The Dental Syringe: Past and Present, a Pain Management Perspective

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What do patients fear about going to the dentist? Patients cite a number of reasons to explain their dental phobia, including fear of pain, fear of injections (or fear the injection won't work), fear of anesthetic side effects, feelings of helplessness, and embarrassment and loss of personal space.[1-3] As dental professionals we can't say we blame them.

One of the first instances of pain a child is subjected to is the pain caused by a battery of immunization shots. Children are conditioned to equate pain with needles and a doctor's office. This "fear conditioning" may continue to early adulthood and beyond.[4] Unfortunately, dental professionals have to deal with the ramifications of these fears.[5,6] On the other hand, dentistry now has the tools and techniques to help alleviate fear of the dental injection, both psychologically and physiologically.

The Advent of the Dental Syringe

The first known use of a syringe-like device to perform a medical procedure dates back to 900 AD, when the Egyptian surgeon Ammar ibn Ali al-Mawsili devised a thin, hollow glass tube with suction to remove cataracts. Syringes were only used to remove objects or fluid from humans, not inject them. In 1650, Blaise Pascal invented the concept of a syringe (not necessarily hypodermic) as an application of what is now called Pascal's Law. Forms of intravenous injection and infusion were used in the 1830s to treat cholera with intravenous saline. Credit for the hypodermic syringe for medical purposes goes to Dr. Alexander Wood in 1853. He modified a regular syringe, which at the time was used for treating birthmarks, by adding a hollow needle.

Wood had been experimenting with a hollow needle for the administration of drugs into the body. In 1855 he published an article in *The Edinburgh Medical and Surgical Review* in which he demonstrated that the method was not necessarily limited to the administration of opiates.[7,8]

In the late 1800s, Dr. William Halstead applied the use of the hypodermic syringe to dentistry, demonstrating that an interstitial injection of aqueous cocaine resulted in an effective inferior alveolar nerve block; that a small amount of anesthetic injected into the trunk of a sensory nerve resulted in a numbing of pain in all that nerve's branches. This discovery ushered in a new era of local pain management.[9,10]

The First Significant Change

It is interesting to note that during the past 150 years, the basic design of the hypodermic syringe has not changed very much. The first hypodermic syringes consisted of a cylinder with a movable plunger inside (Figure 1). Notable improvements included the incorporation of a glass piston within the cylinder to prevent leaks and reduce the chance of infection. As plastics developed, they were incorporated into the design to reduce costs and improve safety (Figure 2). However, the basic design, mechanics, and manual operation of the dental syringe has, until very recently, remained essentially unchanged.

Recently a new device called the STA System (Figure 3) was launched by Milestone Scientific, Inc. STA stands for Single Tooth Anesthesia, and it represents a major technological advance in anesthetic delivery. It is a computer-controlled, local anesthetic delivery system that consists of a drive unit about the size of a cable modem, and a separate single-use, disposable handpiece/needle assembly, referred to as The Wand. The drive unit provides real-time dynamic pressure sensing technology, which allows dental professionals to perform the most predictable, successful, and virtually painless single-tooth anesthesia technique known to date.[11,12] The core technology uses an electromechanical motor regulated by a central processor functioning in concert with a force/pressure transducer.

The Physiology of Dental Injection Pain

Contrary to popular thought, the needle entering tissue is not the primary cause of discomfort. Rather, it is the volume and pressure of the anestheti being injected that causes the most distress.[6] The main factor for pain control during a dental

injection is the slow dispensing of the anesthetic. Anesthetic injection with a conventional dental syringe is not only technique-sensitive, it is also a "blind" injection because there is no way of precisely knowing when the needle tip has reached its target, and also no way to observe the deposition of anesthetic solution as it enters the tissues to monitor the rate of flow. A continuous stream of anesthetic solution is not the goal; rather, the aim is to produce a constant, interstitial drip that delivers the anesthetic below the threshold of pain.

Computer-controlled anesthetic injection devices automatically incorporate this pain reduction strategy because they deliver the anesthetic more slowly and precisely than a conventional syringe. A device such as the STA System delivers precise pressure and volume ratios (flow rate) of anesthetic using standard cartridges and needles. Even in resilient tissues such as the palate and periodontal ligament, this system maintains an optimal flow rate for an effective and virtually pain-free injection.[13,14]

During needle insertion, continuous positive pressure delivers an anesthetic drip that precedes the needle. The combination of an anesthetic pathway and controlled flow rate results in a virtually imperceptible injection and rapid onset of profound anesthesia.

In addition to the benefits of a more comfortable injection, the dentist is also afforded the benefit of a predictable outcome inherent only via computer-controlled dental anesthesia. For example, when administering an intraligamentary injection with the STA System, the computer senses and records the interstitial exit pressure of anesthetic at the needle tip and, when the specific resistance of intraligamentary tissue is identified, an audible announcement is given to confirm that the periodontal ligament has positively been reached.

Figure 1—Vintage syringe.

Another important clinical aspect of the intraligamentary injection is that it only requires between 1 and 4 minutes of total injection time; the onset of anesthesia is immediate, so treatment can begin right away (as opposed to a 5- to 8-minute waiting period required with traditional syringe injections), and it numbs only the tooth or teeth to be treated, with no collateral effect.

Patient Perception

As soon as the clinician has the physiological aspects of pain under control, he or she must also deal with patients' psychological manifestations of pain. As mentioned in the introduction, patients' fear of dental injections stems from preconceived and previously learned experiences. Therefore, the mere thought or sight of a syringe or needle is enough to cause anxiety and fear.[15] The STA System's handpiece does not look like a foreboding conventional syringe, but rather resembles an ordinary pen with a length of hollow tubing attached.

Incorporating certain procedural when injecting local anesthetics—such as vocal sedation methods and therapeutic touch—also put the patient's mind at ease before injection.[16] Other ways to help reduce anxiety are providing patients with

Figure 2—Modern syringe

headphones and soothing music, or allowing them to watch a video.

Comparative research has demonstrated that pain perception with the STA System is significantly lower than with a traditional syringe. One study found that fear and anxiety levels associated with dental injections were dramatically reduced up to 88% after just 1 injection with the STA System.[17] These percentages are statistically significant and remarkable because the desensitization to fears is based on multiple exposures to the feared stimulus. Another study comparing the pain-related behaviors of the STA System vs a traditional syringe injection showed a significant reduction in the likelihood of disruptive behaviors during the initial moments of an injection.[18] And last, a third study comparing the perception of pain and time of anesthetic onset in children between the ages of 7 and 18 years resulted in significantly lower pain ratings than for the same injections with a traditional syringe.[19]

Conclusion

Pain management in association with dental injections has always been

Figure 3—STA System (Milestone Scientific, Inc).

a sticking point in dentistry. For more than a century, aside from refinements in design and materials, little has changed with the look, feel, and mechanics of the traditional dental syringe. Only within the last decade has progress been made to incorporate high-tech, computerized anesthetic delivery systems into the realm of dental injections, all in an effort to provide a more comfortable, effective, and stress-free experience for both patient and practitioner alike.

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Product References

Product: STA System
Manufacturer: Milestone Scientific, Inc.
Location: Livingston, New Jersey
Phone: 800.862.1125
Web site: www.milestonescientific.com