BRITISH MEDICAL JOURNAL
LONDON
SATURDAY SEPTEMBER 19 1942

THE ANATOMY OF CUTANEOUS SENSIBILITY

The increase of peripheral nerve injuries related to war conditions, and, more particularly, their segregation in special centres for treatment, have again focused attention on the anatomy of cutaneous sensibility. Von Frey is often credited with having established the relation between specific nerve-endings and specific modalities of sensation. Dallenbach[1] has pointed out, however, that in reality von Frey was more cautious in his statements. Recently, Gilmer and Haythorn[2] have attempted to identify skin-pressure vibration spots with nerve-endings beneath them. Using a variety of staining methods and thin serial sections of biopsy material they were unable to find endings of one particular type beneath the spots. They stated, however, that all the staining methods employed were unsatisfactory in that no single stain demonstrated all the nerve elements they wished to study, and it was thus necessary to treat a number of the sections by different methods. They tentatively concluded that richly innervated arteriovenous anastomoses might be in some way related to the sensory interpretations, for in several biopsy specimens such bodies were present just beneath the sensitive spots. Woollard *et al.*,[3] on the other hand, brought forward very good evidence that specific endings at different depths beneath the skin subserve specific modalities of sensation, and they also showed that cutaneous pain is subserved by a morphologically specific type of nerve termination. Weddell,[4] proceeding on the lines indicated by Woollard, has insisted on the need for examining large whole preparations of skin, including the underlying tissues, to get a true picture of the relation of a sensory "spot" to its subjacent nerves and endings. For this purpose he uses vital staining with methylene blue to demonstrate both the nerve fibres and their endings. By such methods it has been shown that sensory "spots" in the skin overlie more than one individual nerve-ending (or group of endings) of the same type, and that the nerve fibres subserving the endings (or groups of endings) are not a series of collaterals derived from one nerve fibre, but (as far as they can be traced) are separate fibres which approach the "spot" from different directions. For example, it was found in one case that situated beneath a cold "spot" were two groups of Krause's end-bulbs lying at a depth of 1 mm. beneath the skin surface and separated from each other by 3 mm. It has also been demonstrated (Weddell[5]) that in a human finger pad, an area of acute tactile sensibility, large Meissner's corpuscles are situated in groups of two or three, each ending connected with a single unbranched nerve fibre. In addition, it has been shown that, while in the finger pad certain nerve fibres are surmounted by single Meissner's corpuscles, in the forearm a single nerve fibre may give rise to a number of separate Krause's end-bulbs; and, furthermore, cutaneous pain is shown to be subserved by terminal networks which spread over still larger areas. For example, a single nerve fibre in the dorsum of the hand has been found to give rise to a terminal network of fine beaded fibres covering an approximately circular area of maximum diameter 0.75 cm. In confirmation of such histological findings, Tower[6] has been able to show by electrophysiological methods that the terminal ramifications of a single afferent fibre from the rabbit's cornea comprise a unit area of from 50 to 200 sq. mm., the area having sharply defined limits. She has suggested the term "sensory unit" for such terminations, on the analogy of the "motor unit."

Thus, it becomes clear that a sensory "spot" is not synonymous with a single nerve-ending at the end of a single nerve fibre. "Spots" overlie groups of specific endings which lie at some depth from the surface and are borne upon separate nerve fibres. It also appears that a "spot" need not immediately overlie one particular ending or group of endings, but is so situated that the application of the stimulus affects the maximum number of subjacent specific terminals. The failure of Gilmer and Haythorn to find specific nerve-endings beneath skin-pressure vibration spots is thus hardly surprising, but, as explained above, their failure is not an argument in favour of the non-specificity of cutaneous nerve terminals.

It has been suspected for some time that the innervation of sensory "spots" is not simple; in fact Head[7] found it necessary to postulate two collateral systems of nerve fibres (protopathic and epicritic) to account for his observations on the return of cutaneous sensibility after division of a cutaneous nerve. Boring,[8] on the other hand, was led to infer a multiple innervation of sensory "spots" by fibres of one type to explain his own observations after division of a cutaneous nerve. In a recent critical review on the anatomy and physiology of cutaneous sensibility Walshe[9] has shown that the histological findings of Woollard and Weddell form a concordant anatomical basis for the careful clinical observations of Trotter and Davies,[10 11] who repeated and elaborated the work of Head from a quantitative rather than a qualitative point of view As Walshe points out, the work of Trotter and Davies has not received the attention and credit which are due to it from neurologists. To quote a passage from his review: "In view of the richly suggestive character of Trotter's writings upon cutaneous sensibility it is striking how little influence they have exerted, and the cynic might submit that this is because he coined no new words to adorn his exposition. The sway exercised upon the imagination of neurologists and physiologists by the words 'epicritic' and 'protopathic' may have had not a little to do with the continued currency of the hypothesis which was their setting."

THE DEMAND ON THE BLOOD DONOR

The general acceptance of blood transfusion as a practicable form of treatment can be dated at 1922, when there were 13 calls on the British Red Cross Society Blood Transfusion Service. In 1930 the number had risen to 1,627. The service was still confined to London, and, though the curve continued to rise, the rate of acceleration slowed down for the next five years.[12] At that time a transfusion was synonymous with the administration of a pint of fresh blood, but the work of Marriott and Kekwick[13] on massive drip transfusion in 1935 led to a considerable increase in the size of individual transfusions and in the indications for the operation. Further increases have come with developments in the use of stored blood, serum,

1 *Amer. J. Psychol.*, 1927, **39**, 402.
2 *Arch. Neurol. Psychiat.*, Chicago, 1941, **46**, 621.
3 *J. Anat.*, Lond., 1940, **74**, 413.
4 Ibid., 1941, **75**, 346.
5 Ibid., 441.
6 *J. Neurophysiol.*, 1940, **3**, 486.
7 *Studies in Neurology*, 2 vols., London, 1930.
8 *Quart. J. exp. Physiol.*, 1916, **10**, 1.
9 *Brain*, 1942, **65**, 48.
10 *J. Physiol.*, 1909, **38**, 134.
11 *J. Psychol. u. Neurol.*, 1913, **20**, Ergnzngshft., 102.
12 *Times*, April 27, 1931.
13 *Lancet*, 1935, **1**, 977.