How to overcome failed local anaesthesia

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Local anaesthetic failure is an unavoidable aspect of dental practice. A number of factors contribute to this, which may be related to either the patient or the operator. Patient-dependent factors may be anatomical, pathological or psychological. This paper considers the reasons for unsuccessful dental local anaesthetic injections and describes techniques which may be useful in overcoming failure.

The provision of many dental treatments depends upon achieving excellent local anaesthesia. Pain-free operating is of obvious benefit to the patient, it also helps the operator as treatment can be performed in a calm, unhurried fashion. Failed local anaesthesia therefore can have effects at both ends of the syringe.

Every dentist experiences local anaesthetic failure. Published studies on local anaesthetic efficacy do not report 100% success;[1–4] normally, failures are readily rectified. However, sometimes a simple remedy, such as repeating the original injection, does not overcome the problem. This article aims to offer practical advice in the approach to overcoming local anaesthetic failure. The most rational method is to consider the reasons why a local anaesthetic injection fails. These causes can be classified as:

Operator dependent
- Choice of technique and solution
- Poor technique

Patient dependent
- Anatomical
- Pathological
- Psychological.

Pharmacological causes are not included as modern local anaesthetic solutions, when used appropriately, are reliable. Although there are some drug interactions which theoretically could decrease efficacy, these are not a concern.

Operator dependent variables

This really means poor technique, administration of insufficient solution or use of an inappropriate anaesthetic or method of administration. As a general rule, in adult patients about 1.0 ml of solution should be deposited for infiltration injections in the maxilla; for most regional block techniques 1.5 ml should be injected (palatal blocks and long buccal blocks however only require about 0.2–0.5 ml).

An example of an inappropriate method is the use of infiltration anaesthesia to obtain pulpal anaesthesia in permanent mandibular molars in adults.

Choice of solution

The most appropriate local anaesthetic solution for most dental procedures is lignocaine with adrenaline. In some medically-compromised patients adrenaline-free solutions may be preferred, however for the majority of cases lignocaine with adrenaline is the 'gold standard'. The use of plain lignocaine does not give reliable pulpal anaesthesia and in addition its effect is short-lived.

Poor technique

The most likely defect in technique is faulty needle placement. Failure to aspirate before injection, which could lead to intravascular deposition of solution might also lead to failure of anaesthesia although this has never been proven. Success may be related to the speed at which the solution is deposited. It is easy to imagine the anaesthetic being directed away from a nerve trunk during forceful injection. There is evidence in the surgical literature that the success of some techniques is increased with slower injection speeds.[5]

This paper:
- Explains the reasons for local anaesthetic failure
- Describes injection techniques to overcome failure
- Offers a rational approach to the failed local anaesthetic case

As far as conventional methods of local anaesthesia are concerned poor technique usually relates to mandibular anaesthesia, specifically failed inferior alveolar nerve block injections.

The success rate for inferior alveolar block injections with lignocaine and adrenaline is more than 90%.[1,2] Practitioners who regularly fail with this method should reassess their technique. The best way to achieve success with the inferior alveolar nerve block is to use the direct technique where the dentist places the thumb intra-orally at the deepest concavity of the anterior ascending ramus and the index finger at the same height extra-orally on the posterior aspect of the ramus. The puncture point is half-way between the mid-point of the thumb nail and the pterygomandibular raphe and the needle is advanced through this point being delivered parallel to the occlusal plane from the premolar teeth of the opposite side. The proper bony end point is reached between 15 and 25 mm of penetration. The common causes of failure are touching bone too soon on the anterior ascending ramus (rectified by swinging the syringe across the mandibular teeth on the same side, advancing 1 cm and then returning to the original angle of approach) or injecting inferior to the mandibular foramen (countered by injecting at a higher level). In most cases the dentist who experiences the odd failure rectifies the problem with a repeat injection, perhaps at a slightly higher level. An orthopantomogram may help in locating the position of the mandibular foramen. In those cases where a second injection has not overcome the failure, an alternative approach to the inferior alveolar nerve should be considered. There are a number of approaches to the inferior alveolar nerve, including extra-oral techniques. Some of the intra-oral methods are described below.

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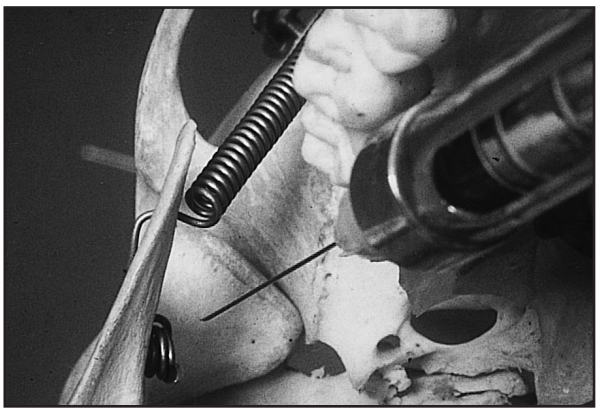

Fig. 1a and 1b The position of the needle during a Gow-Gates 'high' block of the inferior alveolar nerve

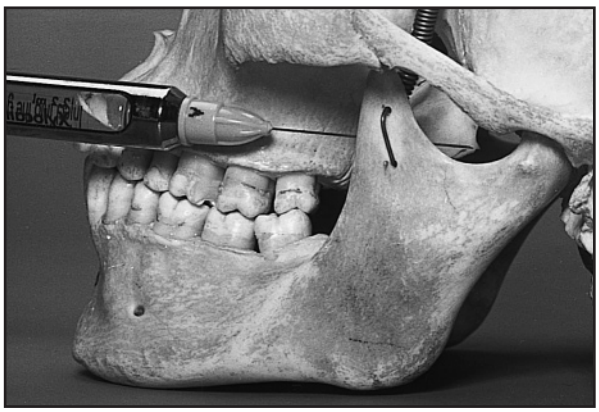

Fig. 2a and 2b The position of the needle during an Akinosi 'high' block of the inferior alveolar nerve

Methods of overcoming a failed inferior alveolar nerve block injection

The Gow-Gates technique

This is technically more difficult than the standard direct approach to the inferior alveolar nerve. The method relies upon deposition of local anaesthetic adjacent to the head of the mandibular condyle (fig. 1a).[6] The patient has the mouth wide open and the dentist imagines a line drawn from the angle of the mouth to the inter-tragic notch. This is the plane of approach. The needle is introduced across the contralateral mandibular canine and directed across the mesio-palatal cusp of the ipsilateral upper second molar (fig. 1b). The point of mucosal penetration is thus higher than with the conventional block and the needle is advanced until bony contact is made. The point of bony contact is the condylar head. The needle is withdrawn slightly, and after aspirating a full cartridge is deposited. The patient should keep the mouth open for a few minutes until the subjective signs of inferior alveolar anaesthesia are reported.

The Akinosi technique

This method,[7] which is also known as the Vazirani-Akinosi closed-mouth technique, is useful when conventional block anaesthesia fails (fig. 2a,b). It is simpler than the Gow-Gates method, and uniquely for intra-oral approaches to the inferior alveolar nerve, it does not rely upon contacting a bony end-point. The patient has the mouth closed and the syringe, fitted with a 35 mm needle, is advanced parallel to the maxillary occlusal plane at the level of the maxillary muco-gingival junction. The needle is advanced until the hub is level with the distal surface of the maxillary second molar, by which stage it will have penetrated mucosa at a higher level than with the direct approach to the nerve. At this point a cartridge of solution is deposited.

The Gow-Gates and Akinosi techniques are both 'high' methods of blocking the inferior alveolar nerve; both anaesthetise the lingual nerve. In addition the Gow-Gates method will block conduction in the long buccal nerve (occasionally this also happens with the Akinosi technique).

The Gow-Gates and Akinosi methods are best reserved for those cases where the conventional block methods fail as they can produce more complications than the standard approach. The higher the needle is inserted the closer it is to the maxillary artery and the pterygoid plexus. Contacting the maxillary artery can cause pain

and produce blanching because of arteriospasm, laceration of vessels in the pterygoid plexus can cause an alarming haematoma which is controlled by firm pressure but may produce post-injection trismus which may last for weeks.

Other methods of anaesthetising mandibular teeth include infiltration anaesthesia, incisive and mental nerve blocks, intraligamentary (or periodontal ligament), intra-osseous and intra-pulpal methods.

Infiltration anaesthesia

Buccal infiltration anaesthesia in the mandible can be effective in some areas. Indeed in children this may the preferred technique when treating the deciduous dentition.[8] In adult patients buccal infiltrations may be effective in the mandibular incisor region.

Mental and incisive nerve block

When treating the lower premolar and anterior teeth a mental and incisive nerve block may overcome a failed inferior alveolar nerve block. When using this method 1.5 ml should be injected in the region of the mental foramen which is often located between the apices of the lower premolars (available radiographs can be used to accurately localise the foramen).

Intraligamentary and intra-osseous anaesthesia

These techniques rely on the same mechanism to achieve anaesthesia, namely deposition of solution in the cancellous bone of the alveolus. The intraligamentary method gains access to the cancellous space by the periodontium, the intra-osseous technique by way of a perforation through the buccal gingiva. They can be used in either jaw.

Intraligamentary anaesthesia

This may be used both as a primary or a secondary technique. It has limitations as a principal method of anaesthesia (such as variable duration) but has been used to overcome failed conventional methods.[9,10]

The technique is equally effective with conventional or specialised syringes. Glass cartridges are used in this method as the plastic type deform under the pressures produced.[11]

When administering intraligamentary injections the needle is inserted at the mesio-buccal aspect of the root and advanced until maximum penetration. A 12 mm 30 gauge is recommended although efficacy is independent of needle diameter.[9,10] Ideally the bevel should face the bone although effectiveness is not impaired with different orientations.[12] The needle does not penetrate deeply into the periodontal ligament but is wedged at the crest of the alveolar ridge. Around 0.2 ml of solution is injected per root. When using an ordinary dental syringe 0.2 ml is the approximate volume of the cartridge rubber bung. The injection must be delivered slowly, at least 10 seconds is recommended. Rapid injection can lead to tooth extrusion, indeed an inadvertent extraction has been reported as a result of this method of anaesthesia.[13]

When using the intraligamentary method success is highly dependent upon the presence of adrenaline in the local anaesthetic solution.[14] Care must therefore be taken in patients at risk of increased circulating adrenaline levels as solution injected intra-osseously enters the systemic circulation rapidly. Intraligamentary injections produce a significant bacteraemia[17] and thus should not be given to patients at risk of infective endocarditis unless appropriate antibiotic prophylaxis has been provided.

Intra-osseous anaesthesia

As with the intraligamentary injection this method can be performed using conventional or specialised equipment. Similarly it is more effective when a vasoconstrictor-containing solution is used.[18] Modern custom-made equipment however simplifies the technique. Specialised equipment consists of a matched perforator and needle. If the patient has radiographs of the tooth to be treated these are useful in locating the best inter-radicular zone for anaesthetic injection. If it is not already anaesthetised the gingiva in the area of perforation is infiltrated with a small volume (0.1 ml) of anaesthetic solution. The region to perforate is within the attached gingiva about 2 mm below the gingival margin of the adjacent teeth in the vertical plane bisecting the interdental papilla.The perforator is fitted to a standard dental handpiece and advanced through the buccal cortex until the unmistakable drop into the cancellous space is experienced. The perforator is removed and the small 6 mm 30 gauge needle is advanced through the defect into the cancellous bone where 0.2–0.5 ml of solution is administered slowly. Although there are aspects which preclude intra-osseous anaesthesia as a primary technique it is a useful adjunct to block anaesthesia.[19]

Intra-pulpal anaesthesia

A technique of anaesthesia that can be useful in endodontics and oral surgery is the intra-pulpal method. Unlike intraligamentary and intra-osseous techniques this method achieves anaesthesia as a result of pressure. Saline has been reported to be as effective as an anaesthetic solution when injected intra-pulpally.[20] The method is as follows. When a small access cavity is available into the pulp a needle which fits snugly into the pulp should be chosen. A small amount (about 0.1 ml) of solution is injected under pressure. There will be an initial feeling of discomfort during this injection, however this is transient and anaesthetic onset is rapid. When the exposure is too large to allow a snug needle fit the exposed pulp should be bathed in a little local anaesthetic for about a minute before introducing the needle as far apically as possible into the pulp chamber and injecting under pressure.

Anatomical causes of failure of anaesthesia

Individual variations in the position of nerves and foramina

The foramina of importance in regional block anaesthesia in dentistry do not have a consistent location between patients. Many of the methods described above to

surmount poor technique will overcome any problems resulting from anatomical variations. Available radiographs may be helpful in anticipating this situation.

Accessory nerve supply

Teeth may receive innervation from more than one nerve trunk (Table 1). Accessory nerve supply can lead to failure of anaesthesia following both infiltration and regional block methods. Pulpal supply to upper molar teeth may arise from the greater palatine nerves and a buccal infiltration is unlikely to affect transmission by this source. Similarly maxillary anterior teeth can receive innervation from the naso-palatine nerve. The solution for both these cases is a palatal injection.

The long buccal nerve will occasionally provide innervation to the lower molar pulps and a long buccal block or mandibular buccal infiltration may be necessary for complete anaesthesia in such cases. The lingual nerve may also contribute pulpal supply to the mandibular teeth but this will normally be counteracted by the lingual nerve block given in association with the inferior alveolar nerve block. However it will not be affected by the mental and incisive nerve block.

Further accessory supplies innervate mandibular teeth. Such supply can be derived from the mylohyoid nerve, the auriculotemporal nerve and the upper cervical nerves.

The mylohyoid branch leaves the main inferior alveolar trunk more than a centimeter superior to the mandibular foramen[21] so may not be affected by a conventional approach to the latter nerve. However, it may be anaesthetised using the techniques of Gow-Gates and Akinosi. Alternatively, a lingual infiltration adjacent to the tooth of interest may be effective.

The auriculotemporal nerve occasionally sends branches to the pulps of the lower teeth through foramina high on the ramus.[22] This supply, like the mylohyoid branches, is countered by a 'high' block such as the Gow-Gates or Akinosi.

When removing third molar teeth it is not unusual to discover that, despite an apparently effective lingual block, the disto-lingual gingiva is not anaesthetised. This accessory supply is readily countered by injecting just disto-lingual to the third molar. In fact this finding is so common that a routine injection of about 0.2 ml solution at this site is recommended prior to third molar surgery.

Table I Accessory nerve supplies to the teeth

Tooth	Main supply	Accessory supply	Accessory supply countered by:
Maxillary	Superior alveolar nerve	Greater palatine/ Naso-palatine	Palatal block or palatal infiltration
Mandibular	Inferior alveolar nerve	Long buccal nerve	Long buccal block or buccal infiltration
"	"	Lingual nerve	Lingual block or lingual infiltration
"	"	Mylohyoid nerve	'High' block or lingual infiltration
"	"	Auriculo-temporal nerve	'High' block
"	"	Upper cervical nerves	Buccal and lingual infiltrations

When using regional block anaesthesia structures in the mid-line may not be satisfactorily anaesthetised as they receive bilateral innervation. A classic example is the failure of inferior alveolar or mental and incisive nerve blocks to anaesthetise a lower central incisor. The solution is to block the contralateral nerve with an inferior alveolar nerve block, incisive nerve block or buccal infiltration. Alternatively, an infiltration, intraligamentary or intraosseous injection may be administered at the outset in this area.

Barriers to anaesthetic diffusion

The most obvious barrier to anaesthetic diffusion is the thick cortical plate of the mandibular alveolus which precludes infiltration anaesthesia in adults with the possible exception of the mandibular mid-line.

The first molar region in the adult maxilla occasionally presents a similar problem. In this region the thick zygomatic buttress can prevent passage of the anaesthetic to the dental apices. The answer to this problem is to inject mesial and distal to the first molar away from the buttress (as the first molar can obtain supply from both posterior and middle superior alveolar nerves a posterior superior alveolar nerve block may be unsuccessful).

Pathological causes of failure of anaesthesia

Factors precluding access

Factors which can preclude access include trismus (because of a number of causes) and anatomical changes because of trauma or surgery. Trismus is the most likely factor in practice and this is often because of an infective cause. Buccal infiltrations in the maxilla are still possible with the mouth closed. A way to anaesthetise the palatal tissues in the patient with trismus is to inject while advancing a needle toward the palate through the mesial and distal gingival papillae from the buccal side.

The best way to achieve inferior alveolar anaesthesia in the patient with trismus is to use the Akinosi closed-mouth technique described above. There are extra-oral approaches but these are not recommended in practice.

Although methods of anaesthetising the nerve supply to the teeth are possible in the patient with trismus the practi-

tioner must question the appropriateness of administering the injection. Can the proposed treatment be completed in such patients? It may be that half-completed treatment is worse than none at all. It may be prudent to allow the trismus to resolve prior to dental treatment.

Inflammation

It is apparent to all practitioners that teeth with inflamed pulps can be difficult to anaesthetise. A number of suggestions have been proposed to explain this finding. The classic explanation for this is that the low tissue pH in areas of inflammation affects the activity of the local anaesthetic solution by decreasing the concentration of the unionised (lipophilic) fraction which diffuses through nerve sheaths. Similarly areas of inflammation have an increased blood supply due to vasodilatation and this might increase anaesthetic 'wash-out'. However, these answers do not explain the failure of regional block techniques where the solution may be deposited 4 or 5 cm from the area of inflammation. The most plausible explanation is that inflammation makes nerves hyperalgesic.[23] Minimal stimulation results in conduction. However, no tooth is resistant to local anaesthesia. The practitioner therefore has to decide on the maximum volume of local anaesthetic he is willing to inject for that patient and be prepared to use up to that maximum to anaesthetise that tooth. This may mean limiting treatment to only one tooth but if it takes the maximum safe dose — so be it. On no account should the predetermined safe maximum dose be exceeded. In healthy patients there is usually sufficient room for manoeuvre to administer a dose sufficient to halt conduction in the tooth without producing generalised central nervous system effects. The use of higher concentrations of local anaesthetic solutions (such as 5% lignocaine[24]), although effective, is not a viable option in practice. The answer is to inject more solution. This does not have to be at the same site, eg the combination of infiltration and regional block anaesthesia can be used in the maxilla (eg infiltration at the apex of an upper lateral incisor plus an infra-orbital nerve block). This can be supplemented with intraligamentary or intra-osseous injections if required.

Psychological causes of failure

There are undoubtedly patients who do not do well with local anaesthesia but in whom the local anaesthetic appears to have been effective. This may be because of fear and apprehension. In such patients the use of sedative techniques can be helpful as successful anaesthesia is easier to achieve in the relaxed patient.[3] Benzodiazepines offer the added bonus of reducing local anaesthetic toxicity which is useful when multiple injections are being administered.

An approach to the failed local anaesthetic case

When an initial local anaesthetic fails the best treatment is to repeat the injection; this will often lead to success. In the case of repeat block injections it is easier to palpate bony landmarks at the second attempt as the needle can be manoeuvred in the tissues painlessly. If a second injection fails then the alternative approaches discussed above should be employed namely: 'high' blocks, infiltrations to eliminate accessory supply, or one of the intra-osseous techniques (fig. 3).

When a practitioner is treating a patient who has had difficulty in being anaesthetised in the past, or has been referred from elsewhere because of failed local anaesthesia there is an argument for applying a 'blunderbuss' technique from the start — it is often difficult to gain a patient's trust at that session if they have been hurt therefore they should be given 'the best shot' at the outset. When this achieves success it is extremely satisfying.

A technique suggested for patients who have experienced local anaesthetic failure in the mandible is this:

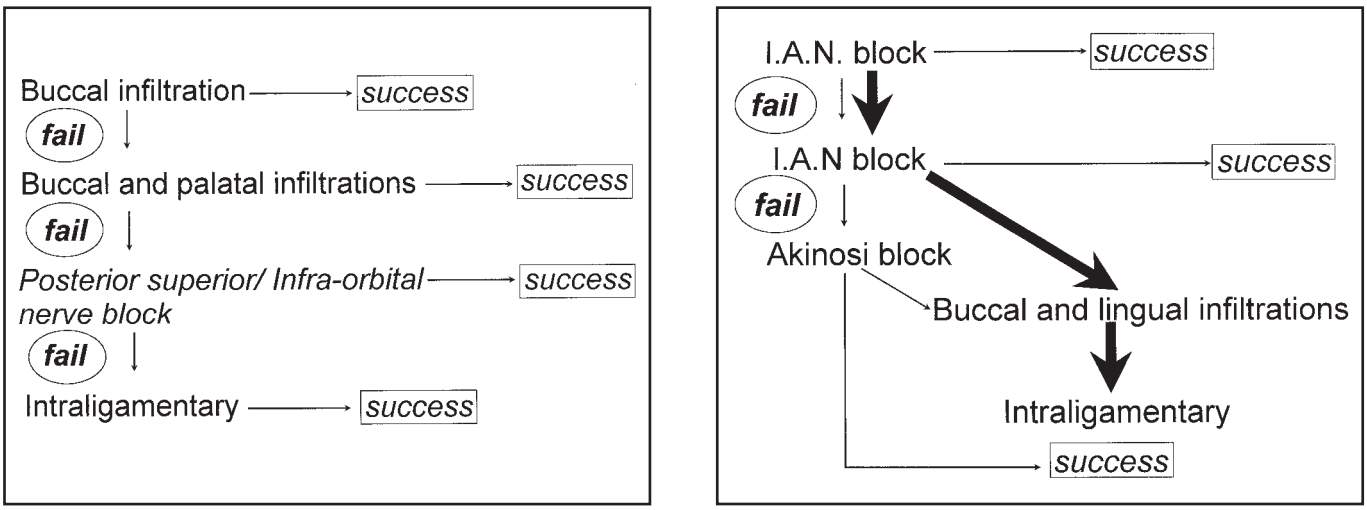

Fig. 3a and 3b The flow diagrams for management of failure in both jaws. The broad arrows in 3b show the 'blunderbuss' approach to the tooth which has proved resistant to local anaesthesia in the past

1. Conventional inferior alveolar and lingual block with lignocaine and adrenaline (1.5 ml), followed by long buccal nerve block with remainder of cartridge.
2. After subjective soft tissue signs of first block have taken effect a repeat inferior alveolar and lingual block injection using 3% prilocaine with 0.03 IU/ml felypressin. There is no scientific evidence that changing the active agent increases duration or depth of anaesthesia. However, there are a number of reasons why changing the solution might offer an advantage. Firstly, with the combination suggested there is an increase in the amount of local anaesthetic without increasing the amount of adrenaline administered. This can be of particular importance in some medically-compromised individuals. Secondly, there is some evidence that the combination of lignocaine and prilocaine provides a greater spread of anaesthesia[25] and this may be of some clinical benefit.

   If subjective signs of inferior alveolar nerve block anaesthesia are not apparent after a second block then an Akinosi block is recommended with lignocaine and adrenaline.
3. Buccal and lingual infiltrations adjacent to the tooth of interest using around 1.0 ml of lignocaine and adrenaline in total (this to eliminate any accessory supply).
4. Intraligamentary injection of 0.2 ml lignocaine with adrenaline per root.

This may seem extreme but the total volume injected is less than 6.0 ml which is acceptable in healthy adults. In the severely medically-compromised however, such as those with unstable angina this volume of an adrenaline-containing solution may be excessive and the technique mentioned above is not recommended in such patients. In these individuals an adrenaline-free solution such as 3% prilocaine with felypressin should be used and a 'high' block should be considered after an initial failure. The supplementary infiltrations should be given with the same solution.

Future developments

Researchers are developing methods of reducing pain perception in pulpitic teeth by means other than injecting local anaesthetics. The intraligamentary injection of analgesic drugs (such as opioids) has been investigated and has shown promise.[26] Progress in this field will undoubtedly occur, but at present these are research tools.

Another advance which would help those patients in whom adrenaline should be limited would be the provision of an adrenaline-free solution which is consistently reliable when administered via the periodontal ligament. The relatively new anaesthetic agent ropivacaine is equally effective as a plain and adrenaline-containing solution in surgical practice and this may offer possibilities.[27]

Conclusions

Failed local anaesthesia is a feature of dental practice. Most practitioners will experience it less often than they achieve success. The answers offered above, based on an understanding of the reasons for failure, should help overcome most cases encountered in practice.

Figures 1a and b are reproduced from Pain and Anxiety Control for the Conscious Dental Patient *by kind permission of Oxford University Press.*

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