

DURATION OF LOCAL ANESTHESIA IN RELATION TO CONCENTRATIONS OF PROCAINE AND EPINEPHRINE

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In order to achieve a prolongation of local anesthesia, addition of epinephrine has been recommended (1) and used extensively. However, few exact experiments have been made to determine the optimal concentration of procaine and epinephrine necessary for a certain duration of local anesthesia.

Procaine.—From previous experiments (2), in which anesthesia was tested on the rabbit's cornea after subconjunctival injection of procaine HCl, it was concluded that the optimal amount of fluid has to be adapted according to size and type of the injected area; an increase beyond this optimum does not increase the depth or prolong duration of anesthesia to any noteworthy degree. The duration of anesthesia with procaine HCl was found to be only slightly increased by increasing the concentration of the drug above 1 per cent. Figure 1 shows that a tenfold increase (from log. —3 to log. —2) results only in a prolongation from about 36 to 64 minutes. The practicability of increasing the concentration is still more restricted by the toxicity of procaine which is known to increase in geometrical ratio to its concentration (3). Thus, about 200 cc. of a $\frac{1}{2}$ per cent. solution of procaine HCl can be used for infiltration anesthesia, 80 cc. of 1 per cent., 20 cc. of 2 per cent., and only 5 cc. of 4 per cent. The corresponding absolute amounts of procaine are 1.0, 0.8, 0.4, and 0.2 grams respectively.

Procaine and Epinephrine.—Although causing local anemia and prolonging anesthesia, epinephrine may increase the dangers of anesthesia, at the site of injection, e.g. causing ischemic gangrene of the fingers, and systemically in vasolabile and hyperthyroid patients, or through accidental intravenous injection (4). It, therefore, seemed important to study the effect of different concentrations on duration in order to be able to reduce the amount of epinephrine to the lowest possible level. Figure 2 shows the effect of different concentrations of epinephrine added to 1 per cent. procaine HCl. The solution was injected under the conjunctiva of the rabbit's eye and the resulting anesthesia of the cornea tested with the help of an electric inductorium. Epinephrine 1:1,000,000 showed no prolongation, 1:400,000 an average of 40 per cent. prolongation, and 1:200,000 60 per cent. prolongation (to 91 minutes), concentrations above 1:200,000 increased the duration of anesthesia only to a very small extent; 1:50,000 gave an average duration of 98 minutes.

Occasionally these higher concentrations caused reactive hyperemia and edema of the conjunctiva, or failure of return to the normal sensitivity of the cornea within the next few hours; these symptoms have to be considered as signs of damage to the tissue. Bieter (5), using $\frac{1}{8}$ per cent. procaine HCl in the human wheal test, obtained comparable results; his value for duration of anesthesia with $\frac{1}{8}$ per cent. procaine is 16.6 minutes; after addition of epinephrine 1:500,000 = 65.4 min.,

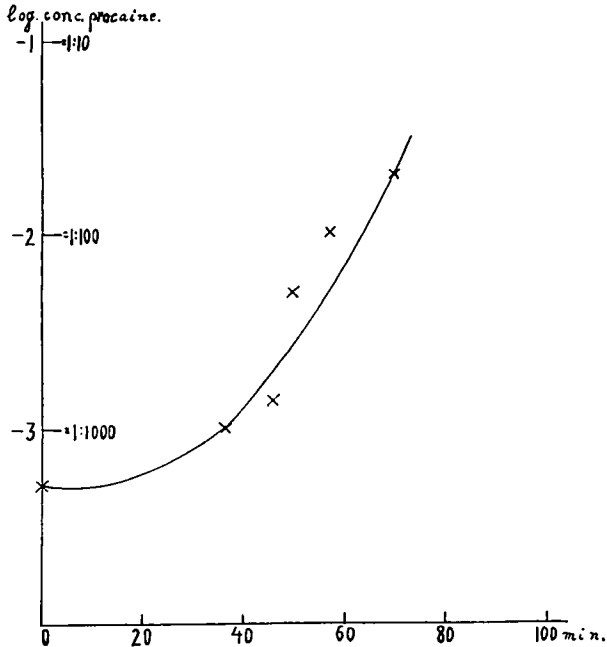


FIG. 1. Concentration-duration curve for injected procaine HCl. Fluid volume constant (0.8 cc.). Abscissa: duration of anesthesia in minutes. Ordinate: logarithm of concentration per cent. Total number of experiments 88.

1:200,000 = 89.2 min., 1:100,000 = 87.2 min., 1:50,000 = 83.0 min. Thus no further prolongation could be obtained by increasing the concentration beyond 1:200,000; he reported similar results for Metycaine, Cocaine, and Panthesine.

Summary.—Increasing the concentration of procaine beyond 1 per cent. results in a prolongation of anesthesia proportional to a simple multiple of the logarithm of concentration.

Epinephrine 1 : 200,000 prolongs anesthesia with 1 per cent. procaine HCl by about 60 per cent.; lower concentrations are less, higher are slightly more effective, but the latter may cause damage to the tissue.
 The author is indebted to Dr. C. H. Thienes for many valuable suggestions.

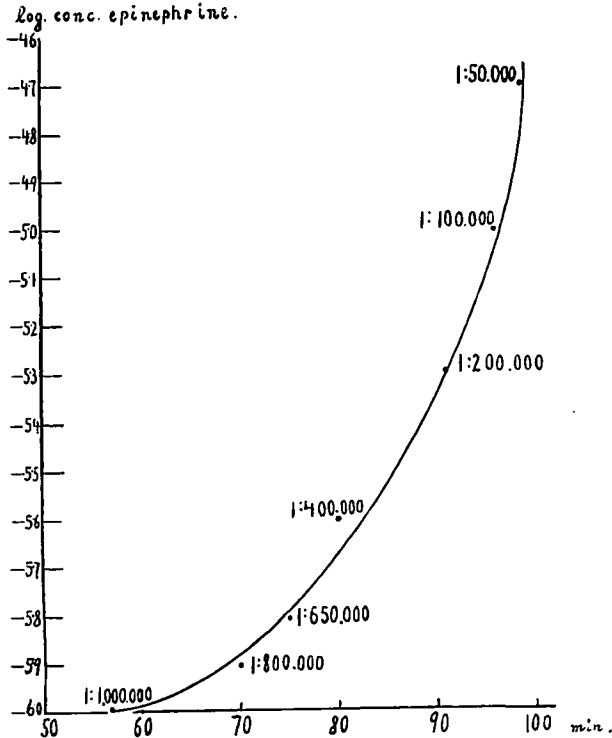


FIG. 2. Concentration-duration curve for injected procaine HCl and epinephrine HCl. Procaine HCl concentration constant 1 per cent. Fluid volume constant (0.8 cc.) Abscissa: duration of anesthesia in minutes. Ordinate: logarithm of concentration of epinephrine HCl. Total number of experiments 37.*

* This and the preceding graph are based on arithmetic averages. The deviation from the mean was within ± 30 per cent.

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