

Local Anesthesia in Dental Practice — New Methods of Local Anesthesia

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INTRODUCTION

Almost all the dental procedures are done under local anesthesia. Local anesthesia is inevitable in dental practice. First of all, the dentists should have the same understanding that local anesthesia is straightly leads to great pain sensation. It derives from needle injection of sensitive oral mucosa, poor technique and incomplete topical anesthesia. Dental anesthesia itself has a contradiction because it gives intolerable pain before painless practice.

TOPICAL ANESTHESIA

At least now, all the effective anesthetic methods need injection needles. Every needle gives the patient prick and injection pain. To diminish the pain, topical or surface anesthesia is often used. However, insufficient anesthetic effect is often recognized during routine dental general practices.

We carried out two clinical studies regarding topical anesthesia. For the first experiment, we used topical anesthetic, 20% benzocaine, or commercially available Hurricane. In order to enhance the anesthetic effect, it was put on either side of the attached gingiva of apex of the incisors for 20 minutes and was applied using

strong adhesive (Fig. 1).

After application of the topical anesthetic, the anesthetized area was sealed with tape and cotton rolls. The volunteers were kept calm for 20 minutes.

To measure the effect of topical anesthesia, we performed 3 kinds of painful stimulation; puncture at 2 mm depth by needle, insertion of the needle to the cortical bone, and injection of 0.9 ml of 2% lidocaine. We modified the infiltration needles, which have a stopper up to 2 mm of needle depth in order to regulate the magnitude of pain sensation. For each painful stimulation, pain rating score (PRS) and visual analog scale (VAS) were applied to each volunteer to evaluate the degree of pain. PRS consists of 4 categories of pain; they are no pain, slight pain, pain, and severe pain. The volunteer reports one of them immediately after each stimulation. VAS is 10 cm long line and the left end indicates no pain and the right end means intolerable pain. The volunteer is asked to check one point of line according to a degree of each pain. The result is that there was no difference between the control side and anesthetized side by PRS using 20% benzocaine (Fig. 2). VAS did not recognize any difference between the control side and topically anesthetized side, either. These results indicate 20% benzocaine could not diminish needle pain significantly.

On the contrary, 60% lidocaine significantly reduced needle pain: Nineteen out of 20 volunteers answered no pain of needle puncture. PRS was also depressed by concentrated anesthetic even after stimulation by injection (Fig. 3). VAS also revealed that 60% lidocaine gel significantly depressed the pain sensation by those

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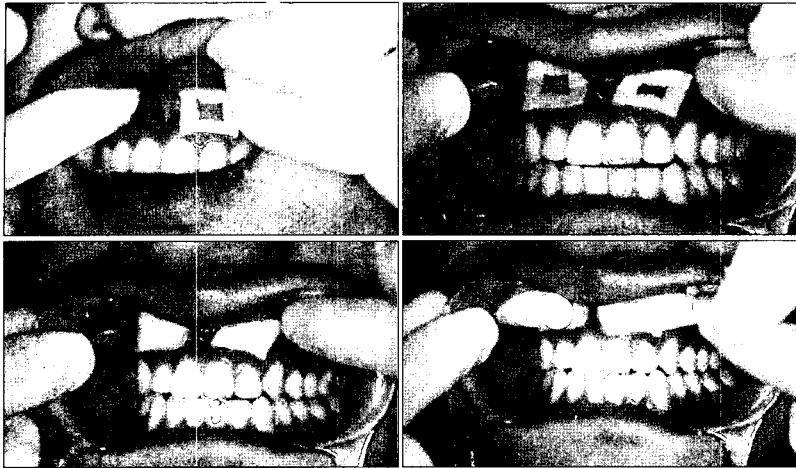


Fig. 1. Placement of topical anesthetic. Before topical anesthetic was applied to the apical area of the central incisors, adhesive patches were attached on the area. The area was then covered by surgical tape and cotton rolls.

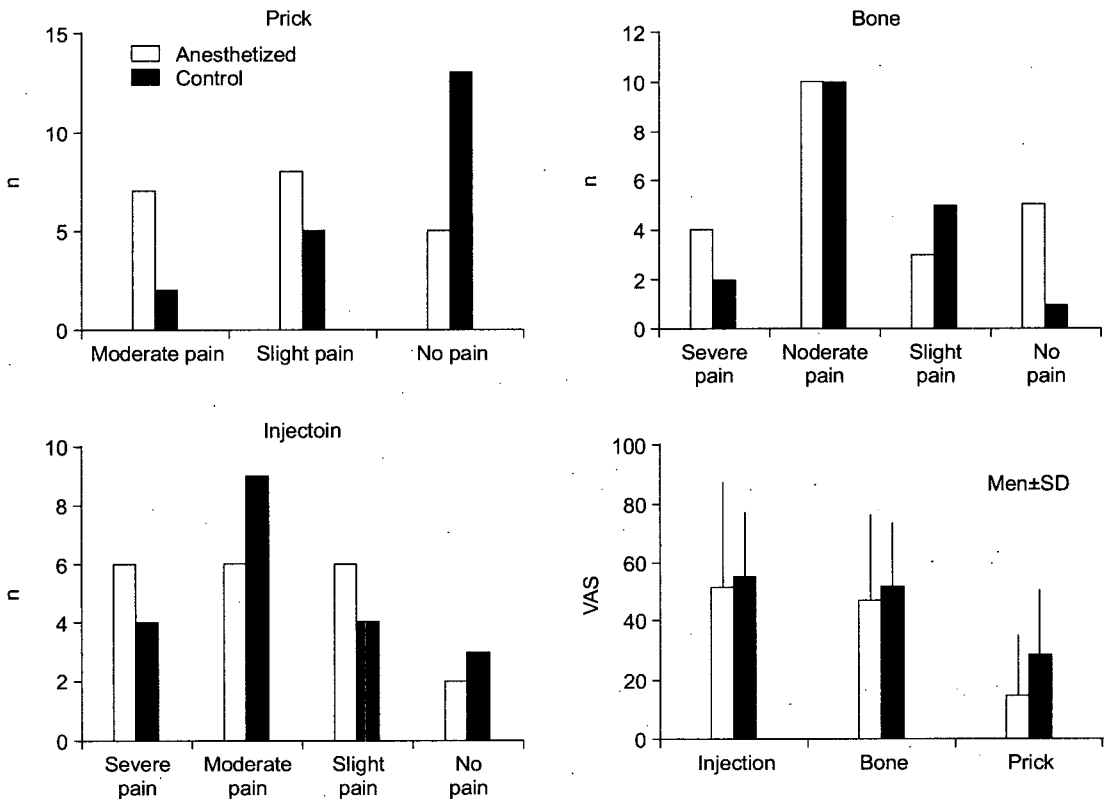


Fig. 2. Pain rating score by prick, bone and injection and visual analog scale after application of 20% benzocaine.

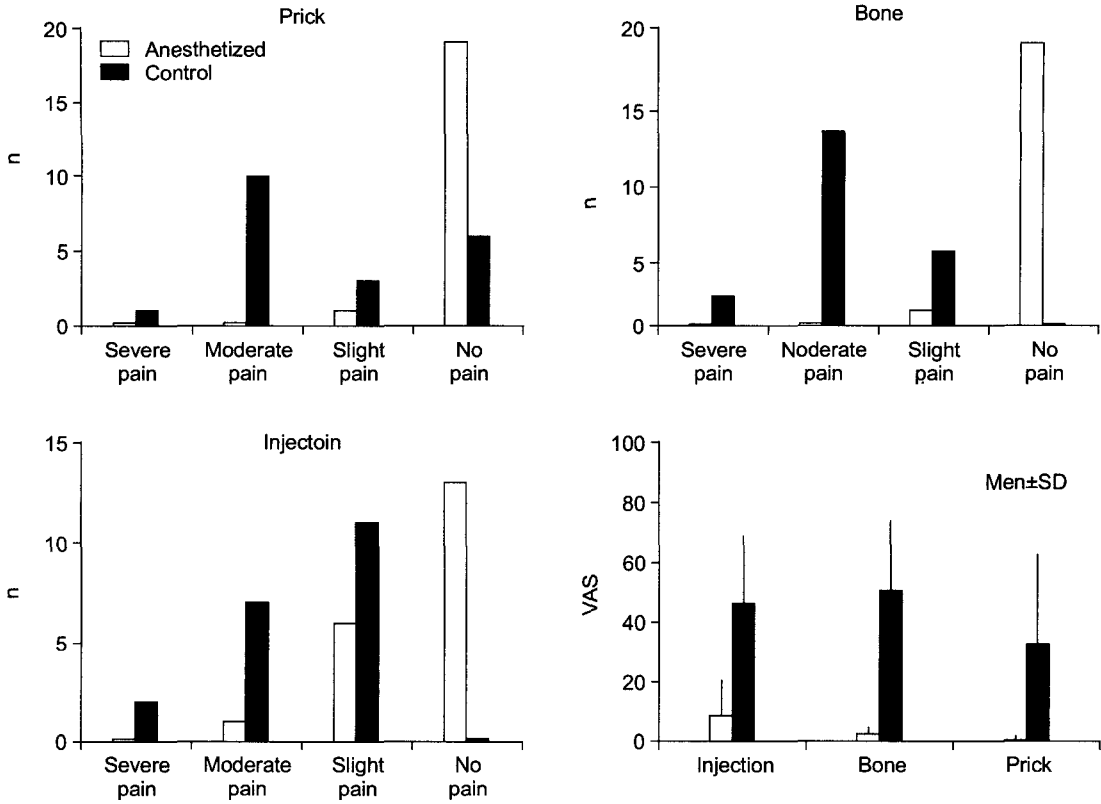


Fig. 3. Pain rating score by prick, bone and injection and visual analog scale after application of 60% lidocaine.

3 kinds of stimulation. They almost recognized no pain by prick and bone stimulation. Injection of anesthetic caused less pain compared to un-anesthetized side. PRS and VAS were significantly decreased by the topical anesthetic. We succeeded in enhancing topical anesthesia using concentrated anesthetic.

However, their application time was 20 minutes using special drape. In addition, the 60% lidocaine gel was sample agent. It means the situation is not clinically available. Though the same concentrated lidocaine is commercially available as adhesive tape in order to diminish catheterization intravenously, it is contraindicated to the oral mucosa. Generally, factors to enhance topical anesthesia are: more concentrated anesthetic, longer application time, and modified application method. Further researches are required to discuss addition of absorbents that will accelerate the drug delivery.

NEW ANESTHETIC DEVICES

New devices for local anesthesia have been introduced in order to reduce the pain, to relax the patient, and to ensure the anesthesia.

A small device is now commercially available in Japan and the US, called Vibraject (Fig. 4A, B). It is 18 g weight and battery operated machine. The structure is simple enough to be attached to the conventional infiltration anesthesia syringe or cartridge. It produces ultrasonic vibration by the motor powered by the batteries. The syringe itself begins to vibrate at a rate of 3,000 Hz to turn it on, which eliminates puncture pain at infiltration anesthesia. Thirty injections were given to the volunteers with or without Vibraject vibration. The results by PRS and VAS

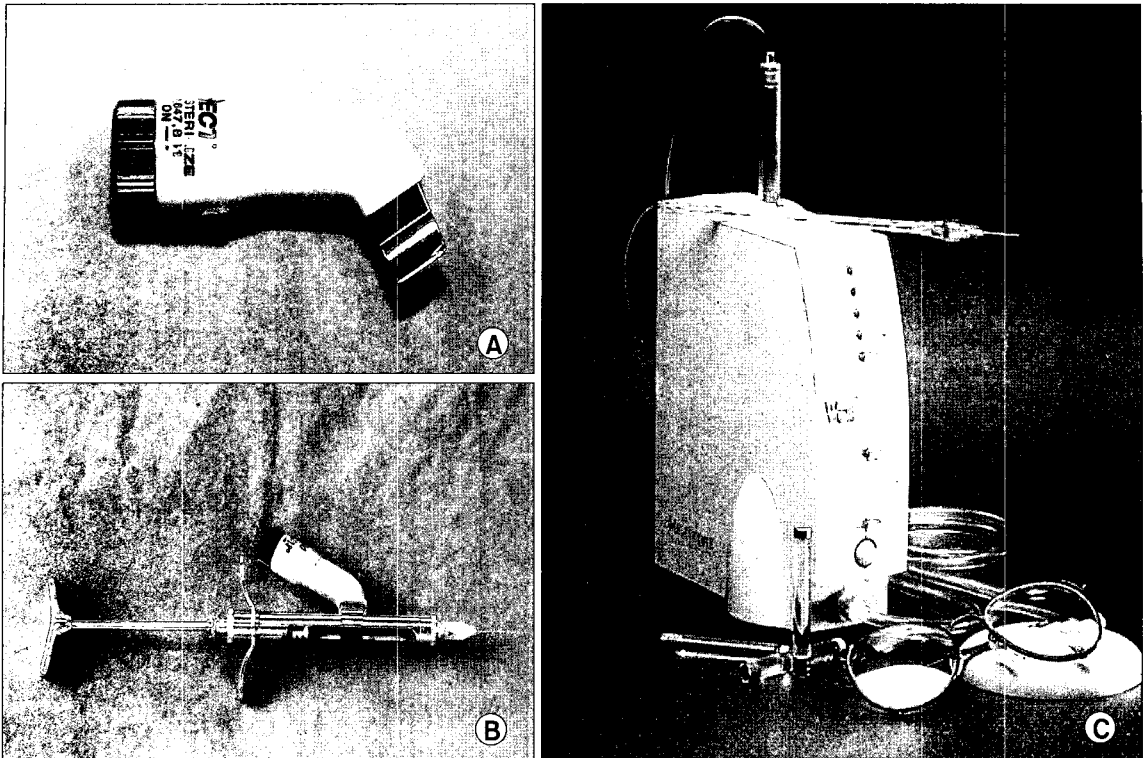


Fig. 4. Vibraject and the Wand. Vibraject (A), Vibraject attached to cartridge (B), the Wand (C).

showed no difference was found using Vibraject.

The next new system for local anesthesia is the Wand (Fig. 4C). It has its unique outlook but it can provide the same anesthetic, the same injections and the same pain control. It consists of microprocessor unit, plastic handpiece and foot control. The needle can be handled by pen like grasp and the anesthetic flow is controlled by CPU, switched by foot controller. Microprocessor unit regulates flow rate precisely in spite of various tissue resistance and the foot controller eliminates hand and arm fatigue. Pen-like grasp facilitates easy, precise and accurate injection. In addition, the needle can be rotated lightly, which enables to designate injection point. It is specifically advantageous for longer insertion technique like inferior alveolar nerve block. Rotation of the needle and slow penetration can make anesthetic pathway that is followed by the needle and can reduce the penetrating pain at inferior alveolar nerve block.

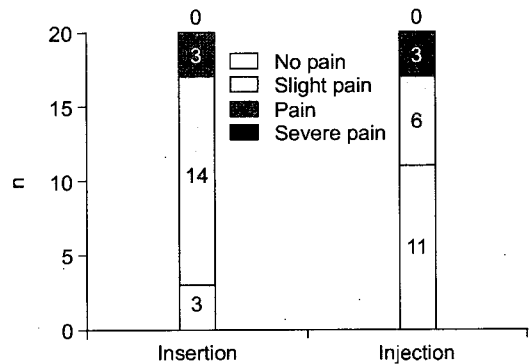


Fig. 5. Pain rating score by AMSA (Anterior Middle, Superior Alveolar) block by the Wand. Both insertion and injection caused little pain to the volunteers.

The new anesthetic system, the Wand, has also serves anterior middle superior alveolar, or AMSA, block of the maxillary nerve (Fig. 5). Single palatal injection leads upper 5 teeth anesthesia without numbing the la-

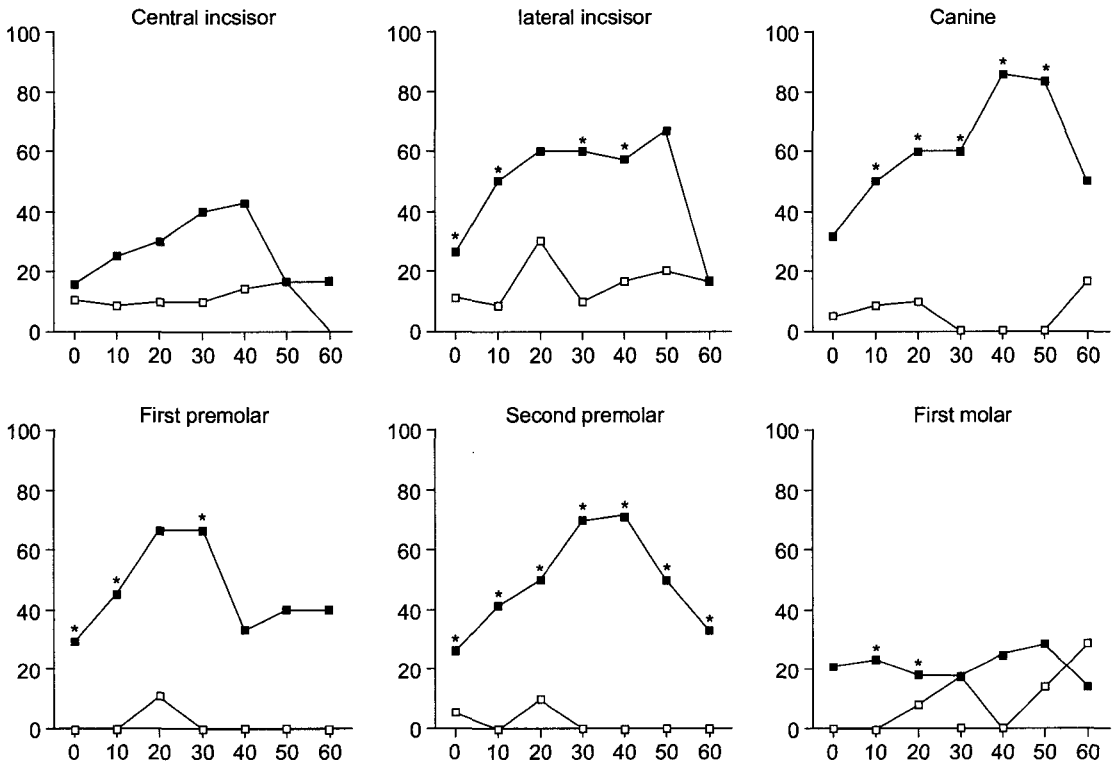


Fig. 6. Incidence of pulp anesthesia in the examined maxillary teeth by the time after injection and the percentage of 80 readings of pulp tester.

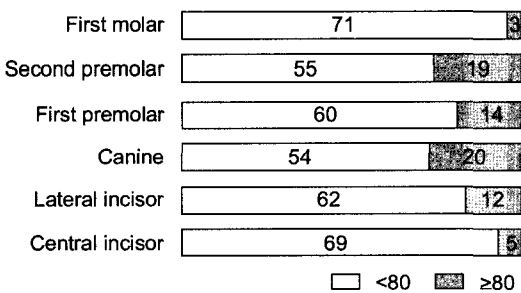


Fig. 7. Pulp tester readings of each upper tooth.

bial or buccal mucosa. According to the manual, AMSA provides anesthesia of the central incisor to the second premolar. We studied the AMSA using the 14 volunteers. Puncture and injection pain was assessed by PRS and VAS. The anesthetized tooth was investigated using Analytic pulp tester every 10 minutes. The injection point is bisect premolars, midway between gingi-

val margin and mid-palatine suture. Puncture and injection pain by the Wand were not so large as expected as in the left slide (Fig. 6). No one complained severe pain by injection. VAS also showed the palate injections were not big deals as concerned. Slower penetration and slower flow rate reduced pain even to the palatal injection as determined by visual analog scale. Analytic pulp tester was used for evaluation of the effect. Each tooth of both anesthetized side and control side was checked every 10 minutes up to 60 minutes after injection. The result showed canine, first premolar and second premolar were more completely anesthetized compared with central incisor and first molar (Fig. 7). It can be concluded that AMSA anesthesia is good enough to anesthetize the upper 3 teeth with single injection without collateral anesthesia and that it can be used as an alternative method for maxillary anesthesia. The Wand also provides PDL, or

periodontal ligament injection, safely and precisely. Although PDL needs more power to inject anesthetic into periodontium and causes intolerable pain, the machine can provide constant and high pressure, which eliminates damage of periodontium and pain. Because the injection power is supplied electrically, the dentist can concentrate on its injection point and injection direction. Although conventional syringe can deliver PDL, the new injection system can save the power to inject. It is easy to administer, no collateral anesthesia, reduces time of onset, which enables smoother practice.

These days, intraosseous injection has been focused on. We sometimes suffer from the patients' complaints that they feel pain of lower molars even after sufficient infiltration anesthesia. The concept of intraosseous injection is to inject anesthetic to spongy bone through

cortical bone. It provides excellent anesthetic effect. The system, which consists of two small needles, is called Stabident that are made in the US (Fig. 8A, B). The penetrating device, the perforator is exactly the same length and diameter as the injection needle. It has three steps. At first, the infiltration anesthesia is given to gingiva using the conventional needle as you see in the right slide. Secondly, the cortical bone was perforated to the spongy bone by the sharp perforator attached to a contra-angle handpiece at a high speed. Finally, the anesthetic is injected using the specific needle that has the same length and the same diameter as the perforator (Fig. 8C). Intraosseous anesthesia has another alternative system, which is called X-tip and consists of a needle and 2 parts of the perforator. Like Stabident, the spongy bone was perforated by the thinner and small

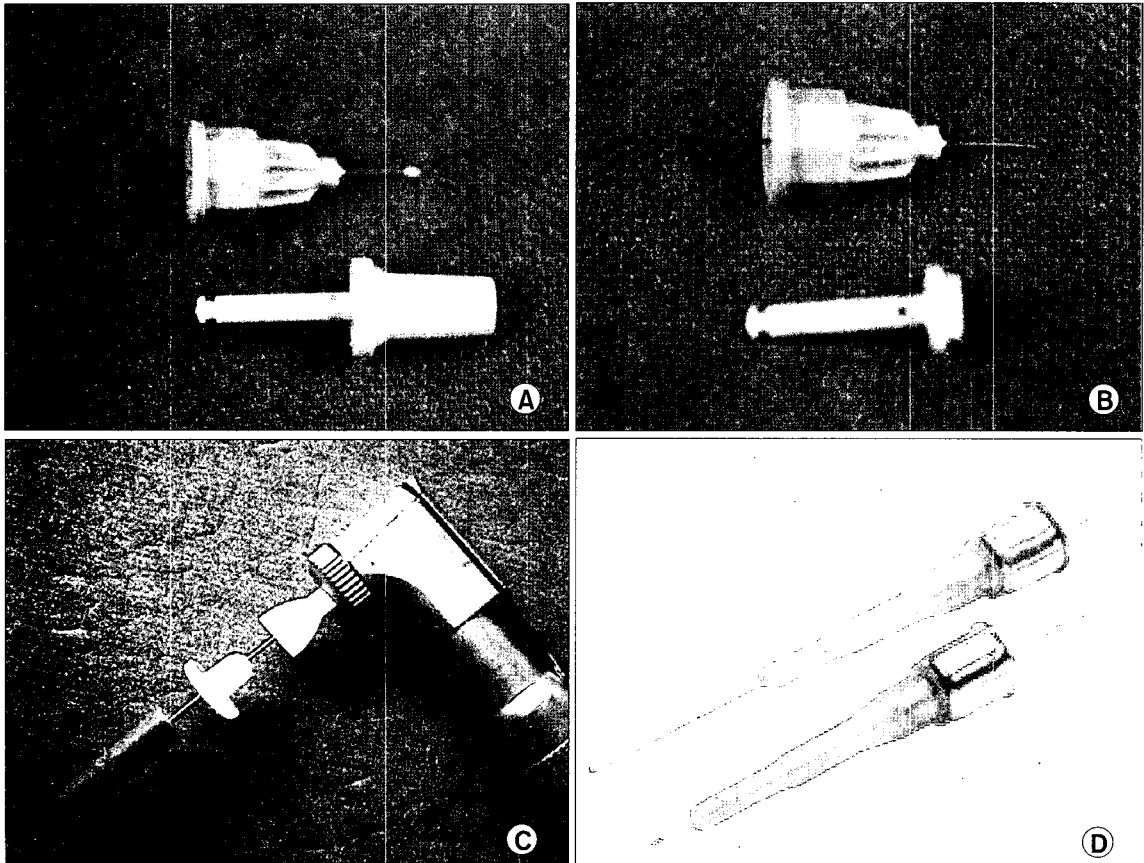


Fig. 8. Intraosseous injection devices; Stabident (A, B), X-tip (C), MPL (D).

drill set attached to the contra-angle handpiece. After perforated to the spongy bone, the upper part of the perforator is removed and the rest is left in the alveolar bone. It is a good indicator for injecting anesthetic to the spongy bone. The anesthetic injected by a needle that is the same diameter and length of the remaining perforator. After the injection, the perforator is easily pulled out by a forceps. Our experience shows both Stabident and X-tip work enough to anesthetize both teeth conjugating the injection site.

Hypointraosseous needle, or MPL, is a simple needle system consisted of one part (Fig. 8D). The sharp needle is covered by metal sheath, which enables easy and tight perforation to spongy bone. First the gingiva is lightly anesthetized and make a needle progress. After the sheath is protruded, the inner needle goes

into spongy bone through the cortical bone. The spongy bone is then anesthetized.

Sleeper One and Quick Sleeper are the new brands that were developed and now commercially available in Europe (Fig. 9A, B). Both of them provide intraosseous anesthesia like Stabident, X-tip, or MPL. Their unique characters are that Quick sleeper can rotate itself to penetrate into the alveolar bone. The component of the needle and the anesthetic cartridge rotates itself. MCCA, or Midwest Comfort Control System is another kind of syringe pump. Apart from the Wand, they have motors, which directly connected to the needles. That is why they are heavy to handle precisely. To use Quick Sleeper, the gingiva is anesthetized by infiltration method and the bone is drilled by Quick Sleeper, followed by anesthetic injection.

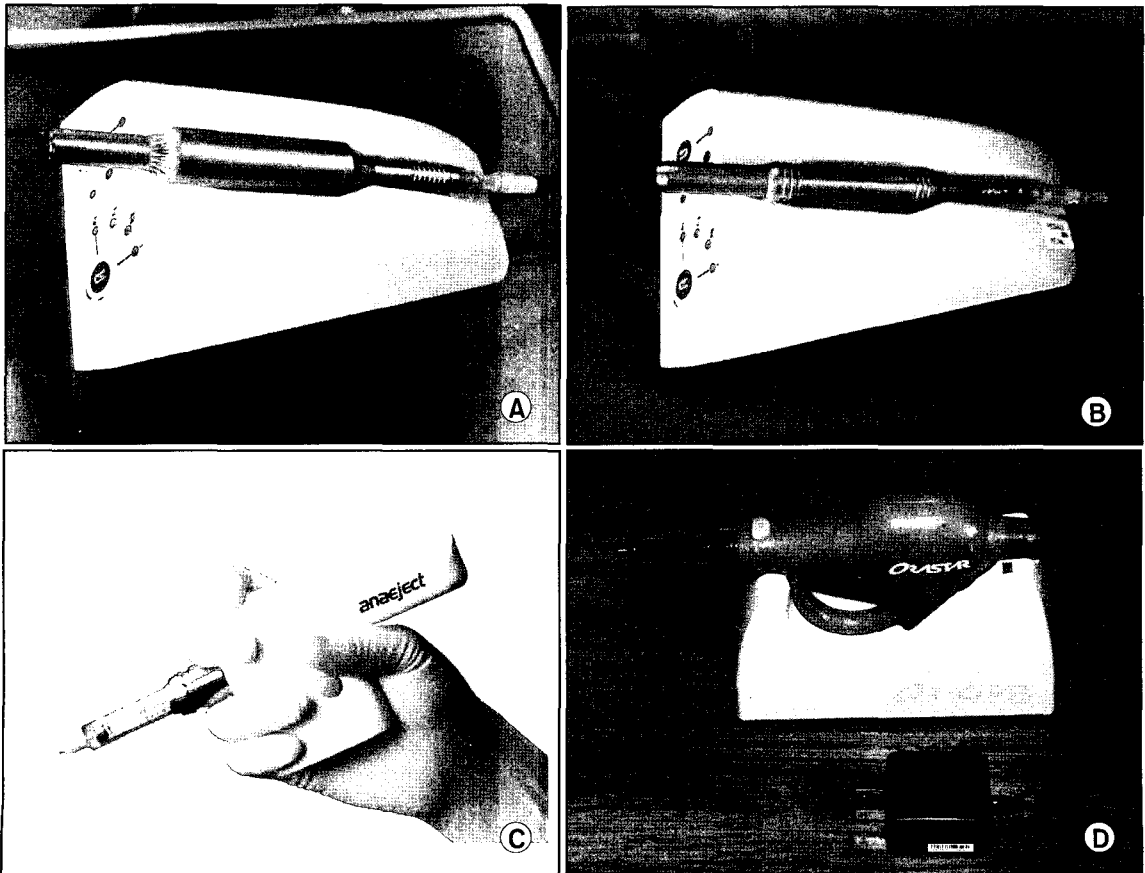


Fig. 9. Electric anesthesia systems; SleeperOne (A), QuickSleeper (B), Anaject (C), Ora Star (D).

Those intraosseous injection systems seem to cause great pain when injection to the bone. However, we have had seldom complaints by the patients. One of the reasons is sparse pain points within spongy bone of the alveolar.

Electric syringe pump systems are also available in our country (Fig. 9C). Anaject has been currently sold. It utilizes conventional needle and anesthetic cartridge. Anaject has a good competitor, called Orastar (Fig. 9D). Both are easy to use and allow the dentist to concentrate on the site of injection and the penetration of gingiva without hand and arm power, although they are heavy compared to conventional syringe and look shooting pistols.

FUTURE OF LOCAL ANESTHESIA IN DENTISTRY

One of our expectations of future of local anesthesia is continuous injection of anesthetic using catheter. Epidural or lumbar anesthesia often used in the general surgery and the system can be utilized for continuous injection for maxillary or inferior nerve block. Customized introducer, needle, adapter and extra thin catheter are used for the purpose.

Under the sterile circumstances, the catheter is inserted to round foramen or oval foramen. After the insertion, anesthetic solution is administered like the right slide. We are studying continuous infusion using syringe pump.

Iontophoresis will be an excellent candidate to control the pain in dentistry. Direct current iontophoresis was tried for pain control but was not clinically utilized because of severe pain and burn. Altered current iontophoresis is now being investigated vigorously. The optimum condition has been shown by a *in vitro* study using the specific cell shown in the right slide. The round shaped electrode for altered current iontophoresis will provide better drug delivery. Smaller electrode is expected. Altered current iontophoresis experimentally utilized for oral and maxillofacial pain clinic. The patch includes lidocaine solution and it can be deliv-

ered percutaneously. The patient has been relieved from pain of oral and maxillofacial region.

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REFERENCES

- Coggins R, Reader A, Nist R, Beck M, Meyers WJ: Anesthetic efficacy of the intraosseous injection in maxillary and mandibular teeth. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1996; 81: 634-41.
- Donaldson D, Meechan JG: A comparison of the effects of EMLA cream and topical 5% lidocaine on discomfort during gingival probing. *Anesth Prog* 1995; 42: 7-10.
- Hersh EV, Hoput MI, Cooper SA, Feldman RS, Wolff MS, Levin LM: Analgesic efficacy and safety of an intraoral lidocaine patch. *Journal of the American Dental Association* 1996; 127: 1624-34.
- Fukayama H, Sunakawa M, Mori M: Researches of enhancement of topical anesthesia in dentistry. *Journal of the Japanese Association for Dental Science* 2001; 20: 80-5.
- Fukayama H, Suzuki N, Umino M: Comparison of topical anesthesia of 20% benzocaine and 60% lidocaine gel. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002; 94: 157-61.
- Friedman MJ: New advances in local anesthesia. *Compendium* 2000; 21: 432-40.
- Friedman MJ, Hochman MN: A 21st century computerized injection system for local pain control. *Compendium* 1997; 18: 995-1003.
- Friedman MJ, Hochman MN: P-ASA block injection: A new palatal technique to anesthetize maxillary anterior teeth. *J Esthetic Dent* 1999; 11: 63-71.
- Friedman MJ, Hochman MN: The AMSA injection: A new concept for local anesthesia of maxillary teeth using a computer-controlled injection system. *Quintessence Int* 1998; 29: 297-303.
- Friedman MJ, Hochman MN: The AMSA injection: Anesthetize the teeth, not the face. *Contemporary Esthetics and Restorative Practice* 2000; 1: 1-2.
- Fukayama H, Yoshikawa F, Kohase H, Umino M, Suzuki N: Efficacy of anterior and middle superior alveolar (AMSA) anesthesia using a new injection system: The Wand. *Quintessence Int* 2003; 34: 537-41.

- Hochman MN, Friedman MJ: In vitro study of needle deflection: A linear insertion technique versus a bidirectional rotation insertion technique. *Quintessence Int* 2000; 31: 33-9.
- Hochman M, Chairello D, Hochman CB, Lopatkin R, Pergola S: Computerized local anesthetic delivery vs. traditional syringe technique. *New York State Dental Journal* 1997; 3: 24-9.
- Houpt MI, Heins P, Lamster I, Stone C, Wolff MS: An evaluation of intraoral lidocaine patches in reducing needle-insertion. *Compendium of Continuing Education in Dentistry* 1997; 18: 309-10.
- Kinoshita T, Shibaji T, Umino M: Transdermal delivery of lidocaine in vitro by alternating current. *J Med Dent Sci* 2003; 50: 71-7.
- Kohase H, Miyamoto T, Umino M: A new method of continuous maxillary nerve block with an indwelling catheter. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002; 94: 162-6.
- Krochak M, Friedman N: Using a precision metered injection system to minimize dental injection anxiety. *Compendium* 1998; 19: 137-47.
- Lieberman WH: The Wand. *Pediatric Dentistry* 1999; 21: 134.
- Martin MD, Ramsay DS, Whitney C, Fiset L, Weinstein, P: Topical anesthesia: Differentiating the pharmacological and psychological contributions to efficacy. *Anesth Prog* 1994; 41: 40-7.
- Meechan JG, Donaldson D: The intraoral use of EMLA cream in children. *ASDC* 1994; 61: 260-2.
- Milestone Scientific: Operating manual, the Wand. 6th ed. Illinois, Milestone Scientific Dental Revision. 1999, 25
- Miura K, Beppu S, Sato Y, Sekita S, Amemiya Y: A study of the effectiveness of topical anesthetic (Penles) on the oral mucosa. *JJDSA* 1997; 25: 174-7.
- Oldak SB, Jackson LA: The Wand. *J Southeastern Soc Pediatric Dentistry* 1999; 5: 38.
- Replogle K, Reader A, Nist R, Beck M, Weaver J, Meyers WJ: Anesthetic efficacy of the intraosseous injection of 2% lidocaine (1 : 100,000 epinephrine) and 3% mepivacaine in mandibular first molars. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1997; 83: 30-7.
- Shibaji T, Yasuhara Y, Oda N, Umino M: A Mechanism of the high frequency AC iontophoresis. *Journal of Controlled Release* 2001; 73: 37-47.
- Stabile P, Reader A, Gallatin E, Beck M, Weaver J: Anesthetic efficacy and heart rate effects of the intraosseous injection of 1.5% etidocaine (1 : 200,000 epinephrine) after an inferior alveolar nerve block. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000; 89: 407-11.
- Svensson P, Petersen K: Anesthetic effect of EMLA occluded with orahesive oral bandages on oral mucosa. A placebo-controlled study. *Anesth Prog* 1992; 39: 79-82.
- Svensson P, Petersen JK, Svensson H: Efficacy of a topical anesthetic on pain and unpleasantness during scaling of gingival pockets. *Anesth Prog* 1994; 41: 35-9.
- Taware CP, Mazumdar S, Pendharkar Adani MH, Devaraja PV: A bioadhesive delivery system as an alternative to infiltration anesthesia. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1997; 84: 609-15.
- Umino M, Kohase H, Ideguchi S, Sakurai N: Long-term pain control in trigeminal neuralgia with local anesthetics using an indwelling catheter in the mandibular nerve. *The Clin J of Pain* 2002; 18: 196-9.
- Yomosa H, Nagahata T, Nakahashi K, Yokoyama T: The effect of lidocaine tape in children. *J Clin Anesth* 1996; 20: 195-7.
- Yoshikawa F, Ushito D, Ohe C, Shiraishi Y, Fukayama H, Umino M: Vibrating dental local anesthesia attachment to reduce injection pain. *JJDSA* 2003; 31: 194-5.