

Self-Aspirating Syringes with Consideration of Epinephrine Level

Self-aspirating syringes have been gaining popularity recently. The self-aspirating mechanism works by a little bump at the end of the syringe compressing the diaphragm of the anesthetic cartridge during injection. When the pressure of injection is released (Figure 1), there is the relaxation of the diaphragm, thus creating negative pressure. In general, these self-aspirating syringes do not offer harpoons and their plungers end with pistons (Figure 2).

In self-aspirating needles and syringe system, **aspiration can occur only after injection has been started**. The most local anesthetics used in dentistry contain epinephrine. In the inadvertent cases of injection into the bloodstream, there are concerns of epinephrine level before self-aspiration can take place. The main purpose of this paper is to review the safety of the patients regarding the self-aspirating syringes regarding the epinephrine level. Depending on the volume of the anesthetic, the amount of epinephrine could trigger the unexpected cardiovascular events in the compromised patients.

Dr. John A. Yagiela published a paper titled *Local Anesthetics* in *Anesth. Prog.* 38:128-141, 1991. In his paper he compiled the results by different authors and plotted the changes in the plasma epinephrine concentration level absorbed from the injection sites as the different amounts of epinephrine were injected.

The rule of thumb is that 2 cartridges (1.8 ml) of 2% lidocaine with epinephrine 1:100,000 (36 microgram of epinephrine) are considered safe in most cardiac patients. According to Dr. Yagiela's graph, from the resting level of 39 pg/ml, **infiltration of 36 mcg of epinephrine** would produce **additional increase in blood level of 150 pg/ml** thus to **the new total of 189 pg/ml**, which is assumed to be safe.

In the self-aspirating syringe, a few droplets of the anesthetic solution have to be expressed prior to self- aspiration. The minimum amount is calculated to be between 0.1 to 0.15 ml. The amount of epinephrine in the 0.15 ml of 2% lidocaine with epinephrine 1:100,000 is calculated to be **1.5 mcg**. The resultant level of the epinephrine has to be safe after inadvertent injection of 1.5 mcg of epinephrine into the bloodstream to conclude that the self-aspirating syringe is safe.

According to Dr. Yagiela, the resting level of 39 pg/ml of epinephrine is calculated to be 0.1365 mcg of epinephrine is circulating (endogenous) in an average female body. The inadvertent injection of 1.5 mcg epinephrine (exogenous) plus 0.14 mcg of resting level (endogenous) add up to total of **1.64 mcg of the new circulating epinephrine**. In an average female body, the addition of **1.5 mcg of injected epinephrine intravenously** (according to the calculations in the opposite page) gives to **the new serum level of 470 pg/ml**, which is **dangerous** to the patients with significant cardiovascular compromises.

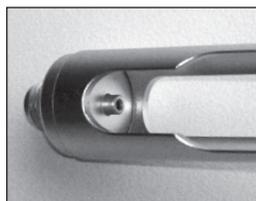


Figure 1

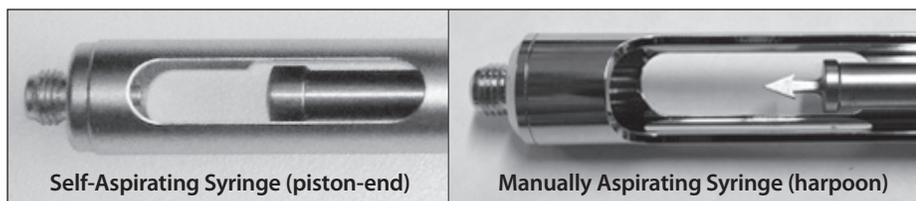


Figure 2

For reference:

$$150 \text{ pg/ml} = 150 \text{ ng/l} = 0.15 \text{ mcg/l}$$

$$1 \text{ pg} = 10^{-12} \quad 1 \text{ ng} = 10^{-9} \quad 1 \text{ mcg} = 10^{-6}$$

- 1). An average adult male is 70 kg (154 lb) and adult female is 50 kg (110 lb).
- 2). The volume of blood in a healthy person is calculated to be 7% of body weight.
- 3). In average the volume of blood is 4.9 liter and 3.5 liter in male and female respectively. For our calculation, we will use female's body weight for additional safety.
- 4). The resting level of epinephrine is 39 pg/ml prior to injection of local anesthetics.

$$0.039 \text{ mcg/l} \times 3.5 \text{ l (blood volume of female)} = 0.1365 \text{ mcg}$$

0.1365 mcg of circulating epinephrine (endogenous) will be used as a baseline

- 5). 1.5 mcg of epinephrine was injected into the bloodstream prior to testing self-aspiration which is the amount of epinephrine in the 0.15 ml of anesthetic (exogenous).

$$1.5 \text{ mcg (exogenous)} + 0.1365 \text{ mcg (endogenous)} \approx 1.64 \text{ mcg (total)}$$

$$\frac{1.64 \text{ mcg (total circulating epinephrine)}}{3.5 \text{ l (blood volume of adult female)}} \approx 0.47 \frac{\text{mcg}}{\text{l}} = 470 \frac{\text{pg}}{\text{ml}}$$

Although it can be argued that for patients with significant cardiovascular diseases, the operator should choose the local anesthetic without epinephrine and it is a poor choice of the medication, not a failure of the medical device; however, the design and usage of a medical device should have the compensatory mechanism built in to accommodate the frequent usage of the medical device.

Therefore, **self-aspirating syringes should not be used with local anesthetics containing vasoconstrictors like epinephrine.** Furthermore, **self-aspirating syringes should not be used on children under the age of 12 and weighing less than 100 lbs (45kg) for consideration of systemic overdose of the local anesthetics themselves.**