THE SEGMENTAL DISTRIBUTION OF THE CUTANEOUS NERVES IN THE LIMBS OF MAN

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TWENTY-SEVEN FIGURES

INTRODUCTION

The segmental distribution of the cutaneous nerves in the limbs of man has been the subject of considerable confusion and uncertainty, due to limitations of technique and lack of well controlled human cases for study. A new approach to this problem has been furnished by the many clinical cases in which herniation of the nucleus pulposus of an intervertebral disc compresses a single nerve root intraspinally and is operated for relief (fig, 1), This common cause of nerve root pain radiating down a limb, previously called sciatica, was first clearly identified by Mixter and Barr ('34) and has since become generally recognized by report of many operated cases. Surgical demonstration that this discrete nucleus pulposus herniation commonly compresses only one nerve root, and the finding of an area of diminished cutaneous sensitivity for this functional loss (Keegan, '43, '44, '47) has permitted the drawing of new dermatome charts of the limbs of man and these have been combined with standard dermatomes of the trunk to form a new dermatome chart of the human body (fig. 2). This chart differs significantly from those of previous investigators in that it presents a regular pattern of serial dermatomes in the limbs extending as continuous bands from the dorsal midline of the body down the arm and the leg. This finding and report is based on 165 cases of dermatome hypalgesia of the upper limb, 47 of which have been verified by surgery, and 1264 cases of dermatome hypalgesia of the lower limb, 707 of which have been verified

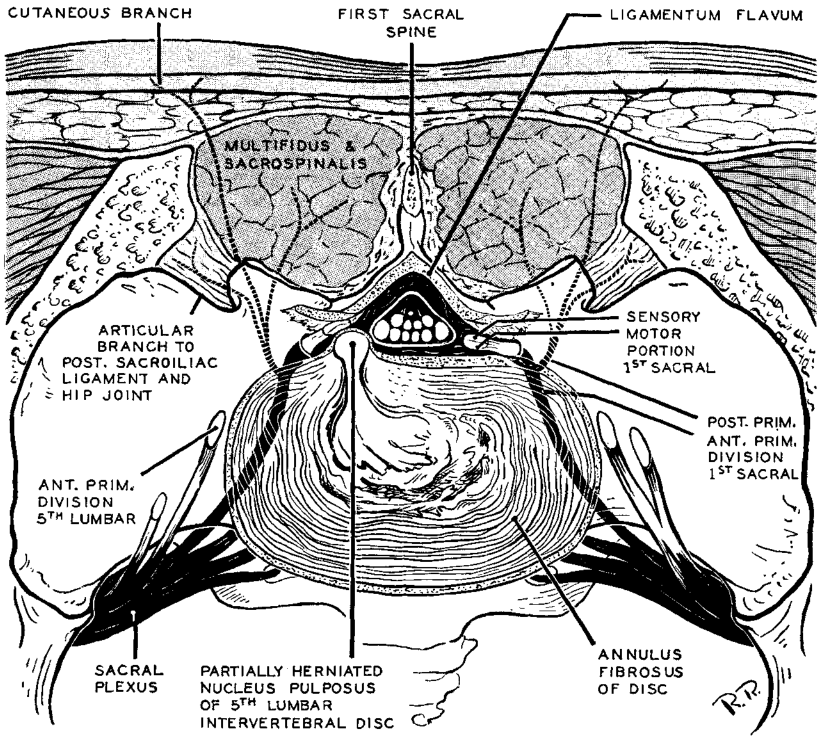

Fig. 1 Cross-section anatomy at the level of the 5th lumbar disc to show relation of the first sacral nerve root to herniation of the 5th lumbar nucleus pulposus.

by surgery. Verification has been done by demonstration of single nerve root compression at operation, by traction on the exposed nerve root, by section of the nerve root in a small number of cases and by x-ray controlled novocaine injection of a single nerve root in medical student volunteers and clinical cases. Published recognition of this work has been given by Reese ('44); Sachs ('45); Cerny ('47); Falconer, Glasgow and Cole ('47); White ('47); Bailey ('48), and by many others in personal communication.

The current anatomical concepts of segmental cutaneous nerve distribution are derived chiefly from Sherrington's

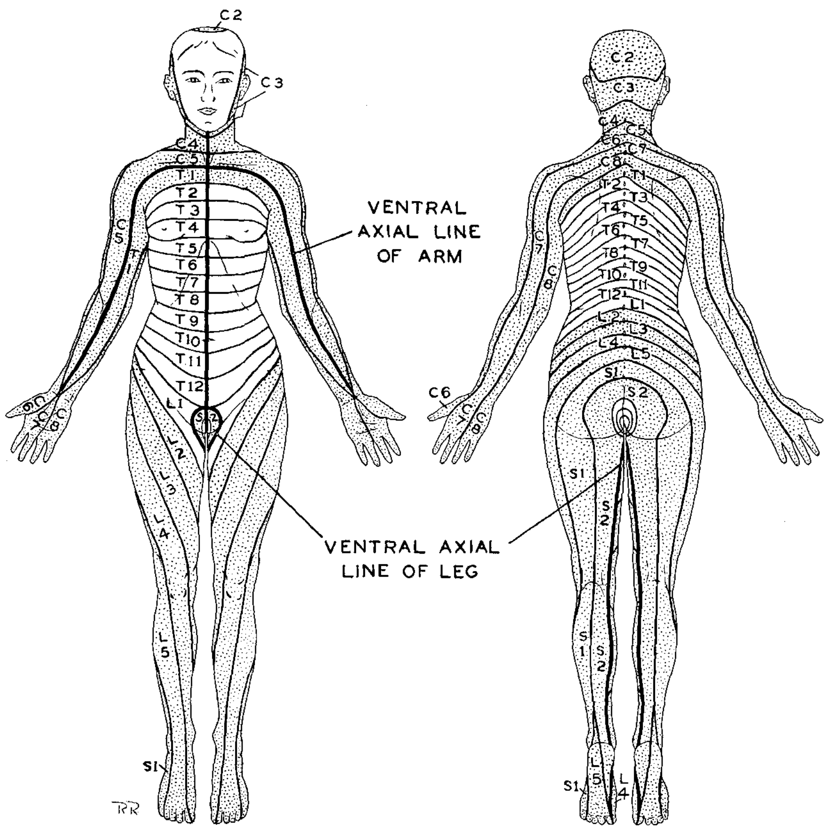

Fig. 2 Dermatome chart of the human body with new patterns in the extremities continuing in serial sequence from the spine.

(1892, 1893, 1898) physiological observations on monkeys, Bolk's (1898–1899) dissections of a human subject, and the careful clinical observations of Head (1893, '00) and of Foerster ('33, '36), supplemented by the experimental studies of Winkler ('03) and his pupils, and by a great mass of less systematic clinical observations by various authors. The resulting outline of sensory dermatomes, while reasonably clear in the trunk, is imperfect and confusing in the extremities (figs. 3 and 4). Many authors, protesting against the prevailing confusion, have undertaken to draw a somewhat hypothetical dermatome chart which would illustrate in better

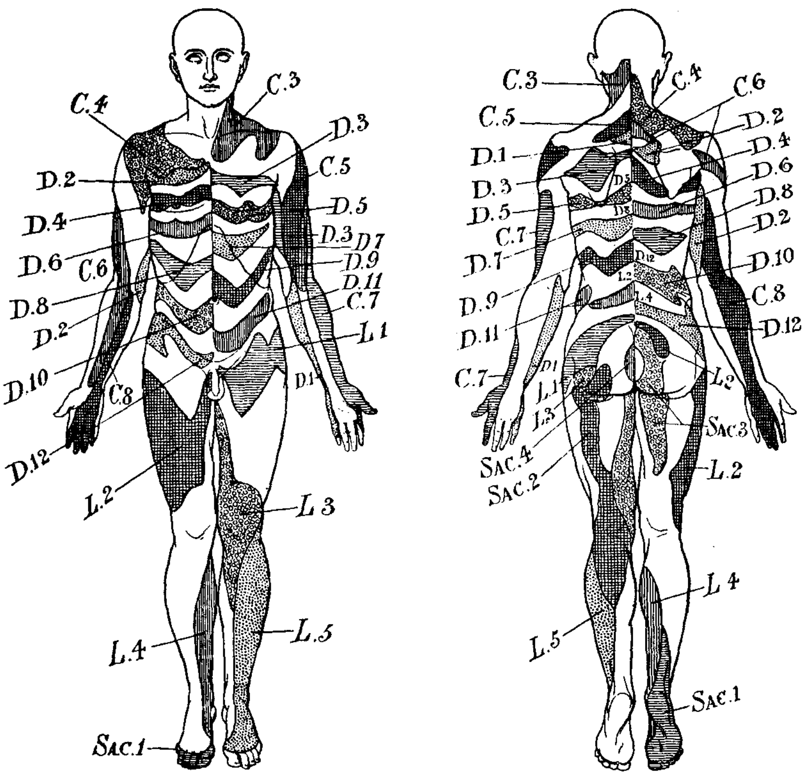

Fig. 3 Head's (1893) chart of the human dermatomes.

manner the serial segmental distribution of the dermatomes in the limbs. The most noteworthy early chart of this kind was prepared by Edinger ('04, fig. 5) and was used by Bing ('21). It is interesting to note the surprising agreement of Edinger's chart with that found in this study by plottong the area of decreased skin sensitivity for a single nerve root. A more complicated early dermatome chart was drawn by Déjerine ('14) and has been used by Tilney and Riley ('21). While it is appreciated that long accepted findings of honored investigators as Sherrington, Head and Foerster should not be lightly questioned, yet it should be recognized that there is

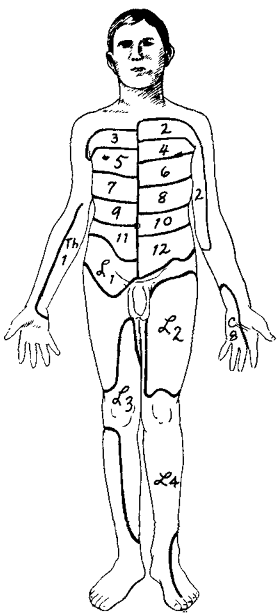

Figure 4

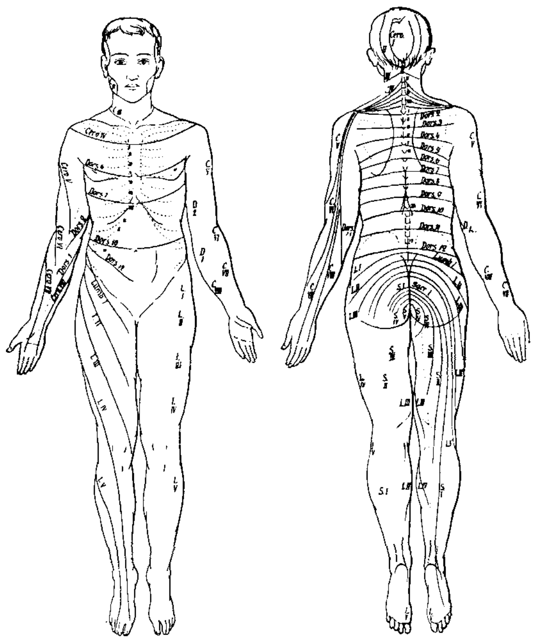

Figure 5

Fig. 4 Foerster's ('36) chart of the human dermatomes.
Fig. 5 Edinger's ('04) chart of the dermatomes.

possibility of incompleteness or error in their findings and interpretations, and that contradictory findings based on new technique and adequate material should be given careful consideration.

METHODS AND RESULTS

The relations of the nerve roots distributed to the extremities, as they leave the spinal cord, are particularly favorable for single nerve root compression by herniation of the nucleus pulposus of an intervertebral disc. In the lower lumbar region (fig. 6) the nerve roots pass out obliquely, so that the common posterolateral nucleus pulposus herniation compresses a single nerve root, the one next below the numbered intervertebral disc. Thus herniation of the 5th lumbar disc compresses the first sacral nerve root and gives rise to radiating pain, first in the distribution of the posterior primary division to the gluteal region and later in the distribution of the anterior primary division down the posterior

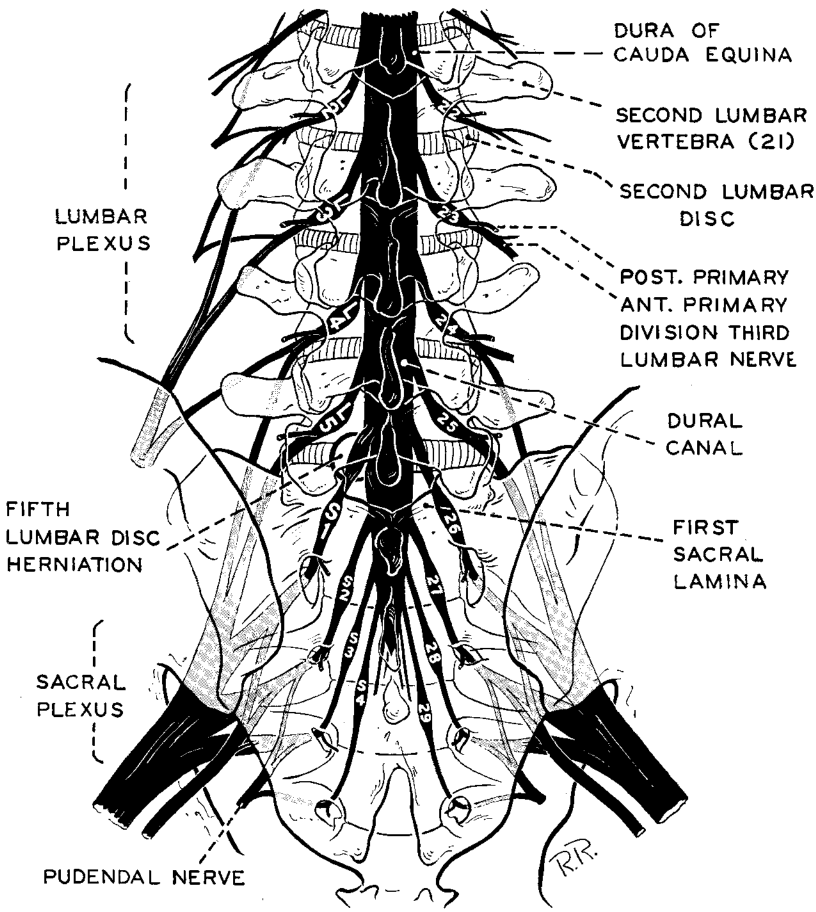

Fig. 6 Posterior view of the nerve roots of the lumbar and sciatic plexuses in relation to vertebrae and intervertebral discs.

surface of the thigh and calf, with corresponding sensory reduction (fig. 7). In the lower cervical region (fig. 8) the nerve roots pass out transversely so that posterolateral herniation of a disc there compresses the nerve root of the corresponding interspace, but not numbered the same, due to lack of a disc between the first and second cervical vertebrae and identification of the first cervical nerve root above the first cervical vertebra. Radiating pain first appears in the upper medial scapular distribution of the posterior primary

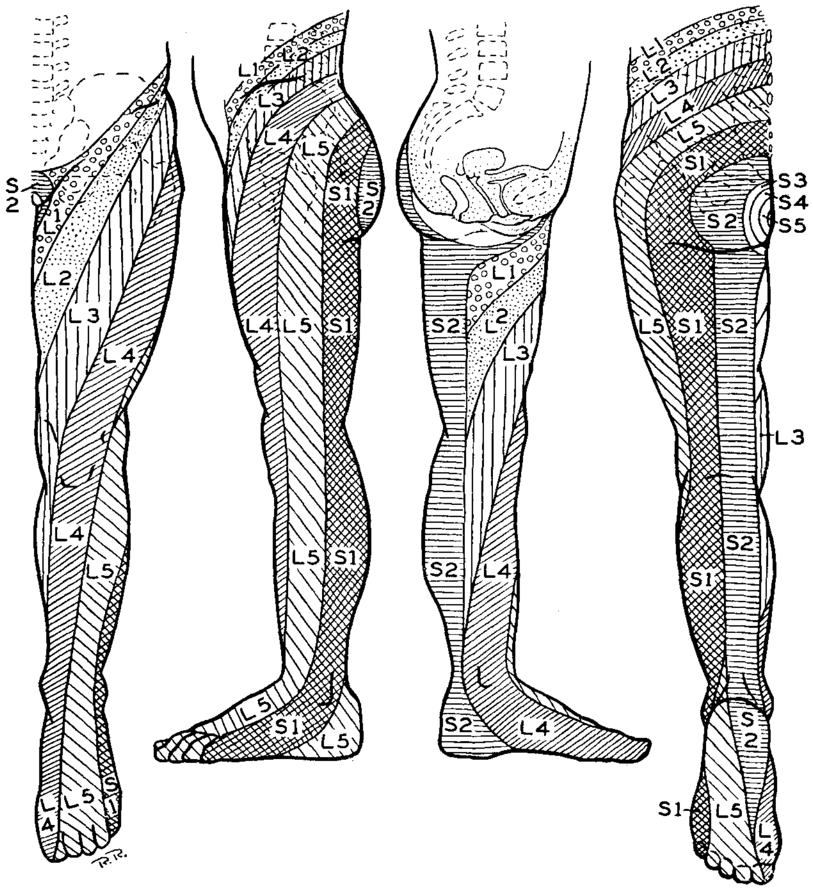

Fig. 7 Dermatome chart of the lower extremity of man outlined by the pattern of hyposensitivity from loss of function of a single nerve root.

division and later radiates over the shoulder and down the arm in fairly well localized dermatome distribution, with corresponding sensory reduction (fig. 9). During operation for removal of this discrete nucleus pulposus herniation it is necessary to retract the nerve root to expose the herniation tumor. This traction of a single nerve root, which often has

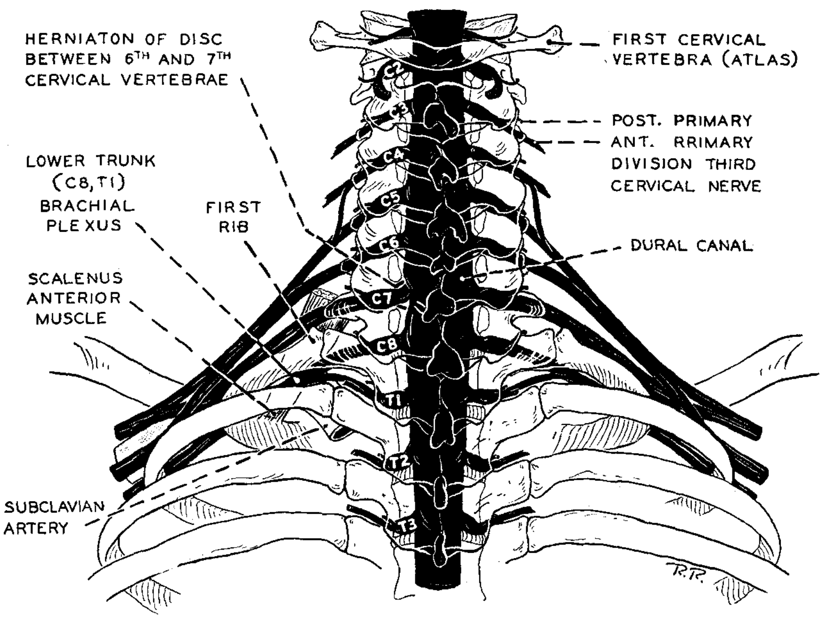

Fig. 8 Posterior view of the nerve roots of the brachial plexus in relation to vertebrae and intervertebral discs.

not completely lost its function before operation, leads to temporary complete loss of function of a certainly identified nerve root for postoperative testing. Added identification of nerve root loss has been found after purposeful section of a single nerve root to the lower extremity in 13 clinical cases and by novocaine injection of a single lower cervical nerve root in 10 medical student volunteers.[1] In the latter the

[1] Medical students injected: L. H. Blattspieler, R. Chesnut, E. Davis, R. Geesaman, T. Hubbard, J. Laws, W. McQuillan, L. Morgenstern, H. Rodman, V. Worthing.

desired position of the needle was secured by inserting it from an anterolateral direction until it contacted the transverse process of a cervical vertebra where the nerve root is closely applied as it leaves the intervertebral canal. With the needle in situ, roentgenograms were taken to establish its position and 2 cm of 2% novocaine then were injected around

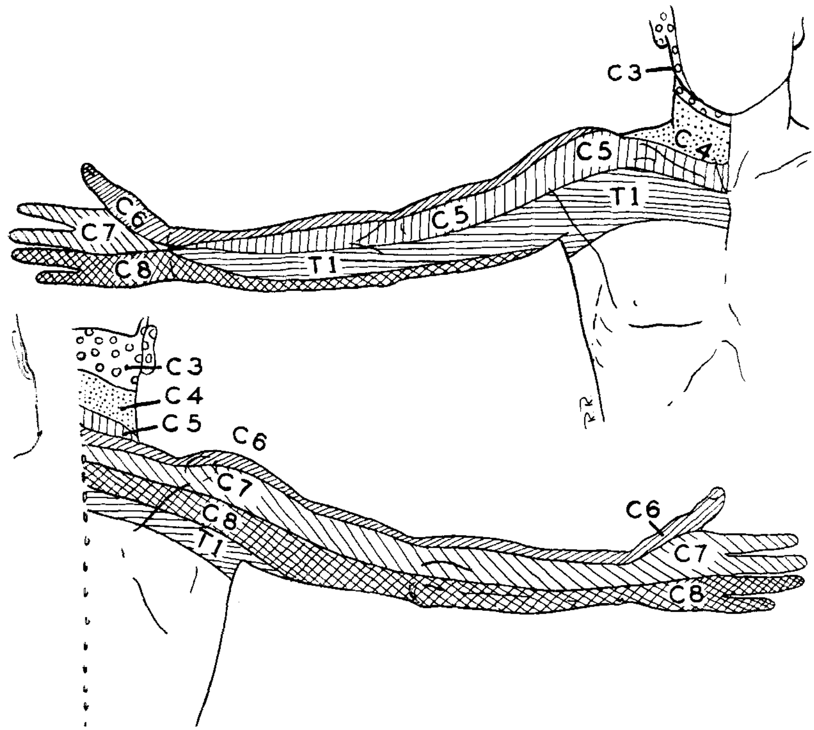

Fig. 9 Dermatome chart of the upper extremity of man outlined by the pattern of hyposensitivity from loss of function of a single nerve root.

the nerve root and found sufficient to block the sensory fibers of that root without spreading to adjoining roots.

The ability of the average individual to detect a diminution of sensitivity when function of a single nerve root is interrupted is contrary to the frequently voiced opinion that "division of a single nerve root produces no loss of sensitivity" (Foerster, '33). This opinion cannot be accepted, for many patients with compression, traction or section of a single nerve root to an extremity are aware and even complain of an area of ''numbness'' which they locate accurately in the dermatome area in which faint but definite reduction of sensation can be demonstrated. The best method of marking out this area of detectable hyposensitivity is by use of light pin scratch for pain sensation, although it can be found for temperature and for tactile sensation also. The pain stimulus strength must be adjusted carefully so that it is not disagreeably painful in the area of diminished sensitivity; then the contrast with an adjoining more sensitive area becomes evident as the pin crosses into the more normal sensitive zone of the adjoining nerve root, often to the extent of surprised withdrawal. Experience enables one quickly to determine the proper pressure for a given individual. Testing is done entirely by free hand, using a medium size safety pin opened to right angle for better hand control and lightly scratching the skin from the hyposensitive zone across into the sensitive zone. A series of points on the line between hyposensitive and sensitive areas are marked with wax pencil and these points then are connected to outline an area of primary diminished sensitivity. The accuracy of the test which can be gauged by repetition does not vary more than one centimeter in well defined cases and the dermatome areas thus plotted do not seem to overlap significantly in different individuals. Sometimes, by continuing the pin scratch around the extremity, a secondary zone of very slight hyposensitivity can be found, representing the recognized overlap distribution of the nerve root. This is shown by photograph of a verified clinical case of left 6th cervical nerve root compression (fig. 10) right 5th lumbar nerve root (fig. 11) and right first sacral nerve root (fig. 12).

Since the dermatomes of the trunk are fairly well established and do not involve the question of limb bud migration, this investigation has been limited to those nerve roots sup-

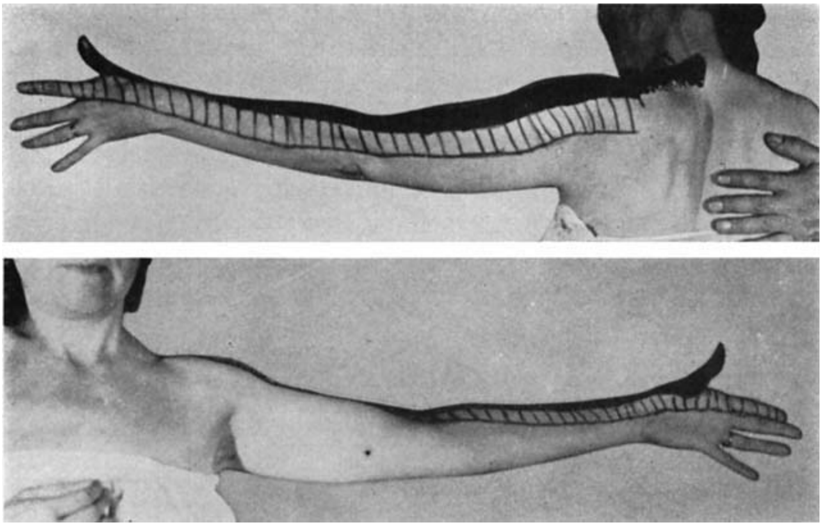

Fig. 10 Dermatome hypalgesia of 6th cervical nerve root with fainter overlap distribution.

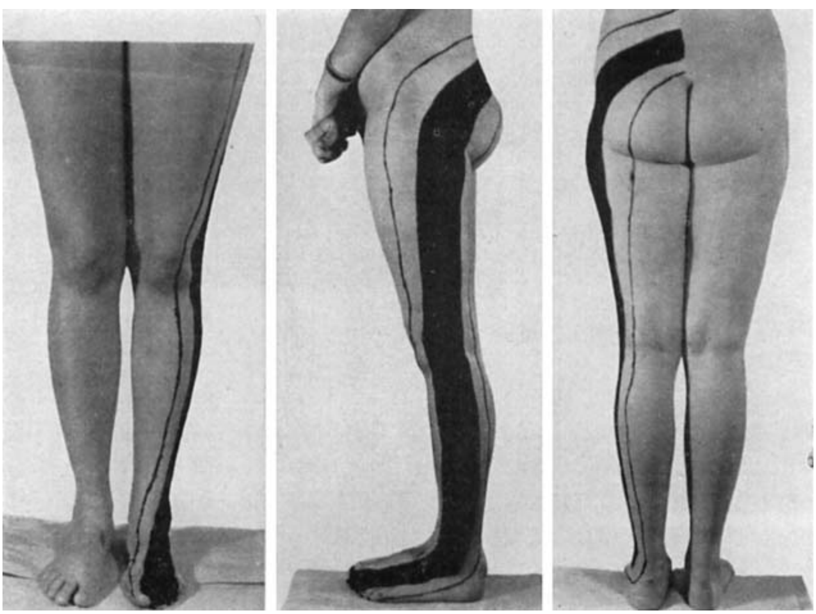

Fig. 11 Dermatome hypalgesia of 5th lumbar nerve root with fainter overlap distribution.

plying the extremities, from the 5th cervical to the first thoracic and from the third lumbar to the second sacral. Thus the dermatome hypalgesia pattern has been plotted in 19 cases for the 5th cervical nerve root, 28 cases for the 6th cervical, 49 cases for the 7th cervical, 46 cases for the 8th cervical plus 53 cases of combined anterior primary divisions of 8th cervical and first thoracic nerve roots, 19 cases of third

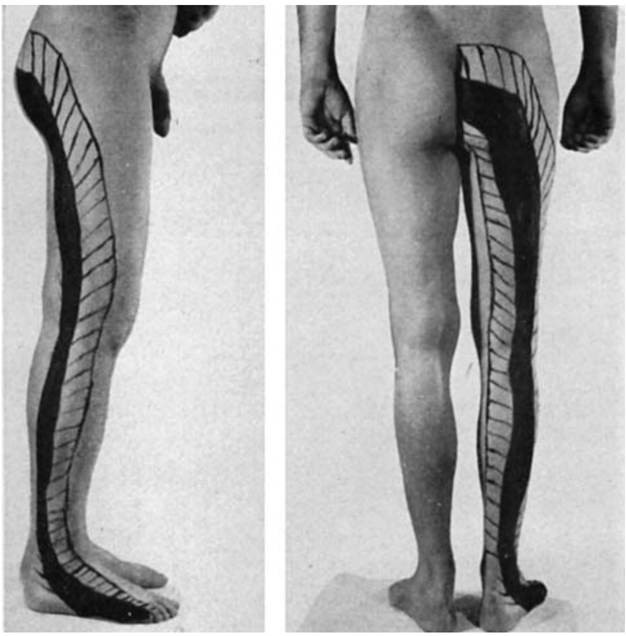

Fig. 12 Dermatome hypalgesia of first sacral nerve root with fainter overlap distribution.

lumbar nerve root, 117 cases of 4th lumbar, 517 cases of 5th lumbar, 670 cases of first sacral and 19 cases of second sacral nerve root. This makes a total of 1556 plottings of a single nerve root dermatome hypalgesia, 826 of which were verified by surgery or x-ray. Additional cases of upper cervical dermatome hypalgesia have been found and will be reported in a later article by Dr. Alister I. Finlayson.

DISCUSSION

The exact anatomical significance of these dermatome areas of primary hyposensitivity from single nerve root loss is somewhat uncertain. They obviously do not represent the full area of cutaneous distribution of nerve fibers entering over a single nerve root, for the classical researches of Sherrington (1892, 1893, 1898) and Foerster ('33, '36) have shown that the total area supplied by each nerve root overlaps broadly with its neighbors on each side. Klessens ('13), by strychninizing individual nerve roots and plotting the area of hypersensitivity thus produced, was able to show as many as 4 different root distributions overlapping at some places. There must be, however, a definite difference of distribution between the area of primary hyposensitivity outlined in this study and the areas of overlap on each side, indicating that many more fibers of the root involved supply the primary area than the neighboring areas of overlap. This is supported by Head's (1893) finding of little overlap of dermatomes in his herpes zoster cases. Also there must be a relatively narrow zone of transition from the primary area of more dense distribution to the area of less dense distribution of the terminals, to account for the precision with which the hyposensitive area from single nerve root loss can be outlined. One might postulate a developmental sequence involving a primitive and primary connection of the specific root fibers with the hyposensitive area, followed by a spreading over the surrounding territory of overlap and establishment of fewer or less sensitive terminations in the secondary overlap area. This would imply that the hyposensitive area represents the true primitive dermatome, interpreted as that area of the skin most directly associated with the body segment in question through early contact with such segmental structures as blood vessels and nerves.[2] By contrast, the total area of distribution of nerve roots demonstrated by classical in-

[2] The authors believe it unlikely that the so-called dermatomic portion of the primitive somite retains any individuality in the developmental stages under consideration.

vestigators, and by them designated "dermatomes," would appear to have a less fundamental morphological significance than the primary hyposensitive areas of this study.

Whether or not the hyposensitive areas represent true primitive dermatomes, they must indicate rather accurately the

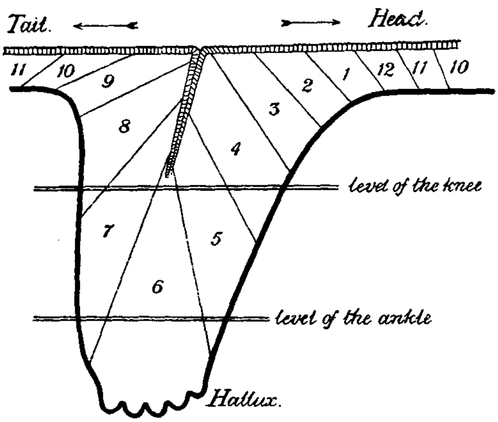

Fig. 13 Sherrington's (1893) "Scheme of the sensory skin fields of the hind limb of Macacus rhesus."

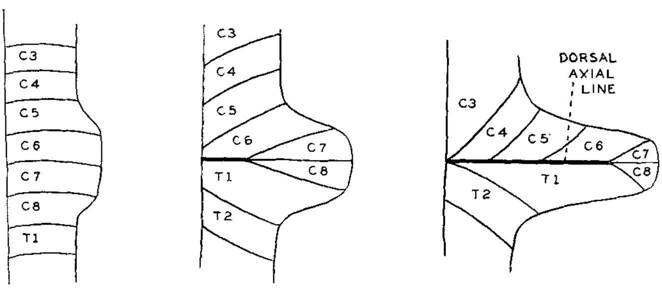

Fig. 14 Bolk's (1898) conception of the migration of the extremity dermatomes in limb bud development.

movements of the nerve fibers in the developing limbs. If so, they contradict the classical theories of dermatomic development in the limbs which are implied in Sherrington's (1893, 1898) description (fig. 13) more precisely formulated by Bolk (1898, II), (fig. 14). These theories postulate a simple outward bulging of already delimited trunk dermatomes which are carried in the form of loops over the expanding limb buds, presenting dorsal and ventral [3] portions on the two surfaces of the limbs. These authors further postulate a separation of the limb dermatomes from the midline so that the dermatomes extend only to the dorsal and ventral axial lines of the limb, called "mid-dorsal" and "mid-ventral" lines of the limbs by Sherrington and "Differenzirungsgrenze" by Bolk. The results of this study indicate that dorsal axial lines of dermatomic junction have no reality; that the dermatomes continue unbroken from dorsal midline to their termination in the limb, and that they have developed in a very different manner than postulated in the loop theory. Reference again should be made to figure 2 which suggests the course of nerve development as a regular outgrowth over the dorsal surfaces of the limbs, assuming that the definitive position of the dermatomes indicates the course taken by the outgrowing nerve fibers. The highest and the lowest segmental nerves apparently have spiraled in a regular manner about the rostral and caudal limb borders respectively, to supply the ventral surfaces of the limbs and to meet each other along what might be termed the "ventral axial line." The intermediate segments have continued outward along the dorsal surfaces of the extremities to terminate near their tips. Reference to the extremity charts of this study adds clarifying details. Notice that in the arm (fig. 9), the highest and the lowest primary dermatomes, 5th cervical and first thoracic, spiral in opposite directions closely about the shoulder to meet in the axilla and run a parallel course along the ventral surface to terminate at the wrist. The remaining space around the arm is occupied in regular manner by the 6th, 7th and 8th

[3] Throughout this paper the usual nomenclature of limb surfaces is used as follows: *Dorsal*, the back of the hand and arm and convexity of the elbow; the top of the foot, front of the leg and convexity of the knee. *Ventral*, the palm of the hand, inside of the arm and concavity of the elbow; the sole of the foot, back of the leg and concavity of the knee. *Rostral*, the thumb and radial surface of the arm; the great toe and medial surface of the leg. *Caudal*, the little finger and ulnar surface of the arm; the little toe and lateral surface of the leg.

cervical dermatomes, covering the rostral, dorsal and caudal surfaces of the arm and all surfaces of the hand. The pattern on the leg is similar though somewhat less regular (fig. 7). There the first lumbar and second sacral spiral about the hip to meet on the medial side of the ventral surface, but the first

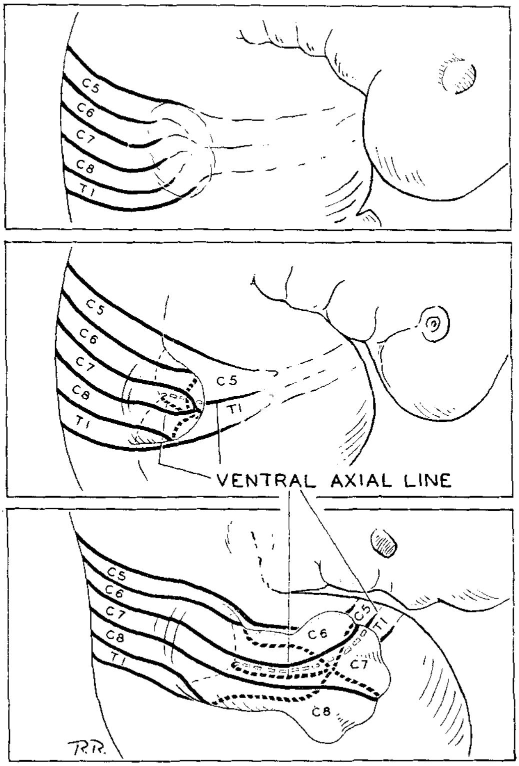

Fig. 15 The authors' conception of the development of the dermatomes in the limb bud.

lumbar ends here and only the second sacral continues down the leg. The second and third lumbar dermatomes likewise end against the second sacral and only the 4th and 5th lumbar and first sacral continue parallel with the second sacral to the end of the extremity where all interdigitate on the sole of the foot. An attempt has been made in figure 15 to show this conception of the developing dermatomes in the limb bud of the human embryo at three different stages.

Since this interpretation of cutaneous limb innervation differs so sharply from that of Sherrington and of Bolk, and since none of the subsequent investigators have questioned their views, it has seemed advisable to compare in detail these dermatome findings with the dermatomes of the previous principal investigators, Sherrington, Bolk, Head and Foerster. This comparison is made by superimposing the areas from the charts of the above authors (diagonal lines) on corresponding areas of Keegan's chart for each dermatome (stippled) (figs. 18 to 27).

Sherrington obtained his results by isolating a single nerve root in the Macacus rhesus monkey, cutting two or three nerve roots above and below and determining the area of remaining pain sensation to skin pinch, registered by minimal motor reflex action. He thus obtained what approached the total distribution of the nerve root, showing considerable overlap with neighboring areas. The dermatome areas of the arm of the monkey are comparable to those of man and are transposed without modification. It is very difficult to compare the dermatome areas of the lower extremity of the monkey with those of man, both because of different conformation of the extremity and the question of analagous nerve roots. Sherrington (1892), from motor root stimulation experiments, interpreted the second lumbar nerve root of the Macacus analagous to the first lumbar root of man, and the roots below correspondingly. This is supported by the fairly constant abolition of the knee jerk by section of the sensory fibers of the 5th lumbar nerve root of the monkey (Sherrington, 1893), whereas in man the knee jerk most commonly goes out with the 4th lumbar nerve root loss. However, the closure of the vagina by the muscles of the pelvic floor of the monkey results chiefly on excitation of the 9th subthoracic nerve root, third sacral or 28th of the total series. This corresponds to the similar innervation of the pelvic floor of man by the 28th nerve root, 9th subthoracic, 4th sacral or pudendal nerve. The anatomical similarity of the Macacus spine and nerve roots to those of man (fig. 16) has been called to attention (Keegan, '47b). Each has 7 cervical, 12 thoracic, and 10 subthoracic vertebrae to the end of the sacrum, the last or 28th nerve root of the total series contributing similarly to the pudendal nerve. From this it would seem that the only

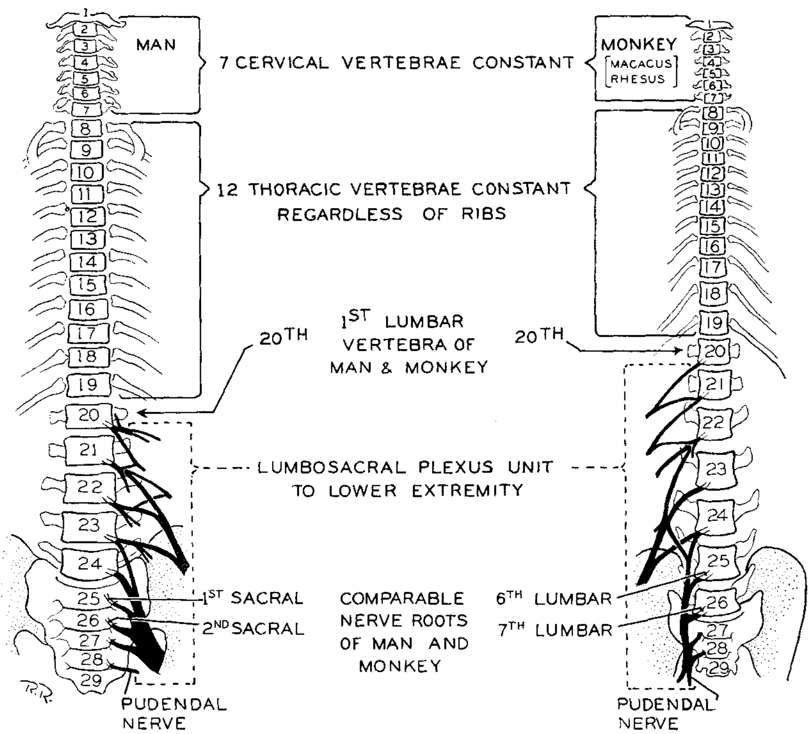

Fig. 16 Comparison of the spine and lumbosacral nerve roots of Macacus rhesus monkey and man.

significant difference beween the Macacus monkey's spine and man's spine is the fusion of the 6th and 7th lumbar vertebrae of the monkey into the sacrum of man. Also it has been found (Keegan, '47b) that nerve roots in man do not change in their cutaneous distribution with added or reduced lumbar vertebrae, if the vertebrae are identified by total numerical sequence and not by variable number of ribs or lumbar vertebrae. Accordingly, in this study, comparison of Sherrington's chart of the dermatome areas in the lower extremity of the monkey with the dermatome hypalgesia areas has been made by considering the first 5 lumbar nerve roots of monkey and man analagous, the 6th and 7th lumbar nerve roots of the monkey analagous to the first and second sacral nerve roots of man, and the first and second sacral nerve roots of the monkey analagous to the third and 4th sacral roots of man.

Bolk's data resulted from careful gross dissection of a single human body and tended to present the total distribution of a nerve root, but unavoidably lack the distribution of the fine branches. His charts are used without modification.

Head (1893, '00) drew his data largely from the distribution of skin lesions in cases of herpes zoster involving a single nerve root, but obtained a very irregular and incomplete picture in the extremities, with little or no overlap (fig. 3). He reported no examples of isolated 8th cervical or first sacral involvement in 392 clinical cases and verified only one case in the lower extremity by post-mortem examination, this of the first lumbar nerve root. This would leave some question concerning the accuracy of Head's dermatome areas in the extremities. His charts are used without modification. An interesting observation has been made on a clinical case of herpes zoster in the lower extremities, using light pin scratch technique to outline the area of hyperalgesia recognized to accompany these single nerve root herpetic lesions. It was found that a clearly defined dermatome area of hypersensitivity could be outlined (fig. 17), which included the herpetic eruption but was more extensive and corresponded accurately with the third lumbar and second sacral dermatome areas as previously reported in herniated disc cases by hyposensitivity finding. This indicates that the herpes zoster dermatome areas outlined by Head might have been amplified by outlining more accurately the associated areas of hypersensitivity, to give a dermatome chart corresponding to that of this study (fig. 2).

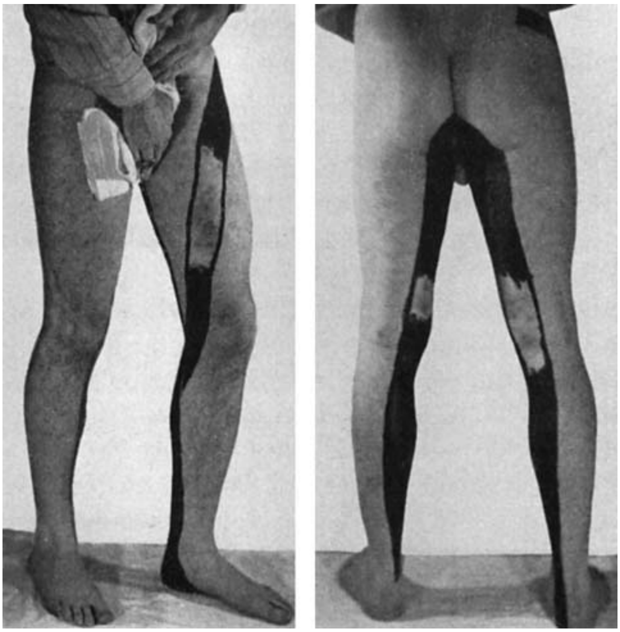

Fig. 17 Photograph of the areas of herpes zoster and associated dermatome pattern of hyperalgesia found in the lower extremities of a clinical case.

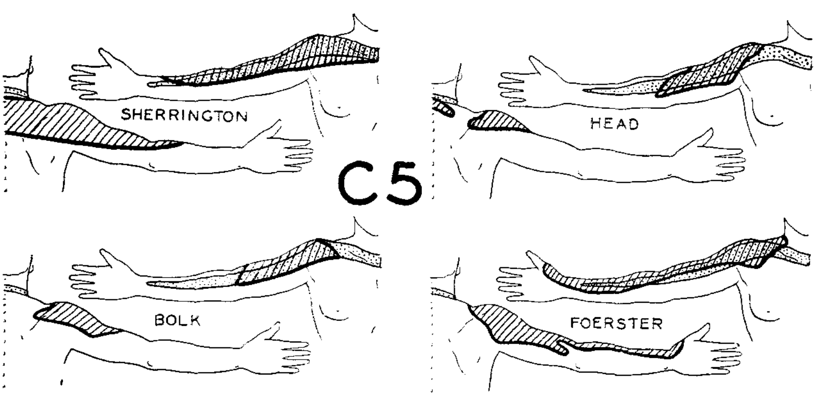

Fig. 18 Fifth cervical dermatome comparison. There is agreement in placement of this dermatome over the biceps swelling, with variable extension proximally and distally, but none to the digits. Evidently distinguishment between primary and overlap sensation has been difficult and confusing with other authors.

Foerster ('33) followed the same method as Sherrington in considerable degree, cutting nerve roots above and below an identified nerve root and plotting remaining tactile and pain sensitivity. He found the remaining tactile dermatome larger than the pain dermatome, with considerable overlap of dermatomes. He also used faradic stimulation of a single nerve root and plotted the resultant vasodilatation dermatome which was less extensive than the tactile and pain dermatomes, approaching the non-overlapping herpetic dermatomes of Head. These

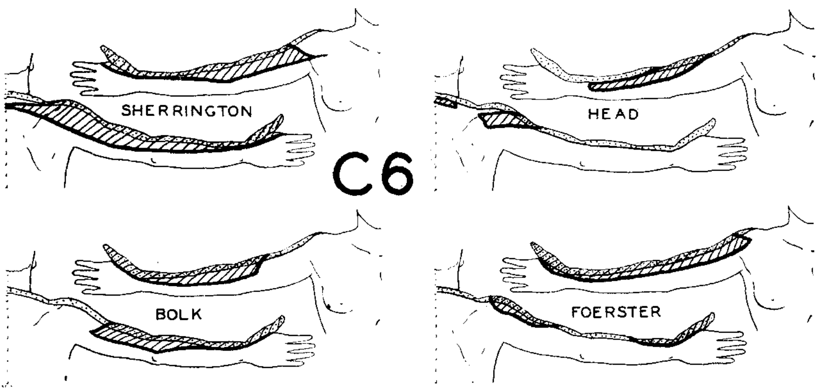

Fig. 19 Sixth cervical dermatome comparison. There is surprising agreement of location along the rostral or outer side of the arm, with variable extension towards the spine.

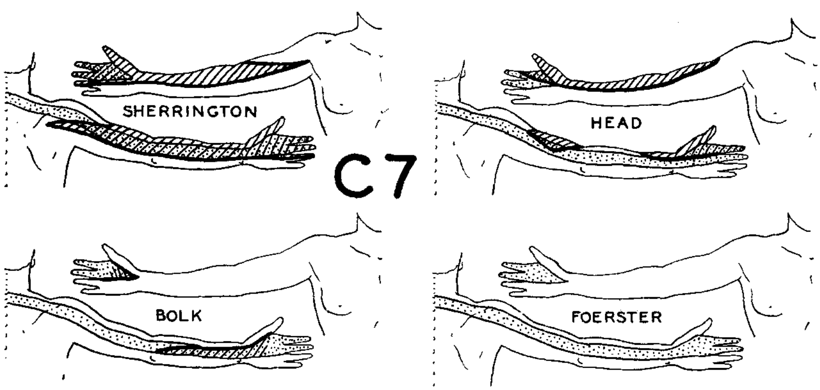

Fig. 20 Seventh cervical dermatome comparison. Distally there is fair agreement in inclusion of the index and middle fingers. Bolk's agreement distally is remarkable. Foerster did not show this dermatome.

variables, including considerable individual case variation, make comparison of Foerster's chart of the dermatomes (fig. 4) with others difficult. Insofar as possible the dermatomes he outlined for pain have been used in this study, taken from individual case findings.

The most conspicuous difference between our findings and those of the other authors lies in representation of complete dermatomes extending without interruption from the dorsal

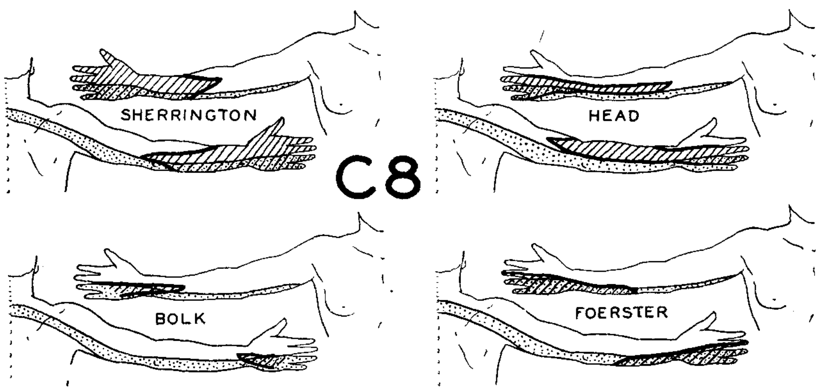

Fig. 21 Eighth cervical dermatome comparison. All charts agree in showing involvement of the ulnar portion of the hand, with Bolk's almost identical. Sherrington and Head show dorsal and ventral portions of a dermatomic loop but with considerable variance in location.

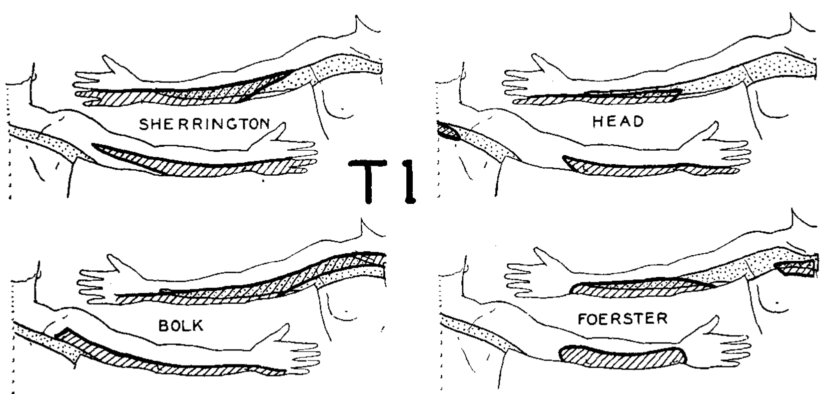

Fig. 22 First thoracic dermatome comparison. On the forearm, agreement between all 5 authors is reasonably close. Bolk and Foerster do not include the little finger.

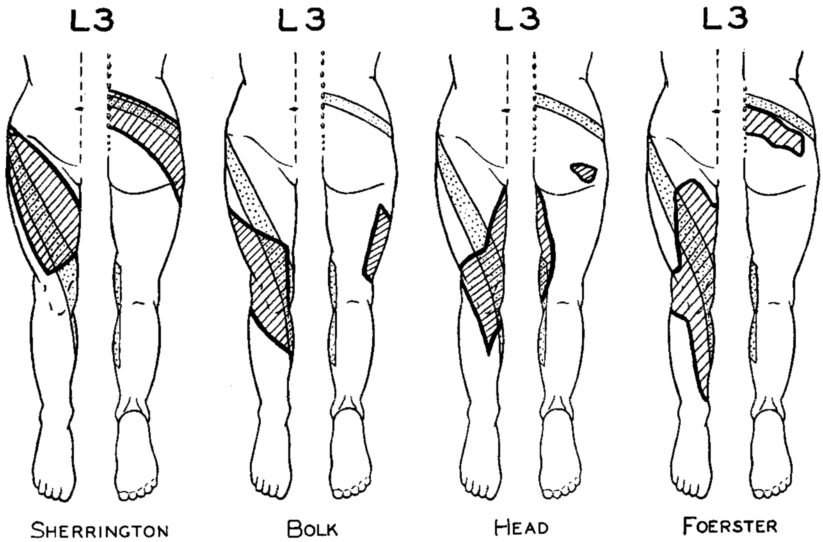

Fig. 23 Third lumbar dermatome comparison. All authors agree in assigning the territory on the medial side of the knee in man. The transposed third lumbar area of Sherrington agrees surprisingly well in the thigh except for its greater extent.

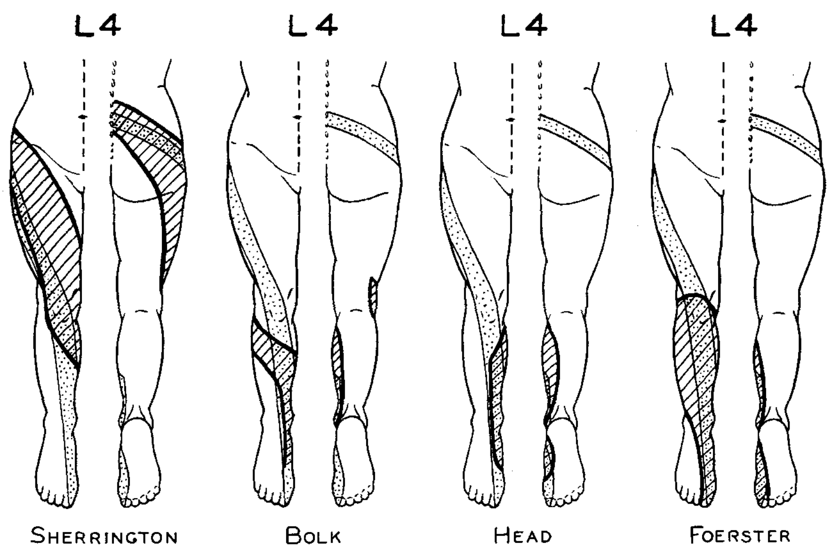

Fig. 24 Fourth lumbar dermatome comparison. Bolk, Head and Foerster agree in including the territory on the medial side of the ankle and foot. Sherrington's larger oblique area is in general agreement above the ankle.

midline to their termination, whereas the other authors frequently represent gaps as occurring in the region of the upper portions of the limb. Interesting in this connection are the variations in degree of hyposensitivity which is found within the area of diminished sensitivity. There often is a rather limited portion of the area which approaches complete analgesia to light pin scratch and may be noticed independently by the patient himself. This usually is located rather distally in the area except in the case of the second sacral nerve. Proximally the degree of sensory impairment tends to diminish so that in the gluteal or scapular regions considerable care is required to delimit the involved area. Clinical cases with incomplete pressure block of the nerve root may show hyposensitivity only in the more distal portion of the limb. It should be emphasized that the location of the line of dermatome junction between primary hyposensitive and adjoining areas is uninfluenced by these changes of upper level of hyposensitivity and is found in the same position as long as it can be demonstrated. It is on this failure to demonstrate the more proximal portions of the dermatomes in the extremities that Sherrington and Bolk principally based their theory of the migration of these dermatomes and the significance of axial lines.

It appears that the only suggestion of a confirmation of Sherrington's theory of dermatomic loop configuration brought out by our comparisons is the representation of the 8th cervical by Head showing what appear to be dorsal and ventral portions of a loop. Even here the correspondence with Sherrington's area is not close. It seems likely that through some chance the ulnar border escaped involvement in the herpetic lesion which formed the basis of Head's description, and that, therefore, the loop configuration is purely accidental. It further appears that in no case is there a fundamental difference between Sherrington and the other investigators in locating the main mass of an area; that Sherrington's loop interpretation depends on relatively slight extensions, all without confirmation, from the territory indicated by the

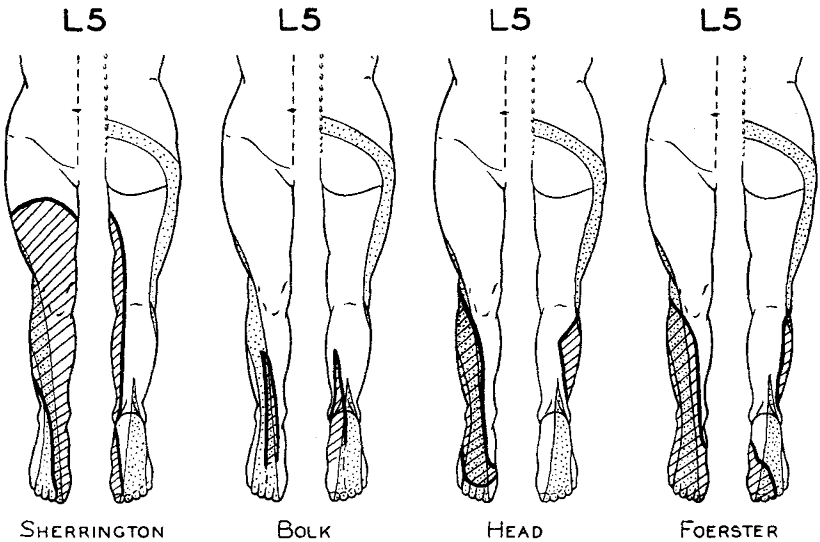

Fig. 25 Fifth lumbar dermatome comparison. Agreement is reasonably good. The transposed 5th lumbar area of Sherrington is more medially located.

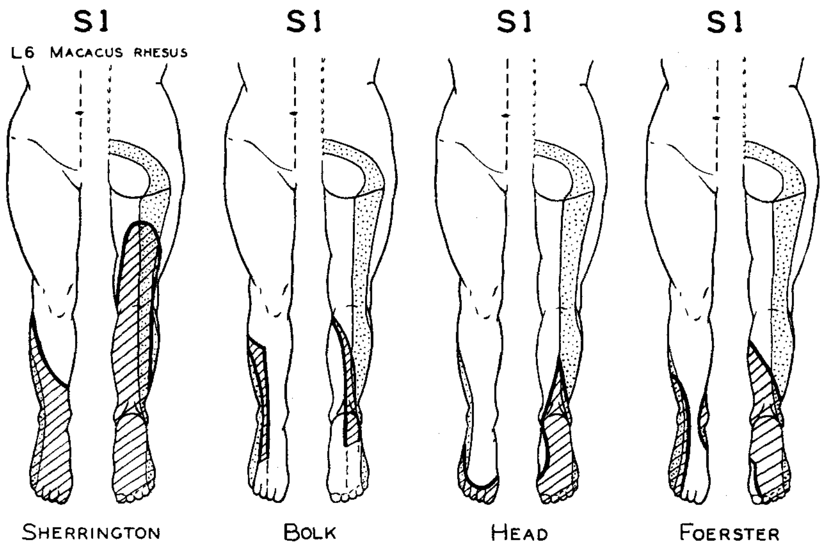

Fig. 26 First sacral dermatome comparison. Head and Foerster agree in assigning this area to the lateral side of the foot and small toe and in excluding all or a portion of the medial side of the foot. Sherrington's 6th lumbar area of the monkey includes all of the foot and posteriorly in the calf and thigh.

other charts. We feel the conclusion justified that Sherrington erred through a relatively minor, though systematic, misinterpretation of his data, and that "dermatomic loops" and "dorsal axial lines" do not exist. The concept of a ventral axial line may be retained for the line of junction between more rostral and more caudal dermatomes after they have spiraled about their respective borders of the limb. This criticism of Sherrington can be applied with even greater

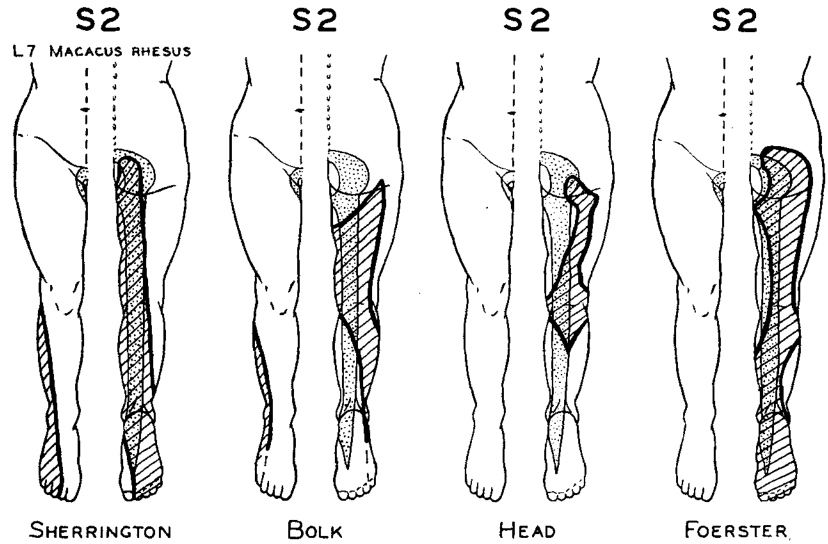

Fig. 27 Second sacral dermatome comparison. All authors agree on a distribution to the medial side of the back of the knee, this being in surprising agreement with Sherrington's 7th lumbar of the monkey. There is quite variable extension into the sole of the foot.

certainty to Bolk. His charts differ chiefly in being less complete. When one considers his method, gross dissection, it becomes remarkable that his results are so similar.

It has been established (Weiss, '41) that the course of a nerve fiber in the definitive organism is determined, first, by the pathway taken by the freely moving tip of the fiber prior to contact with its end organ and later by the towing of the fiber after it becomes attached to the end organ or skin. On the basis of this doctrine the loop hypothesis of Sherrington and of Bolk would imply that the fibers had attained peripheral attachment to the skin organs prior to initiation of limb development, for dermatomic loop would result only from towing of attached fibers as the skin bulges outward to cover a forming limb bud. Bolk based his hypothesis of dermatome development on the now largely discredited fin fold theory of limb development and thus actually described the dermatome as bending over the margin of a horizontal ridge rather than bulging over a limb bud. Dermatome development as we postulate it could occur, obviously, only in connection with a limb bud. Our interpretation, on the contrary, implies a free course of outgrowing fibers through the substance of an already formed bud (fig. 15). The actual course of early innervation of the limb has recently been described in the frog by Taylor ('43). He has determined that the very early limb bud is, in fact, nerveless; that the first fibers grow freely into the limb substance guided, apparently, by the orientation of mesenchymal strands. In a later paper Taylor ('44) shows that some as yet unknown factor determines connection of sensory (and probably autonomic) fibers with the skin and motor fibers with the muscles. Our observations seem to imply that these guiding agencies, whatever they are, must be rather general in their effect, for the primary factor determining the exact attachment of a given fiber has obviously been the even and orderly filling of the space to be occupied.

CONCLUSIONS

A cutaneous area of detectable hyposensitivity results from blocking a single spinal nerve supplying a limb. These areas extend as continuous bands or dermatomes from the spine into the limb, contrary to the theory of the loop development of the dermatome. These newly defined dermatomes of non-overlapping primary hyposensitivity are interpreted as the primitive dermatomes.

This study indicates that postulates of a loop configuration of the dermatomes and of dorsal axial line of dermatomic juncture are untenable. The sensory nerve fibers grow spirally from the dorsal surface of the limb bud, around both rostral and caudal borders, to meet on the ventral surface along a ventral axial line.[4]

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