Correlated Light and Electron Microscopic Observations on the Normal Trigeminal Ganglion and Sensory Root in Man

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Numerous studies of sensory ganglia using light microscopy had been reported by the turn of the century. Cajal summarized much of that information in his treatise of 1909; since then this technique has added only minor details. Electron microscopic studies of the trigeminal ganglion, however, have now added substantially to our knowledge of the fine structure of the trigeminal ganglion and have permitted a more accurate evaluation of normal variants.

One of the major problems inherent in the study of materials suspected of harboring lesions is to determine the range of normal variation in control material. The control material should be as similar as possible to the tissue being investigated, and the techniques of obtaining and processing specimens must be identical at each stage. In the case of the trigeminal ganglion and sensory root in man, control specimens have thus far been obtained only postmortem.

In our study we have placed particular emphasis on the range of normal appearances of myelinated fibers in the trigeminal ganglion and adjacent rootlets in man. The advantages of the great increase in magnification available with electron microscopy are offset to some extent by the technical problem of sampling. A simple evaluation by this method alone would require extremely lengthy studies. The problem has been partially resolved by using "thick" sections (0.5 μ) obtained from the same plastic-embedded material that had been studied under electron microscopy. Normal material (ganglion and sensory root) from cats and monkeys was available for control purposes for light microscopy. Stan-

Fig. 25. Trigeminal ganglion (cat) showing clusters of ganglion cells with initial glomeruli (arrows) and satellite cells, separated by bundles of nerve fibers. Winkelmann silver stain; ×435.
standard techniques for preparation and staining were used; the silver method of Winkelmann has been particularly valuable.

The human material consisted of ganglia obtained at 1 to 4 hours postmortem from six individuals who had died of acute causes and had had no prior history of facial pain. Their ages ranged from 42 to 77 years of age.

**Light Microscopic Studies**

We shall summarize the light microscopic observations for orientation purposes and as a basis for some of the observations on pathological material. The appearance of the normal ganglion is seen in the silver-stained material in Fig. 25. The ganglion cells are arranged in clusters or nests between bundles of axons. Numerous spiral and corkscrew-like processes can be seen in close relation to these neurons; these correspond to Cajal’s initial glomerulus. After a tortuous course of some 100 to 150 \( \mu \) or less, this axon acquires a myelin sheath and follows a relatively straight course to bifurcate in a T fashion into a central peripheral prolongation. Numerous small nuclei surround the cell body; these correspond to the satellite cells that invest the cell closely and accompany the initial unmyelinated segment of the axon.

Investigators before the turn of the century, in addition to identifying these basic characteristics of the neurons, also described very fine nerve fibers that surrounded the ganglion cells and were distinct from the initial glomerulus. Cajal described three separate types of these pericellular skeins or baskets, two of which were unmyelinated and one myelinated. He also noted that there were fine fibers twined around the initial glomerulus. In silver-stained material, pericellular skeins can be identified around some ganglion cells but not around the initial glomerulus. Detail is not sufficiently clear to be able to determine whether endings of the skein are present on the cells.

Fig. 26 illustrates the appearance of a sensory rootlet immediately adjacent to the trigeminal ganglion in a normal 68-year-old man. The myelin sheaths show relatively uniform thickness and closely resemble the usual appearance of cross sections of a peripheral nerve. This regular pattern, however, is subject to marked variations among normal individuals. In some instances, this variation is so pronounced that pathological changes could be suspected.

An extreme case is illustrated in Figs. 27 and 28. This specimen was processed identically to the preceding one and came from the same level of the posterior rootlet of the trigeminal ganglion in a normal 65-year-old individual. There is pronounced thickening and irregularity of many of the myelin sheaths; the myelin is markedly reduced in