Local anesthesics in dentistry

SUMMARY

Local anesthetics are administered every day in the practice of dentistry. Since there are quite a number of solutions on the market today, a dentist should be able to select the most one for every patient and each procedure.

During the last few years Articaine has been strongly promoted. We have tried to compare Articaine and Lidocaine in a clinical setting.

KEY WORDS: local anesthetics, articaine, lidocaine.
The omnipresence of local anesthetics in dentistry makes this class of drugs the most used in practice. For the five last decades, several local anesthetics came to the fore on the market, bringing more latitude to the dentist who now has the advisability to choose which anesthetic solution is adapted to meet a precise clinical situation. On the other hand, knowing the growing number of anesthetic formulas available, it is becoming more difficult to choose since it is not easy to remain current in this field of dental medicine. Certain myths or beliefs circulate among the dental profession people and this information, often unfounded, tends to keep an important place at the time of the decision-making which anesthetic way the dentist will follow.

This article is a literature review on certain nebulous points surrounding the local anesthetics used in cabinet, hoping to make it possible for professional people to do more judicious choices on the scientific knowledge based, known and accepted by the dental profession at present.

HISTORY OF LOCAL ANESTHETICS

It was December 1844 when Doctor Wells, assistant at a demonstration on the nitrogen protoxide, had the idea to use this gas to perform a teeth ablation. An involuntary test realized, at the time of the demonstration, when the speaker injured his one’s leg and he had not any reaction. This moment marked the beginning of the pain control techniques during surgical procedures in dental medicine. The possibility to perform surgery without patient pain was real but the entire procedure was carried out during a period when the patient was unconscious.

It was in 1880s that the second great step occurred, namely local anesthesia. The first local anesthetic drug was cocaine. The first block of the inferior alveolar nerve was dosed by Dr. William Halsted in 1885, in Baltimore. In the beginning, cocaine was drug miracle but it quickly lost its virtues as soon as its harmful side effects committed. In 1904, procaine made its appearance on the market and this new product replaced cocaine. Procaine, a vasodilator, was improved from its beginnings by adding epinephrine at a 1:50,000 concentration; this was the standard. Reactions triggered by the esters anesthetic class (procaine, tetracaine, pipercaine, etc) pushed researchers to synthesize a new class of local anesthetics, amides. In 1943, lidocaine made its appearance and quickly replaced procaine, lidocaine being much less allergen and more effective. Moreover, lidocaine was quicker to express its anesthetizing effect (3 to 5 min.) compared to procaine (6 to 10 min.). The incorporation of epinephrine at various concentrations created the possibility to improve lidocaine’s properties. In 1956, mepivacaine 2% with levonordefrin enters on the market and in 1961, it is mepivacaine 3% without vasoconstrictor's turn. In the middle of the 1960s, prilocaine 4% with and without epinephrine is born. Lidocaine, mepivacaine as well as prilocaine are average duration anesthetics (pulp, 20 to 60 min.) and the need for some longer duration anesthetics is felt. These anesthetics would be useful in order to meet the needs for more elaborate procedures which the dentist has to carry out at present.

At this point, bupivacaine and etidocaine make their debuts. These two drugs of long duration became popular for their duration of effect and their relative power, bupivacaine being four times more powerful than lidocaine.

PHARMACOLOGY

Today, the profession almost exclusively uses amides. In this class of anesthetics, there are lidocaine, prilocaine, articaine, mepivacaine, bupivacaine and etidocaine which are the principal agents. The local anesthetics consist of three distinct structurally parts: 1) the aromatic (or lipophilic) portion which allows the molecule to penetrate the lipid layers of the nervous membranes; 2) the final amino (hydrophilic) portion which allows the hydro solubility of the anesthetic solution in the dental cartridge and finally; 3) the intermediate chain sharing the lipophilic and hydrophilic portion. This intermediate chain is the part conferring to the molecule its ester (-COO-) or amide (-NHCO-) statute. The various arrangements of these three parts of an anesthetic molecule result in various anesthetic solutions having properties distinguishing them from one another. Articaine is an anesthetic containing a thiophene ring, prilocaine a toluene ring and the other amides a benzene core.

The pH, the pKa, the duration of the anesthetic effect, the effectiveness of the anesthetic solution, there are only some examples of affected variables by the molecular structure of the anesthetic.
The difference between the pH of a receiving site and the pKa of the solution determines if the solution will be in its cationic form or as free weak base, the latter being the able form to penetrate the nervous membranes and thus to perform its pharmacological effect. In general, the weaker the pKa is, the more chance there is that the anesthetic solution is in its favourable form, resulting in a faster time to reach the anesthetising effect (onset). The high pKa of bupivacaine explains its slow action debut compared to the other anesthetics. The effectiveness of an anesthetic solution depends especially on its liposolubility, most soluble being most effective. The great liposolubility of bupivacaine compared to lidocaine or mepivacaine makes the first four times more effective (and thereupon, four times more toxic) than the latter two anesthetics. The total duration of the anesthetic effect furnishes evidence of affinity between the molecule of the anesthetic and proteins constituting the nervous membranes, this affinity being also connected to the anesthetic liposolubility. The previous example, is thus always applicable as long as the anesthetic works. Once in the systemic circulation, the amides are metabolized mainly by the liver.

Lidocaine without vasoconstrictor is regarded as being of short duration (pulpal anesthesia of 5-10 min.) while lidocaine with vasoconstrictor, prilocaine with or without vasoconstrictor, mepivacaine with or without vasoconstrictor and articaine with vasoconstrictor are regarded as drugs of average duration (pulpal anesthesia of 20-90 min).

Bupivacaine with vasoconstrictor and etidocaine with vasoconstrictor are regarded as long duration anesthetics (pulpal anesthesia of 90-180 min).

Despite various characteristics between these anesthetic solutions, it results the same effect from their use, i.e. the interruption of the propagation of nervous impulse in various nerve fibres. This action occurs as result of some phenomena such as: 1) the reduction of the permeability of the nervous cell with respect to the sodium ions; 2) a decrease in the amplitude of the action potential; 3) an elevation in the excitation threshold; 4) a deceleration of the conduction speed as well as the fast phase of the action potential; and, 5) the inhibition of the capacity to generate an action potential.

COMPARATIVE STUDIES AND THOUGHTS CONCERNING THE POPULAR USE OF LOCAL ANESTHETICS IN DENTAL MEDICINE

One of the main questions encouraging us to carry out this work was to try to know if ULTRACAINE (articaine) really had a clinical superiority comparatively with the other anesthetics commonly used in dental offices.

This question is always relevant when we notice how popular this drug is with dentists (in Ontario, articaine is the anesthetic solution most employed i.e. 37.84 %). After a review of literature we conclude that it is inaccurate at present to claim that articaine is clinically much higher than its counterparts as lidocaine and prilocaine for example. The virtues which the dentists confer upon it are non-scientifically founded and must be partially regarded as speculation. Present available studies do not show any statistically significant difference between the articaine and other similar anesthetics. Haas, Harper, Saso end Young came to this conclusion when they compared the clinical effectiveness of oral infiltrations at the first molars and upper canines between articaine 4% with epinephrine 1:200 000 and prilocaine 4% with 1:200,000 epinephrine. There was no statistically significant difference between articaine and prilocaine for example. Haas, Harper, Saso end Young did not find any significant difference between articaine 4%-1:200,000 and prilocaine 4%-1:200,000 during jawbones and mandibular nerve blocks infiltrations in restoration dentistry, and this, as well for adults as for children. Other studies having texts in foreign languages but with summaries in English support also the fact that the articaine is not higher than the other local anesthetics. Vähätalo Antila and Lehtinen did not see any statistically significant difference between articaine 4%-1:200,000 and lidocaine 2%-1:80,000 regarding the required time for the anesthetic response and the duration of the anesthetic effect. Articaine does not produce more pulpal anesthesia than lingual comparatively with other solutions when used in oral infiltration on mandible contradicting what certain manufacturers claim.
In pediatric dentistry, the lower primary molars give the possibility to be infiltrated instead to dose a mandibular nerve block in order to obtain an adequate anesthesia for restoration work. This phenomenon does not occur only when the articaine is used but also in case of other anesthetic solutions. In this situation, the clinicians that dose the articaine to their pediatric patients thinking to have an additional effect are in mistake because other anesthetic solutions have the same effect on the lower primary molars. Moreover, the use of a cartridge of articaine which contains the double (in concentration) amount of anesthetic comparatively to a cartridge of lidocaine makes the administration of the anesthetic more perilous in case of children due to the increased risk of overdose and intoxication (4% vs 2%). From this point of view, lidocaine 2%-1:100,000 remains the choice anesthetic when the dentist is confronted with the task of anesthetizing a child.

One interesting fact to be mentioned is that articaine (as well as prilocaine) is associated up to a significant degree (compared to the other anesthetic solutions) with a risk of paresthesia (which remains far from probable nevertheless) during a mandibular nerve block. This retrospective study, led by Haas and Lennon in Ontario, was carried out in the situations where mandibular nerve blocks were administered in order to perform other than surgical procedures.

Pertaining to pediatric dentistry, as mentioned previously, the anesthetic of choice remains the lidocaine 2%-1:100 000 which is the best combination anesthetic-vasoconstrictor able to avoid the toxic level dose as much as possible. These amounts being easily reached in children, it is wise to dose these products in a progressive way and using only the necessary quantity to perform the envisaged works without a problem. One study reveals that the duration of the soft tissue anesthesia is similar depending on whether we use mepivacaine 3% without vasoconstrictor, of prilocaine 4% without vasoconstrictor and lidocaine 2%-1:100 000. This study illustrates that it is not advantageous to use the two first with the objective of reducing anesthesia duration (in order to avoid the problem of soft tissue bite at the children) because all of them offer the same anesthesia duration (soft tissue). If there is no advantage in using these solutions, why should we use them when we just keep increasing the amount of anesthesia (mepi-3% and prilo-4%) administered to the child, moreover not using a vasoconstrictor which enables a certain reduction in the systemic absorption of the anesthetic. Moreover, certain authors suggest the use of lidocaine 1%-1:100,000 in order to decrease the quantity of dosed anesthetic and thus avoid the toxic amount threshold.

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This method is suggested in particular when the dentist foresees performing several minor procedures during the same appointment. Other authors suggest the use of articaine 2% with vasoconstrictor, justifying that the lower concentration and the short half-life of the metabolism (whose elimination is quicker) of articaine would make it more difficult to reach the toxic dose. One study conducted in Florida on dentists treating many children made us realize that there are still simple concepts which remain misunderstood. For example, the initial quantity of anesthetic dosed during a mandibular nerve block is higher than normally accepted amount (1-1.5 ml). Moreover, during this block failure, the clinicians often re-administer too much anesthetic, sometimes risking exceeding the toxic amount limit. In the same article, it is easy to note that certain dentists are not able to perform calculations allowing determining the maximum quantity of anesthetic which can be dosed for a child of a given weight. The concept of maximum amount dose is still misinterpreted. Often there are small simple details as mentioned above, which can involve serious problems for a pediatric patient.

The last subject addressed is long duration anesthetics, in particular bupivacaine and etidocaine. It would be important to underline how much the recent studies encourage the dentists to use them (within a pain management protocol including nonsteroid anti-inflammatory medication administration before and after surgery) during third molars extraction (especially lower, because in the upper maxilla, the pulpal anesthesia is appreciably the same with long duration and medium long duration anesthetics). It even suggests the use of long duration anesthetics during endodontic surgery and when a postoperative analgesia is desired.
Long duration anesthetics have their use in dentistry but it is necessary to be aware that these drugs have a toxicity proportional to their relative power. For example, bupivacaine has a greater potential on cardiac depression compared to lidocaine or articaine. In the department of surgery of the Faculty of Dental Medicine of Laval University, we attempted to clinically compare Ultracaine and Xylocaine. The protocol was very simple. We obtained a thousand (1,000) carpules of Ultracaine DS Forte (Articaine 4% with Epinephrine 1:100,000) and a thousand carpules of Xylocaaine 2% 1:1,000,000.

For the period of 27 February 1995 to 28 April 1995, we used Ultracaine on 232 patients during 21 operations performed in surgery clinics. The anesthesia was administered by fourth year students. Of the 232 patients treated, 45 had to receive an addition of anesthetic because of pain they felt. This represents 20%.

For the period of 26.02.97 to 25.04.97, we used 1,000 carpules of Xylocaine 2% 1:100,000 Epinephrine on 221 patients during 21 operations performed in surgery clinics. 59 patients had to receive an addition of anesthetic. So 26%.

The administration of the anesthesia was performed by finishing students and at a comparable period of the year. However, the students’ expertise cannot be compared with an experienced practitioner’s expertise.

It would thus seem that this “not scientific” clinical research grants a certain superiority to Articaine, which is not the case according to the literature consulted.

This solution is however more expensive than the others and if the dentist buys the product from Hoechst-Roussel Canada, he must get this company’s specific syringe because of the configuration of the stopper which does not allow the use of a harpoon syringe.

Therefore, we suggest to the practitioner having in a choice of local anesthetic in his dental office, the lowest possible effective concentration, with sufficient concentration of vasoconstrictor to obtain an effective anesthesia for the procedure to be performed.

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