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內文:

1. Abstract

- This article describes current concepts in the mechanism of action of local anaesthetic drugs and discusses recent advances in the equipment and drugs that may be used to provide intra-oral anaesthesia.

2. Introduction

- Excellent pain control is an essential part of surgical practice. Local anaesthesia is the mainstay of pain control for outpatient oral surgery procedures.
- The anaesthetic effects of cocaine were discovered by Albert Niemann in the 1850s1. Since that time a number of advances have occurred in relation to local anaesthetic drugs and delivery systems.

- This article will consider current concepts in the action of local anaesthetics and recent developments in drugs and the way they are delivered.

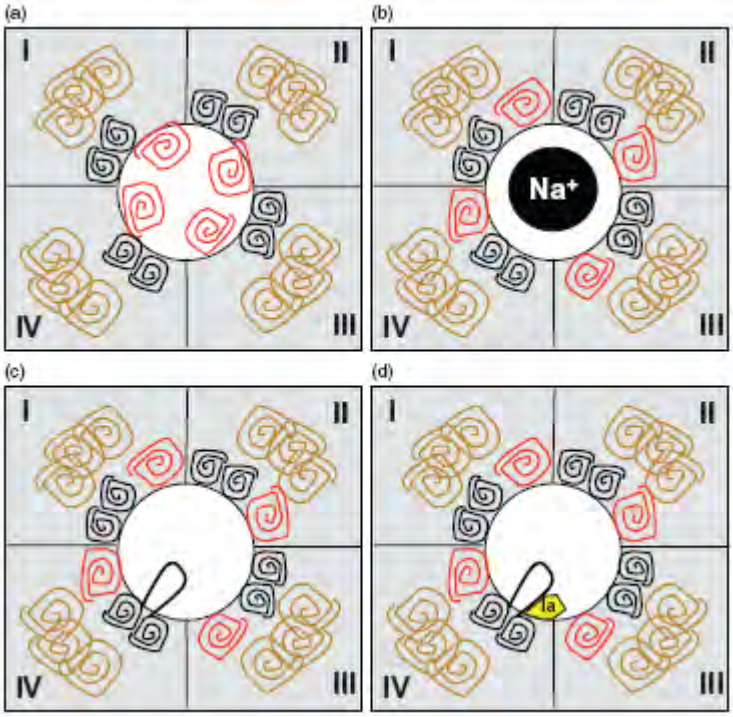
3. Current understanding of the mode of action of local anaesthetic drugs

- There are two theories proposed for the action of local anaesthetics. These are the **membrane expansion theory** and the **specific binding theory**.

(Ⅰ) **membrane expansion theory** is a non-specific mechanism that occurs by swelling of the nerve cell membrane as the lipophilic local anaesthetic is absorbed into the membrane. This perturbation influences the configuration of the sodium channel and inhibits entry of sodium into the cell, which prevents nerve cell depolarisation and thus firing.

(Ⅱ) **specific binding theory** is a more accurate explanation of the mechanism of action of local anaesthetics. The evidence to support this theory is strong. Different isomers of the same drug show different local anaesthetic activity.

- In order to understand the specific binding theory of local anaesthetic action, it is necessary to understand the structure of the voltage-gated sodium channel, which is the site of local anaesthetic action.
- **Nine different types of sodium channels** have so far been identified. These different sodium channels are not all equally susceptible to the action of local anaesthetics and could explain why certain conditions such as **inflammation**, which might lead to the development of altered channels, can lead to failure of local anaesthesia.
- The basic structure of the **sodium channel consists of three subunits known as a, b1 and b2.** The pore through which sodium enters the cell is contained in a subunit. The unit is composed of four very similar zones named **domains I–IV**. Each of these domains contains **six protein helical segments annotated S1–S6**.



These segments vary in their structure; segments S1, S2 and S3 are all negatively charged and S4 is positively charged.

(Fig. 1a) At rest the S4 segments are present in the channel of the pore and act as an obstruction to sodium entry.

(Fig. 1b) Depolarisation and entry of sodium into the cell is achieved by the S4 segments twisting into the body of the a unit– an action known as the sliding helix.

(Fig. 1c) During the refractory period of the firing cycle a protein loop. between domains III and IV extends into the channel preventing further entry of sodium.

(Fig. 1d) Local anaesthetics block sodium entry by maintaining this loop in the position it occupies during the refractory period.

- The fact that specific drug binding sites are now being identified is exciting as this means that local anaesthetic agents with greater specificity for specific sodium channels could be developed. This could lead to the development of agents that are less cardiotoxic as well as those that may perform better in the presence of inflammation. In addition, there is a greater understanding of the heterogeneity of adrenergic receptors; this could lead to the development of site-specific vasoconstrictors, which might further reduce the unwanted effects of local anaesthetics.

4. Recent advances in intra-oral local anaesthesia

A number of developments have occurred over the last decade both in relation to the drugs used for local anaesthesia and in relation to the equipment used to deliver these drugs. Changes in delivery systems have led to the development of different techniques of intra-oral anaesthesia.

5. Local anaesthetic drugs

Developments in relation to local anaesthetic drugs will be discussed in relation to three areas:

- First, the introduction of **articaine** to a larger market.

- Second, the development of new **longer-acting agents**.
- Finally the development of drugs to **reverse the effects of local anaesthesia**.

(Ⅰ) Articaine has been shown to be a safe and effective local anaesthetic in clinical trials in both adults and children. Articaine contains a **sulphur** molecule and it is unique among the amide group of local anaesthetics in that **it is initially metabolised in the plasma**. The other amides are metabolised in the liver.

(Ⅱ) This means that articaine has a much shorter plasma half-life (around 20 min) compared with lidocaine (about 90 min). Therefore, articaine is **systemically less toxic** than lidocaine. It is important to point out that it is the plasma half-life that is reduced, which does not affect the duration of activity of articaine.

(Ⅲ) There is a feeling among general practitioners that **articaine with adrenaline** is an extremely effective solution and appears better than lidocaine with adrenaline. It has been suggested that it is able to **diffuse more widely** than other local anaesthetics.

- One study has suggested that **palatal injections are not required** after buccal anaesthesia with 4% articaine for maxillary dental extractions. There are data suggesting that articaine has a shorter onset time and longer duration of action compared with lidocaine after infiltration anaesthesia in the maxilla.
- One study showed that mandibular buccal infiltration with 4% articaine with 1:100 000 adrenaline was more effective in obtaining **molar pulpal anaesthesia** than a similar injection of 2% lidocaine with 1:100 000 adrenaline. This may be the result of the increased concentration of local anaesthetic drug.
- A point of interest is that, as far as anaesthesia of the lower first molar is concerned, the infiltration of 4% articaine produced equivalent success to inferior alveolar nerve block with 2% lidocaine in a similar study population.

➔This is an interesting finding that merits further investigation as the avoidance of regional block anaesthesia could be an advantage, for example, the reduction of traumatic and chemical injuries to nerve trunks.

(Ⅳ)

- An area of controversy concerning the use of 4% articaine is the suggestion that the production of longlasting paraesthesia is more likely, especially the **lingual nerve**.
- These findings have been questioned by some workers as large-scale studies have shown no difference in the production of paraesthesias following the intra-oral injection of lidocaine and articaine. (This might be due to **direct trauma from the needle** and that **over-reporting** of problems is natural when a new drug is introduced to practice.)

➔ Nerve damage increases with increasing local anaesthetic concentration have been implicated in a greater incidence of paraesthesias.

6. Long-acting local anaesthetics

Long-acting local anaesthetics have been used in oral surgery for a number of years. They are not available in dental cartridges in all countries, including the UK.

- Drugs such as **bupivacaine** have been shown to be useful in reducing postoperative discomfort and decreasing the need for postoperative analgesia.
- The most recently developed drugs are **ropivacaine** and **levobupivacaine**.
  - **Ropivacaine** has a shorter elimination half-life compared with bupivacaine. One useful property attributed to ropivacaine is an inherent vasoconstrictive property. However, when tested during intraligamentary anaesthesia, a technique that requires good vasoconstriction for acceptable efficacy, ropivacaine was not as effective as lidocaine with adrenaline in obtaining

pulpal anaesthesia.

- **Levobupivacaine** is a single isomer of bupivacaine. The advantage of the former drug is that it is less toxic compared with the latter . They appear equally effective in obtaining pulpal anaesthesia after inferior alveolar nerve blocks and levobupivacaine has been shown to reduce analgesic consumption and **decrease postoperative pain.**

7. Reversal of local anaesthesia

✧ This is achieved by injecting the **alpha-adrenergic antagonist** phentolamine mesylate at the end of treatment to oppose the effects of the vasoconstrictor (adrenaline) in the original local anaesthetic.

✧ The local injection of phentolamine has been shown to significantly shorten the time taken for return to normal sensation of the lip and tongue after dental anaesthesia.

➔Although reversal of local anaesthesia may be welcomed in some of the dental specialties there will be few indications in oral surgery where postoperative pain control relies to a degree on local anaesthetic action.

8. Delivery systems

Two will be discussed here, namely **safety syringes** and **electronic (or computercontrolled) delivery systems**.

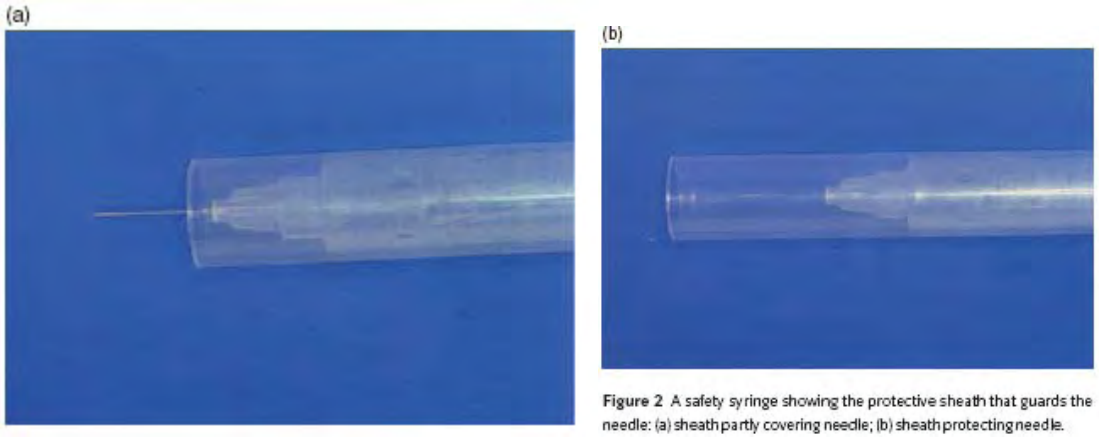
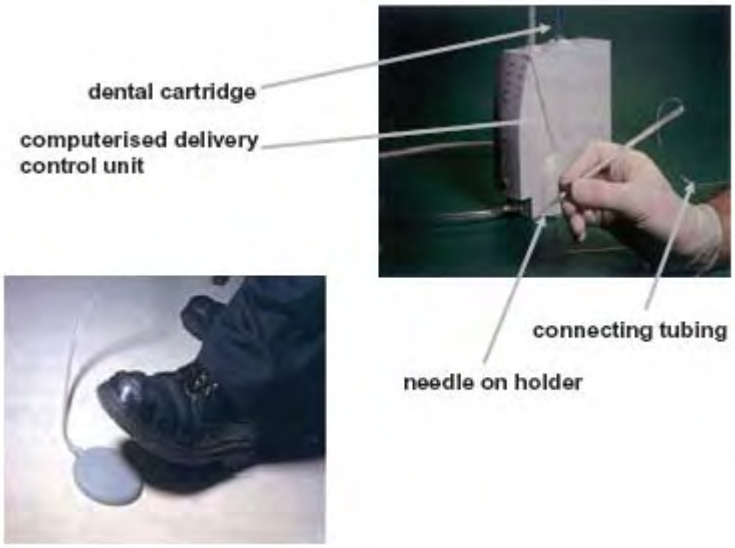


Figure 2 A safety syringe showing the protective sheath that guards the needle: (a) sheath partly covering needle; (b) sheath protecting needle.

◆ **Safety syringes** have been developed to decrease the incidence of accidental needle-stick injury. This can be reduced **if needle resheathing is avoided**. In safety syringe systems the needle and its protective sheath are supplied and disposed of as part of the syringe (Fig. 2). The entire assembly is disposed of as a unit, thus **needle removal is not required**. The introduction of such syringes has been shown to reduce the incidence of needle-stick injury and the system has been shown to aspirate effectively with standard dental cartridges.

◆ **Electronic delivery systems**, such as the Compudent ,consists of a free-standing control unit that contains a microprocessor, which controls the flow rate during injection. This, in theory, should aid patient comfort.



The control unit contains a computerized delivery control unit, a holder for a standard dental local anaesthetic cartridge, a connecting tubing and a needle on holder. The signal to inject and aspirate is governed by a **foot control**.

- Studies have shown no statistical difference in injection discomfort between computerized and traditional syringes in adults; however, in children the computerised system does seem to produce less disruptive behaviour than the traditional system.
- There is evidence that, as well as being safer and more comfortable, some techniques of intra-oral local anaesthesia are more successful when the solution is deposited slowly.
- Two block techniques for use in the maxilla have been investigated. These are the **anterior middle superior alveolar nerve block (AMSA)** and the **palatal anterior superior alveolar nerve block (PASA)**.These techniques are novel in that they are advocated as means of obtaining **pulpal anaesthesia** via a palatal approach.

Figure 4 The position of the needle during the anterior middle superior alveolar nerve block.

Figure 5 The position of the needle during the palatal anterior superior alveolar nerve block.

- The AMSA technique relies on the presence of **multiple small foramina** in the palatal surface of the maxilla. It has been proposed that this technique can anaesthetise the pulps of the **premolar** and **anterior maxillary teeth**. Although this has been shown to occur, the success reported for the technique is limited and varies between the teeth (Table 1).
- The PASA achieves its effect by injecting solution into the **nasopalatine**

duct (Fig. 5). This has been claimed to produce anaesthesia of the **maxillary incisor** and **canine teeth bilaterally** from one injection. The technique has been shown to provide pulpal anaesthesia.

Table 1 Reported success rates of the AMSA and PASA injections in adults using a computerised delivery system[59,61]

Maxillary tooth	Success (%) with AMSA	Success (%) with PASA
Central incisor	35	55–58
Lateral incisor	58	48–58
Canine	52	32–55
First premolar	42	
Second premolar	55	

AMSA, anterior middle superior alveolar nerve block; PASA, palatal anterior superior alveolar nerve block.

➔ Overall, these techniques show some promise and might be useful as supplementary techniques in oral surgery; however, at present they are not preferable to standard primary methods of local anaesthesia.

題號	題目
1	下列何種囊腫(cyst)，是口腔內最常見的非齒源性囊腫 (non-odontogenic cyst) (A) Globulomaxillary cyst (B) Nasolabial cyst (C) Median palatal cyst (D) Nasopalatine duct cyst
答案(D)	出處：Oral and maxillofacial pathology, 2nd , p27
題號	題目
2	在X光片上，上顎兩顆正中門牙(central incisor)牙根尖間若有一圓形或卵圓形的radiolucency，要最先考慮的非齒源性腫瘤為何?
	(A) Globulomaxillary cyst (B) Nasolabial cyst (C) Median palatal cyst (D) Nasopalatine duct cyst
答案(D)	出處：Oral and maxillofacial pathology, 2nd , p27