

variety of possible uses in experimental surgery, and perhaps even in clinical surgery. It might be especially applicable to areas difficult to approach, but which can be reached

by a needle of wide calibre, through which wire, or granulated or perhaps powdered metal could be introduced.

## 14230 P

### Influence of Spinal and Regional Anesthesia upon Vasoconstriction and Vasodilatation of Small Peripheral Blood Vessels.\*

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In the current studies of the development of shock during surgical procedures, alterations in the rhythmical variations in the caliber of the small peripheral blood vessels of the fingers and toes have been noticed after spinal anesthesia and anesthetization of the stellate ganglion.

It is well known that spinal anesthesia may occasion a fall in blood pressure especially in the presence of moderate hemorrhage or trauma.<sup>1,2,3,4</sup> It is also known that peripheral blood vessels dilate when denervated of their sympathetic supply.<sup>5</sup> These two phenomena, fall in pressure and dilatation of the vessels, are related. What is still unknown is how those other small peripheral blood vessels with

their sympathetic supply still intact participate in this result. If the blood pressure and the pulse rate were to remain constant, then, on the assumption that the cardiac output also remains constant, it may be assumed that, as one large set of vessels dilates, another contracts.

**Method.** The pneumoplethysmograph of Turner,<sup>6</sup> as modified by Neumann<sup>7</sup> was used to record the variations in volume of fingers and toes simultaneously. Normally, waves are inscribed representing constantly occurring changes in volume. These include the *pulse waves*, synchronous with the cardiac beat, and *alpha waves*<sup>8</sup> which occur 5 to 7 times per minute and vary in size up to 10 times that of the pulse waves.

Twelve patients free from hypertension and from peripheral vascular diseases, ranging in age from 24 to 54 years were studied. In 9, records were made during and after intrathecal injection of procaine hydrochloride or monocaine formate (150 mg). Sensory anesthesia as determined by testing sensory dermatomes reached the level of the umbilicus (T 12). In 3 patients, records were obtained before, during and after the injection into one stellate ganglion of 10 to 15 cc of 1½% solution of procaine hydrochloride. The clinical

\* This is the 12th paper reporting the results of studies of the small blood vessels and related subjects.

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† Fellow of the University of Cincinnati, working on a grant from the Josiah Macy, Jr., Foundation.

<sup>1</sup> Bradshaw, H. H., *Ann. Surg.*, 1936, **104**, 41.

<sup>2</sup> Co Tui, F., *Arch. Surg.*, 1936, **33**, 825.

<sup>3</sup> SeEVERS, M. H., and WATERS, R. M., *J. A. M. A.*, 1932, **99**, 961.

<sup>4</sup> Smith, H. W., Rovenstine, E. A., Goldring, W., Chasis, H., and Ranges, H. A., *J. Clin. Inv.*, 1939, **18**, 319.

<sup>5</sup> Johnson, C. A., *Surg. Gynec. and Obstet.*, 1940, **70**, 31.

<sup>6</sup> Turner, R. H., *J. Clin. Inv.*, 1937, **16**, 777.

<sup>7</sup> Neumann, C., *Am. J. Physiol.*, 1943, **138**, 618.

<sup>8</sup> Burch, G. E., Cohn, A. E., and Neumann, C., *Am. J. Physiol.*, 1942, **136**, 433.

signs regularly observed after successful injection of the stellate ganglion were uniformly present.

The subjects were recumbent and the fingers or toes were within 6 inches of the level of the heart. None of the patients knew when the anesthetic agent was injected. Records were obtained in the absence of surgical trauma or hemorrhage.

*Observations.* Before anesthesia, the needles being in place, the tracings were normal, the pulse waves being 6 to 7 cu mm<sup>‡</sup> and the alpha waves up to 60 cu mm. Two minutes afterward, in the case of spinal anesthesia, the pulse waves in the toe became progressively larger (up to 15 cu mm) while the alpha waves became smaller and almost disappeared. Concurrently, in the fingers, the size of the pulse waves progressively decreased to one-half or even one-quarter their former size, while the size of the alpha waves decreased, as in the toes.

Similar effects were noticed on injection of one stellate ganglion. Pulse waves of the ipsilateral fingers increased and alpha waves decreased, while in the opposite fingers both waves, pulse and alpha, decreased to one-half or one-quarter the original size. There were no marked alterations in blood pressure or pulse rate during the period of spinal or re-

‡ All changes in volume are calculated for finger tips or toe tips of 5 cc.

gional anesthesia.

Such striking changes were not observed when occlusive vascular diseases were present (3 cases). Cardiac output and volume of visceral flow were not measured.

*Comments.* These observations indicate that when marked dilatation occurs in one peripheral vascular bed, owing to paralysis of the sympathetic supply, concomitant vasoconstriction occurs in certain other remote peripheral beds. The mechanism involved seems to be one of adjustment, possibly compensation, through efferent pathways of the sympathetic system. Paralysis of these nerves permits maximal expansion of the small blood vessels (large pulse waves) and interrupts the pathway of stimuli necessary for the formation of prominent alpha waves; at the same time, increased sympathetic outflow to certain other vascular fields results in vasoconstriction intense and persistent enough to produce small pulse waves continuously and to inhibit the relaxation apparently necessary for the development of alpha waves. It seems that such alterations in the patterns of alpha and pulse waves reflect changes in the activity of certain sympathetic pathways. The method may be useful, then, for clinical studies of the effects of numerous physiological stresses, such as those preceding shock, upon such pathways and upon small peripheral blood vessels.

## 14231 P

### Tubular Resorption of Chloride in Essential Arterial Hypertension: Intensive Study of One Case.\*

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In a previous study<sup>1</sup> we have compared a group of individuals with essential hypertension and a control group of normal subjects, with respect to tubular resorption of chlorides.

\* Funds for this study were granted through the Alice Cook Guild Memorial Fund, established by Kenneth G. Smith.

<sup>1</sup> Farnsworth, E. B., and Barker, M. H., *Proc. Soc. Exp. Biol. and Med.*, 1943, **52**, 74.

In the present study we have taken 2 male subjects of comparable age and investigated them extensively by the same technique, namely chloride excretion considered in terms of the urine concentration of inulin divided by the plasma concentration, or the U/P inulin ratio.

*Methods.* The experimental subject was a retired business man, 55 years of age, who