowly advanced along the root surface using light hand pressure until resistance is met at the base of the sulcus. The mesial and distal points are recommended as the points of administration and should be approached buccally. Additionally, the buccal furcation is also

recommended as it is easily accessible and permits the anaesthetic to diffuse more readily into the bone marrow spaces, via the inter-radicular septum, where the cortical bone is thin and porous.

3. Deposit anaesthetic solution

Administer 0.2 ml over a period of 10-20 seconds ensuring a high degree of back pressure is felt being careful not to shatter the glass cartridge. This pressure, along with soft tissue blanching, indicates the needle tip is in the correct position (Fig. 10).³⁶⁻³⁸ If solution flows readily into the patient's mouth, the needle should be repositioned until this resistance is felt.

Key variables

- Anaesthetic solution

The limited evidence available suggests no statistical superiority of mepivacaine 3%, prilocaine 3% and articaine 4% over lidocaine 2% preparations.³⁹⁻⁴¹ However the use of solutions containing vasoconstrictors does appear to be a significant factor in gaining success.^{41,42}

- Re-injection

Cohen *et al.* reported success of 74% on initial administration and 96% on reinjection for AIMMs, whereas Walton and Abbott found this to be 63% and 72% respectively in healthy mandibular molars.^{4,36,39} Therefore, if the initial ILI fails to achieve clinically acceptable anaesthesia, then a repeat injection is warranted.

- Mode of delivery

Clinical trials have yet to demonstrate any advantage of CCDS over conventional or high pressure syringes. The 56% success rate obtained by Nusstein *et al.* is comparable, and in some cases significantly lower, to that achieved in parallel studies that utilised conventional or high pressure syringes.^{4,32,36,38,43-46} Furthermore, there is conflicting evidence relating to the comfort of CCDS.^{45,47,48}

- Type of tooth

Mandibular posterior teeth receive the greatest benefit from this technique, whereas the incisors obtain the least with success reported to be as low as 18%.^{31,33,49} Out of the posterior teeth, Jing *et al.* suggested it is the second molar that is significantly more likely to achieve pulpal anaesthesia following an ILI.³¹

Summary

- Administer an ILI following a failed IANB and LBI
- Use adrenaline containing anaesthetic solutions if not medically contraindicated
- Deposit 0.2 ml over 20 seconds under back pressure mesially, distally and into buccal furcation

- CCDS can be used but are not essential
- Objectively test the pulp and neighbouring teeth as outlined in Part 1 and proceed cautiously if negative response attained
- Repeat ILI if the initial administration fails
- Proceed to next stage if presenting symptoms persist despite administration of repeated ILIs.

Intra-osseous injection

Although technically more difficult, the IOI is by far the most effective and predictable supplemental technique for anaesthetising AIMMs, with reports of success ranging between 80-100%.^{3,50-58} Specialised delivery systems (Stabident™ [Fairfax Dental Inc., Miami, FL] and X-tip™ [Dentsply, Tulsa, OK]) perforate the cortical plate adjacent to the tooth, allowing administration of anaesthetic directly into cancellous bone. It then bathes the periradicular region to rapidly induce profound pulpal anaesthesia (Fig. 9).

Verma *et al.* found 95% of patients experienced little to no discomfort on perforation.⁵⁵ Reitz *et al.* reported an 11-16% incidence of moderate pain after soft tissue anaesthesia wore off.⁵⁹ And in the 5% of sites that exhibited post injection swelling, complete resolution occurred over the course of several weeks.^{60,61}

Technique

1. Preparation

Prior to perforation, disinfect the mucosa with chlorohexidine to minimise risk of secondary infections. Then infiltrate 0.1 ml of local anaesthetic into the attached gingiva at the site of perforation if not already anaesthetised (Fig. 11).

2. Identify site of perforation

Using the pre-operative radiograph, evaluate root proximity and the site of perforation. This should be distal to the tooth in question, with an exception of second molars where a mesial site is adequate, and 2-4 mm apical to the alveolar crest in the attached gingiva where the buccal cortical bone is approximately 3-4 mm thick.⁵⁹⁻⁶⁷

3. Perforate cortical plate

Connect the perforating component to the slow hand piece and orientate the tip 90° to the site of perforation. Apply light pressure and activate in a series of two second bursts to prevent overheating of the bone to reduce the risk of post-operative swelling. A characteristic give should be felt after four to five seconds indicating penetration through the cortical plate and into the cancellous bone (Fig. 12). If this sensation is not felt after five seconds, select another penetration site.



Fig. 11 IOI: Soft tissue anaesthesia prior to perforation. Images courtesy of Stabident™ [Fairfax Dental Inc., Miami, FL]



Fig. 12 IOI: perforation into cortical plate. Images courtesy of Stabident™ [Fairfax Dental Inc., Miami, FL]



Fig. 13 IOI: local anaesthetic deposition into perforation site. Images courtesy of Stabident™ [Fairfax Dental Inc., Miami, FL]

4. Deposit anaesthetic solution

Guide a 27 gauge ultra-short needle, via conventional syringe, into the perforation site (Fig. 13). Finally, administer between 0.9-1.8ml over a three to four minute period to ensure patient comfort and reduced tachycardia.⁵⁷ Flow of anaesthetic into the cancellous bone is important for success and if seen flowing back out into the mouth, perforation into another site should be considered.⁵¹

Key variables

- Anaesthetic solution

Studies show no difference in anaesthetic efficacy between lidocaine 2%, articaine 4% preparations and different adrenaline

concentrations when administered to AIMMs.⁵¹⁻⁵⁷ However, mepivacaine 3% is an effective substitute for patients with cardiovascular diseases and long acting anaesthetics (bupivacaine) should be avoided due to their cardio-toxic potential.^{50,52,57,62,68,69}

• Re-injection

Jensen *et al.* demonstrated that administering a second IOI 30 minutes after the first, which produced 100% success, prolonged effectiveness and duration of pulpal anaesthesia by 15 minutes.⁷⁰ Additional studies have documented further increases in anaesthetic efficacy after the second IOI in AIMMs.⁵⁰

• Mode of delivery

To date, the Stabident™ and X-Tip™ systems have become the most popular and most researched IO techniques. Unfortunately, there are no direct comparative studies when applied to AIMMs, however, parallel studies conclude similar success rates.^{3,51-57,66,67,71}

Summary

- Administer IOI following failed IANB, LBI and/or repeated ILIs if equipment available
- Use lidocaine 2% anaesthetic with vasoconstrictor
- Use mepivacaine 3% plain in patients with cardiovascular diseases and avoid bupivacaine
- Deposit 0.9-1.8 ml over three to four minutes ensuring no backflow of solution into oral cavity
- Stabident™ and X-tip™ have similar efficacy, however, localising the perforation site is easier with X-tip™
- Objectively test the pulp and neighbouring teeth as outlined in part 1 and proceed cautiously if negative response attained
- Repeat IOI if initial administration fails or wears off
- Proceed to next stage if presenting symptoms persist despite repeated IOIs.

STEP THREE

Intra-pulpal injection

Unfortunately, there are some patients that do not achieve adequate pulpal anaesthesia even after administering a combination of supplemental techniques. For these cases an intra-pulpal injection (IPI) is indicated and conventional methods dictate the anaesthesia to be deposited, via conventional syringe, into a small opening in the pulp chamber, that is the, pulp horn (Fig. 14). A high degree of back pressure is required to induce immediate onset and the patient should be pre-emptively warned of the short-lasting moderate to severe pain they will experience upon administration.^{72,73}

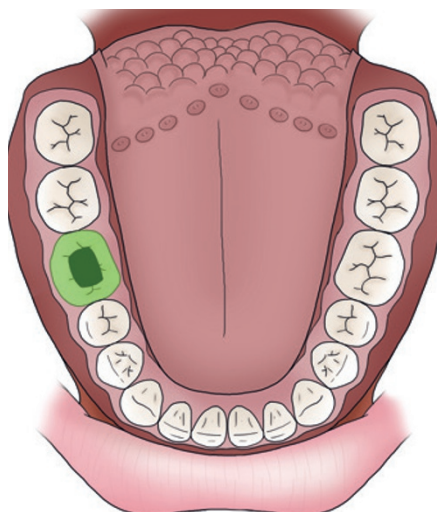


Fig. 14 Zone of anaesthesia achieved from an IPI

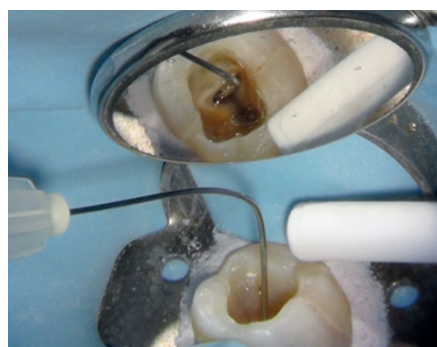


Fig. 15 IPI: local anaesthetic deposited into canal orifices and pulp chamber until half full

However, the conventional IPI technique may not always allow for the anaesthesia to spread throughout the entire pulp. For example, it can be difficult to gain the necessary back pressure when there is persistent bleeding from a hyperaemic pulp or an unintentionally large access cavity. Therefore, despite comfortable removal of coronal pulp tissue, extirpation of the radicular pulp can be a painful process. To counteract this, a variation of the conventional IPI technique has been developed and used by the restorative team at the Leeds Dental Institute and is described below.

Technique

1. Stabilise coronal tooth structure

Administer a conventional IPI and under rubber dam, stabilise the coronal portion of the tooth by conservatively removing all soft caries and failed restorations without involving the pulp.

2. Access pulp and achieve haemostasis

Using a high speed cooled bur, de-roof the pulp chamber so that all pulp horns and undercuts are removed. If this is too painful then administer another IPI and incrementally de-roof the pulp until completely removed. Curette the coronal pulp and then



Fig. 16 IPI: create bung by condensing thermoplastic GP or silicone into pulp chamber

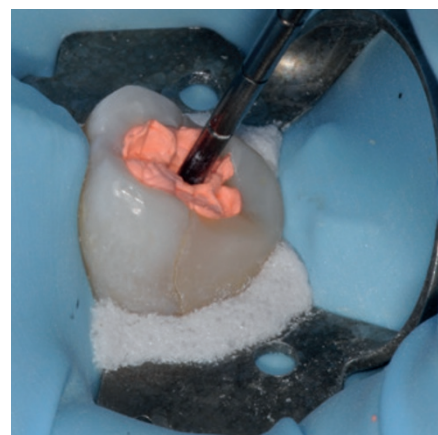


Fig. 17 IPI: force anaesthetic solution into canals by condensing the bung to the floor of the pulp chamber and leaving after 60 seconds

use a local anaesthetic soaked cotton wool pledge (CWP) or other haemostatic agents, such as Racellet® pellets or aluminium chloride to achieve haemostasis. Sodium hypochlorite may also be used.

3. Deposit solution and create bung

Following haemostasis, use a conventional syringe to deposit anaesthetic into the canal orifices and the pulp chamber under back pressure, flooding it to half full (Fig. 15). Then use a packing instrument to condense a small ball of warm thermoplastic gutta-percha (GP) or silicone putty into the pulp chamber for an intimate adaptation to the pulpal floor (Fig. 16). GP is the preferred method as it is easily adaptable, sets quickly, and can be easily adjusted and subsequently removed. A thermoplastic backfilling gun (that is, Obtura™) is ideal, but multiple heated conventional GP cones may also be used.

4. Use bung

When condensed, the bung should be left in the pulp chamber for 60 seconds before its removal (Fig. 17). This produces the necessary pressure to force the solution down into the root canal system creating immediate and profound anaesthesia, particularly in the radicular pulp. The bung can be placed back into the pulp chamber if the anaesthesia wears off during treatment, removing the need to remove the rubber dam.

Summary

- Administer an IPI when all supplemental techniques fail
- For conventional IPIs, adequate backpressure into a small opening is required
- When using the bung, ensure complete removal of the pulp chamber roof and achieve adequate haemostasis before anaesthetic deposition.

CONCLUSION

The basic strategy proposed above is one of many that aim to help practitioners approach the AIMM in a more predictable manner. These principles are not exclusive to the mandibular molars and they can be applied to all teeth diagnosed with acute irreversible pulpitis. An underlying understanding of the aetiology, combined with an awareness of the various supplemental techniques, will help practitioners overcome most cases of failed anaesthesia.

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