Electron Microscopy of the Gasserian Ganglion in Trigeminal Neuralgia*

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The pathogenesis of trigeminal neuralgia has remained an enigma. Its characteristic feature, excruciating, paroxysmal facial pain, may be produced by any number of conditions affecting the Gasserian ganglion either directly or indirectly. These include dental diseases,\textsuperscript{64,141} inflammation of the sclera,\textsuperscript{77} arterial compression of the trigeminal root,\textsuperscript{132} bone changes,\textsuperscript{114} cranial and intracranial tumors,\textsuperscript{58,67,74} and lesions in the veins of the neck\textsuperscript{119} or in branches of the brachial plexus.\textsuperscript{180}

The causes of "secondary" trigeminal neuralgia have included cerebellar pontine angle tumors,\textsuperscript{24,58,67} lesions in the tear ducts,\textsuperscript{107} thrombosis of the posterior-inferior cerebellar artery,\textsuperscript{137} diseases of the mandibular joint,\textsuperscript{21,22,180} syringomyelia,\textsuperscript{48} chronic otitis media,\textsuperscript{166} tuberculous toxemia,\textsuperscript{18,19} nephritis with azotemia,\textsuperscript{31} indoxyluria,\textsuperscript{85} influenza,\textsuperscript{51} polyneuritis, infectious polyneuritis,\textsuperscript{73} encephalomyelitis,\textsuperscript{66} serum sickness,\textsuperscript{167} and lead poisoning.\textsuperscript{49}

In fact there is no part of the trigeminal pathway, from the shin to the cortex, where a lesion has not been described.\textsuperscript{169}

The general belief has been that there are no pathological changes in the trigeminal ganglion itself. Some of this legend, at least, is based upon a single ganglion removed by Victor Horsely and examined by Henry Head, who finally donated the ganglion to anatomy to be used for normal histology instruction.\textsuperscript{169}

Although other investigators have found a variety of pathological changes in the trigeminal ganglion,\textsuperscript{65,113,142} their findings have never been widely accepted, due in part to the fact that even by light microscopy the normal histology of the ganglion has never been clearly defined.\textsuperscript{130,165} Electron microscopy has made the problem even more complicated, for degenerative changes due to aging\textsuperscript{165} or to occult ganglionic disease\textsuperscript{133} must be differentiated from tissue artifacts due to manipulation and to fixation. The necessity of establishing the normal ultrastructure of the ganglion became obvious to us after we had obtained our first few biopsies from patients with trigeminal neuralgia. The resulting initial studies were done first on experimental animals\textsuperscript{222} and subsequently on man.\textsuperscript{5}

For the last few years our main research interest in trigeminal neuralgia has been in relationship to a study of viral diseases of the central nervous system, particularly those viruses which produce intranuclear inclusions. The neurotropic affinity of herpes zoster is well known; and shingles involving a division of the trigeminal nerve is a classic disease entity. It has also been postulated by some investigators that trigeminal neuralgia might actually be due to a latent infection of the ganglion by a related virus, herpes simplex,\textsuperscript{7} the cause of the common fever blister. That this might be the case seemed borne out by experimental involvement of the ganglion\textsuperscript{149} and by the fact that section of the posterior root for trigeminal neuralgia frequently results in the occurrence of herpes labialis,\textsuperscript{15,42} whereas section of the anterior root does not. Initially, we carefully saved a piece of each specimen for viral isolation, but as it became increasingly apparent that we were not dealing with a herpetic ganglioneuritis, this approach to the study was abandoned.

The morphological changes that we encountered in the ganglionic biopsies were so striking that we were encouraged to continue our study of the Gasserian ganglion in trigeminal neuralgia. Biopsies of Gasserian ganglia were obtained from 11 patients (nine female and two male) with classical trigeminal neuralgia of either the second or the third division of the fifth nerve, or both. Because of possible sequelae to tissue removal from the area of the ganglion supplying the ophthalmic nerve, no patients with first division involvement were included in the study. The patients ranged in age from 48 to 77 years, with an average age of 59 and a median age of 56. Symptoms had been present from 6 months to 13 years, with an average duration

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of 4½ years. One patient had a history of trauma with subsequent scarring in the region of the zygoma before the onset of symptoms; one had an episode of transitory facial paralysis 30 years before developing pain; and one had a long history of chronic sinusitis and “migraine headaches.” With the exclusion of one patient who had been in mild congestive heart failure, all of the patients were in relatively good health at the time of surgery, except for the symptoms of trigeminal neuralgia. Medical treatment had been attempted in eight patients, seven receiving diphenylhydantoin (Dilantin); and one a combination of B-12, Dilantin, and mephanesin carbamate (Tolseram). Three of the patients, however, had received no treatment before surgery.

The preoperative medication was atropine. In all cases halothane (Fluothane) was the primary anesthetic agent; in addition, eight patients received sodium thiamylal (Surital) and succinycholine chloride (Anectine), and three were induced with intravenous thiopental sodium (Penthal). In each case the gross appearance of the ganglion and surrounding area was normal, except for calcification of the internal carotid artery in the region of the sella in one 73-year-old woman. Biopsies of the trigeminal ganglion were obtained with a pituitary rongeur, after section of the proximal root. Specimens were transferred from the rongeur to cottonoid saturated with normal saline and, after mincing with a razor blade, were fixed in Dalton's fluid for 1 hour at room temperature. After surgery all of the patients did well; only two of the 11 developed fever blisters.

To determine the effect of the preoperative medication, anesthesia, and surgical trauma, we operated upon Cebus monkeys in a manner similar to that used in the human patients. Some monkeys that received only atropine and halothane anesthesia were sacrificed (intentional halothane overdosage) and the ganglion removed immediately after death.

After fixation, seven human specimens and