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EFFECT OF EPINEPHRINE UPON THE DURATION OF SPINAL ANESTHESIA

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EPINEPHRINE prolongs the action of local anesthetics probably by local vasoconstriction reducing tissue blood flow and thereby the rate of removal of the anesthetic.[1, 2] Bieter[3] has shown that there is an optimal dose (*i.e.*, a dose beyond which there is no increase in effect) of epinephrine for prolonging cutaneous anesthesia. Since epinephrine has been suggested as a possible cause of ischemic tissue destruction following local[1] and spinal[4] anesthesia, we have attempted to determine the optimal dose of epinephrine for spinal anesthesia.

METHODS

The duration of spinal anesthesia was measured in 137 healthy male patients undergoing elective surgery upon the abdominal wall or the lower extremities. Doses of epinephrine, either 0.1 mg., 0.2 mg., 0.3 mg., 0.4 mg., or 0.5 mg., or no epinephrine were selected by random tables. In addition, each patient received 1 per cent tetracaine 12 mg. and 10 per cent dextrose 1.2 ml. A final volume of 3.0 ml. was obtained with spinal fluid. Lumbar punctures were performed in the lateral position following the intramuscular administration of 25 mg. of ephedrine. After the subarachnoid injection of the drugs, the patients were turned to the supine position and remained approximately horizontal throughout the period of study. The level of analgesia was determined by tapping the abdomen with a pin from the level of the pubis upwards until the patient was able to feel the sharp stick of the pin. This was repeated every fifteen minutes until cutaneous hypesthesia was below the twelfth thoracic level. All patients were conscious throughout the period of study; the only sedation which the patients received consisted of meperidine 50 mg. and pentobarbital 100 mg. intramuscularly one to one and one-half hours before operation. A statistical comparison of the duration of analgesia was made between the six groups of patients.[5]

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RESULTS

There were no statistical differences in age, height, weight, or the maximum level of analgesia among the different groups of patients (table 1). When the end point was considered the time that analgesia began to wear off, *i.e.*, the time when the level had dropped at least two dermatomes (table 2), the duration of analgesia was significantly increased as the dose of epinephrine was increased ($b = 7.36$ minutes increase per 0.1 mg. epinephrine, $r = +.276$, $P < .01$). When the end point was the time when the level of analgesia reached the tenth thoracic level (table 3), the increase in duration was again apparent ($b = 9.46$ minutes increase per 0.1 mg., $r = +.273$, $P < .01$). Six patients were not included in this calculation because analgesia did not rise above the tenth thoracic level. The variation in response from patient

TABLE 1

AGE, HEIGHT, WEIGHT OF PATIENTS AND MAXIMUM LEVEL OF ANALGESIA

Dose, Mg. Epinephrine	Number of Patients	Age (Years)		Height (Inches)		Weight (Pounds)		Max. Level* Mean
		Mean	Range	Mean	Range	Mean	Range	
0	22	47	18-74	68.0	60–74	162	130-205	4.45
0.1	21	51	20-76	67.6	60–72	159	106–220	4.55
0.2	18	44	19-69	68.3	64–75	160	100 215	4.12
0.3	29	44	19-70	68.9	60–74	163	100–220	3.89
0.4	24	47	18 79	67.6	61 74	150	110 222	4.33
0.5	23	43	19-76	68.3	65–72	167	85 214	4.26

* Highest thoracic dermatome above which there was no cutaneous analgesia to pin-prick.

to patient was quite large (note standard deviations and ranges).

DISCUSSION

These data demonstrate that epinephrine added to tetracaine and 10 per cent dextrose and injected intrathecally prolongs the duration of spinal anesthesia. This prolongation increased as the dose of epinephrine was increased until a dose of 0.5 mg. epinephrine was reached. Thus, if there is an optimal dose, it is greater than 0.4 mg. The data of Braun [1] and Homeyer, Mintz and Adriani [6] support this assumption. However, Bieter [3] demonstrated that a concentration of greater than 1:200,000 resulted in a diminished effect. If we assume that epinephrine is diluted in about 30 ml. of spinal fluid, the resulting concentration would be 1:60,000 for 0.5 mg. and 1:300,000 for 0.1 mg. As the local anesthetic [7] and the epinephrine become more dilute at higher levels in the subarachnoid space and the effect of the drugs occurs in a few minutes,[8] probably before equilization has had time to take place, high concentrations may be bathing the lumbar nerves leaving the thoracic region exposed to less than optimal amounts of epinephrine. If 1:200,000 is the optimal concentration, 1:60,000 seems more than necessary albeit much less than the concentration which will cause neurological damage.[4]

TABLE 2

DURATION OF ANALGESIA –TIME LEVEL OF ANALGESIA DROPPED AT LEAST TWO DERMATONES

Dose (Mg.) Epinephrine	Number of Patients	Time in Minutes		
		Average	Standard Deviation	Range
0	22	136	32.3	95 210
0.1	21	145	42.3	80 275
0.2	18	153	41.0	90 250
0.3	29	150	60.6	45 355
0.4	24	163	43.6	80 240
0.5	23	174	48.1	110 285

* End point was considered the time when the level of analgesia dropped at least two dermatones.

The slow diffusion of epinephrine through spinal fluid may reduce the actual concentration of epinephrine to which the blood vessels are exposed.

We believe the important point to be made from these data is the variation in response from patient to patient. This is well demonstrated in the data of Bonica, Backup, and Pratt,[2] and Homeyer, Mintz, and Adriani.[6] Considering the standard deviations for the different mean values, our ability to predict how long epinephrine will prolong analgesia in a particular patient is poor. Differences between patients and observers in accurate localization of analgesia by pin-prick may explain some of the variability. Although the subjective complaint of pain due to surgical stimuli is a more practical end point for clinical purposes, the strength of the stimulus is less constant than with the pin-prick. Variation is equally great whether objective or subjective sensory or motor loss is studied.[2] Variation among the groups receiving epinephrine was greater than in the group receiving no epinephrine. This may have been due to

TABLE 3

DURATION OF ANALGESIA—TIME FOR ANALGESIA TO REACH TENTH THORACIC LEVEL

Dose (Mg.) Epinephrine	Number of Patients	Time in Minutes		
		Average	Standard Deviation	Range
0	21	209	49.1	120–295
0.1	20	235	61.1	120–335
0.2	17	252	52.6	190–370
0.3	27	242	60.3	140–385
0.4	23	264	65.5	165–425
0.5	23	258	47.7	175–360

inaccuracy in aspirating epinephrine from the ampuls or variability in the distribution of the drug. In comparing the small increase in the duration of analgesia following each increment of increase in the dose of epinephrine with the large variation between individual responses, we must conclude that the selection of any special dose of epinephrine to achieve analgesia of predictable duration is without merit. In the healthy patient about to undergo an operation expected to last longer than two hours, we use 0.5 mg. epinephrine to prolong tetracaine spinal anesthesia. No systemic cardiovascular reactions have been noted after as much as 1.0 mg. epinephrine was administered intrathecally.[6] If the clinical situation indicates that spinal anesthesia not be supplemented in the event that analgesia became inadequate for operation, we prefer a continuous technique of administration.

SUMMARY

The duration of spinal anesthesia following tetracaine, dextrose and varying doses of epinephrine intrathecally was studied in 137 patients. Analgesia as measured by pin-prick was significantly prolonged as the dose of epinephrine was increased. Variation between patients in their response to the same dose of drug was marked. The inability to predict the duration of spinal anesthesia in individual patients with reasonable accuracy would seem to preclude an attempt to obtain analgesia for a definite length of time with a particular dose of epinephrine.

The statements made herein do not necessarily reflect the opinion of the Navy Department.

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