formation needs further study together with an investigation of the etiological factors involved. It is known that crystal formation occurs as a feature of viral-induced damage in cells infected with Adenovirus type 5[8]. Although unlikely as an etiological factor because of the wide-spread occurrence of Reinke's crystals in human testicular interstitial cells, viruses remain to be excluded as possible agents[9].

Zusammenfassung. Es wird gezeigt, dass in den Leydig'schen Zwischenzellen die Reink'schen Kristalle auch im Zellkern vorkommen und darauf hingewiesen, dass eine Modifikation des Zellkernstoffwechsels zu diesen Bildungen führen könnte.

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Morphology of Muscle Spindles in the Rat

Some morphological features of muscle spindles in the rat have been described (BARKER and HUNT, BRIDGMAN, LANDON, MERILLEES, ZELENA and HNIK[1-5]) but no detailed description exists which is comparable with those available for the cat (BARKER, BOYD[6,7]), rabbit (BARKER[8]), and oppossum (JONES[9,10]). In particular, no information is available on the motor innervation of rat muscle spindles.

In the present investigation we studied the anatomy of muscle spindles in the plantar lumbrical muscles to the second, third, fourth and fifth digits. Rats of Wistar origin were used. Muscles from normal animals were treated as follows: one group was embedded in paraffin and spindles were reconstructed from serial transverse sections stained with hematoxylin and eosin; a second group was stained with gold chloride (COLE[11]), the teased specimens being used for spindle counts and for measuring total spindle length; a third group was stained by a silver technique (WINKELMANN and SCHMIT[12]) and the innervation of teased spindles was examined; a fourth group of muscles with attached nerves was stained with osmium tetroxide and used for the measurement of myelinated nerve fibre diameters in cross sections of the nerve trunk to each muscle. The latter 2 procedures (silver stains and OsO_4 stains) were also carried out on animals in which 1 hind limb had been either de-afferented or de-efferented by selective spinal root section for a period of 35 days.

Myelinated nerve fibre diameters to the lumbrical muscles ranged from 1–10 μ in normal and de-efferented nerves and from 1–7 μ in de-afferented nerves. The total number of motor nerve fibres to any muscle ranged from 5–9, and the sensory nerve fibres from 18–23. From 3–8 muscle spindles/muscle were found in muscles having a wet weight of 4–6.5 mg. No tandem muscle spindles were found.

Reconstructions of spindles from serial cross sections showed that both nuclear chain (NC) and nuclear bag (NB) muscle fibres were present. The mean number of intrafusal muscle fibres in 14 specimens was 3.5, most spindles containing 2 NC and 2 NB fibres. The mean diameter, measured at one pole of the capsule, of the NC fibres was 7.7 ± 1.0 μ ($n = 26$), and the NB fibres 10.0 ± 1.6 μ ($n = 24$), these measurements are uncorrected for shrinkage. The mean length of NB muscle fibres measured from the same paraffin-embedded material was 1.5 mm ($\pm$ 0.5) and that of the NC fibres was 1.2 mm ($\pm$ 0.6). Since the capsule length in all cases was less than 1.0 mm, and most of the muscle fibres were symmetrically placed with regard to the capsule, then the usual situation was that both NB and NC fibres extended beyond each pole of the capsule. The equatorial nucleated region of NB fibres had a mean length of 490 μ, or about $^1/_3$ the length of the NB fibre. This total nucleated length includes both the 'nuclear bag' proper, which contained 2 or 3 nuclei in any cross section, and its flanking myotube regions; the nuclear bag accounted for about half the total figure. The equatorial nucleated region in NC fibres had a mean length of 310 μ, or about $^1/_4$ the length of the NC fibre. The nuclei themselves differed in NB and NC fibres, those in the NC fibres generally being longer and narrower than in the NB fibres. At the equator of the fibres NC nuclei were about 3 μ wide and 8 μ long while the NB nuclei measured 4–6 μ in both the transverse and longitudinal directions. No intrafusal muscle fibre was seen to branch.

The sensory innervation of the spindles was investigated in silver-stained specimens of normal and de-efferented muscles. 50% of the spindles studied contained one primary ending alone. This occupied the central 130–240 μ of the intrafusal muscle bundle and usually took the form of tightly wound spirals on both NB and NC muscle fibres. The remaining 50% of the preparations contained 1 primary sensory ending and 1 or 2 secondary endings. The secondary endings were seen as fine sprays of nerve terminals mainly on the juxta-equatorial regions of NC fibres and occupied from 100–260 μ of the muscle fibre.

The motor innervation of the spindles was studied in normal and de-afferented preparations stained with silver. The most striking feature was that each spindle received

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2 motor axons; one of these fibres would innervate NB muscle fibres, while the other would innervate NC muscle fibres alone. We obtained no evidence for overlapping innervation of NB and NC muscle fibres. Two types of motor nerve terminal could be seen, one resembled the 'plate ending' of cat muscle spindles, the other was a fine single filament. The morphology of the ending, as seen in silver-stained specimens, was not specific to either NB or NC fibres although 'plate' endings were more common on NB fibres. Six cases of skeleto-fusimotor innervation were seen in which the motor nerve divided, sent one branch to skeletal muscle end-plates and the other branch to NB intrafusal muscle fibres.

The muscle spindle in the lumbricals of the rat would appear to be an elementary type of organ: it contains about 2 nuclear bag and 2 nuclear chain muscle fibres which do not branch, and the 2 types of muscle fibre receive separate motor innervation. The sensory innervation is also uncomplicated, 50% of the spindles possessing primary innervation alone. Skeletofusimotor innervation was found in some cases, but it is not possible to say, on the present evidence, how common this condition might be. However, it is possible to estimate, from the numbers of motor nerve fibres and the numbers of spindles in each muscle, that some form of α- and γ-motor-nerve sharing is likely in these muscles.

Zusammenfassung. Die Morphologie und Innervation der Muskelspindeln der Lumbricalmuskulatur im Hinterfuss der Ratte wird beschrieben. Eine typische Muskelspindel enthält zwei «nuclear bag» Fasern und zwei «nuclear chain» Fasern. Jede Spindel enhält 2 motorische Nerven, einer innerviert die «nuclear bag» Fasern, der andere die «nuclear chain» Fasern. 50% der Spindeln haben nur primäre sensorische Innervationen, die übrigen 50% haben eine primäre sensorische Endung und 1 oder 2 sekundäre Endungen.

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Migration of Lymphocytes Through the Endothelium of Venules in Experimental Allergic Neuritis

Intradermal inoculation of peripheral nerve tissue mixed with Freund's adjuvants in various mammals can produce a neuritis which is caused by immunologic mechanisms and called, therefore, experimental allergic neuritis or EAN[1]. In well-developed cases lesions which consist of perivenular collections of mononuclear cells and associated foci of demyelination are scattered throughout the peripheral nerves.

In this laboratory we have been for some time engaged in a light, phase, and electron microscopic study of the genesis of the inflammatory process of EAN in rats[2].

The light and phase microscopic studies show that, beginning 8 or more days after immunization, mononuclear cells may appear within the lumen of venules in the peripheral nerves, in perivenular areas and between nerve fibers prior to any recognizable alteration of myelin sheaths. Similar observations have been made in studies of early lesions in experimental allergic encephalomyelitis or EAE[3], a disease analogous to EAN but in which central nervous tissue is used as antigen and in which the lesions are confined mainly to the central nervous system. It has been concluded that in both diseases hematogeneous cells, presumably sensitized, are attracted to sites containing antigen, i.e. myelinated fibers, in the peripheral and central nervous system respectively. Here they subsequently in a hitherto unknown way will cause destruction of myelin. The mononuclear cells seem to be lymphocytes in the process of reaction i.e. 'transforming lymphocytes'[4]. It is not known why the lymphocytes in the first phase of the disease become arrested during their circulation, nor why they adhere to and migrate through the vascular wall and insinuate themselves between fibers in the peripheral nervous system.

During our electron microscopic studies of venular lesions in EAN, we have noted cells in cavities within the endothelium (Figure). We have concluded that these cells are sensitized lymphocytes, which at the time of sacrifice, were in the process of moving from the venular lumen towards the perivascular area. We further conclude that the normal route of migration of such cells in EAN is through rather than between the endothelial cells. These conclusions are based upon the following observations: (1) few if any cells are to be found in the lumen or in the perivascular areas of venules in peripheral nerves of normal animals or in animals killed during the first few days after inoculation, providing the vascular bed has been perfused according to the technique currently in use in this laboratory[5]. (2) In animals killed 8 days or more after inoculation venular lesions are noted frequently. In some specimens cells collect within but not outside a segment of a vessel; the lymphocytes are then attached to the inner side of the endothelium. In other animals cells are seen both within and without a vascular segment. Lesions of the former type predominate in animals killed earlier, lesions of the latter type in those killed later. (3) By cytologic criteria the 'intraendothelial' cells are of the same type as the intravascular lymphocytes which cling to the endothelial surfaces. (4) 'Intraendothelial' cells have been seen only in sites where there are intra and perivascular cells in the same or in an adjacent venular segment. (5) Degenerated or dead lymphocytic

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