

STUDIES ON THE INTRAORBITAL
GANGLIA RELATED TO
THE GLOBE OF THE EYE



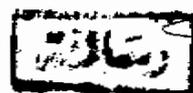
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INTRODUCTION

INTRODUCTION

The ciliary ganglion was described in man (Pines, 1927; Givner, 1939; Nathan and Turner, 1942; Perez and Robert, 1986), in other mammals (Warwick, 1954; Watanabe, 1972; Mahran and Sakla, 1975; Petela, 1980; Kuchiiwa, Takao and Toshiko, 1988), in aves (Marwitt, Pilar and Weakly, 1971; Fiori and Mugaini, 1981), and in reptilia (Mostafa, 1990). However, the quantitative aspect concerned with that ganglion were megre in such reports. Accordingly, it became the aim of the present study to investigate the quantitative parameters of the ciliary ganglion and its constituents perikarya (i.e. parameters of the neurons, their population, cell territory and interneuronal space). Moreover, an attempt was made to screen other ganglionic masses contributing to the parasympathetic innervation of the globe of the eye.

REVIEW OF LITERATURE

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I) STUDIES ON THE CILIARY GANGLION

Pines (1927), classified and described the various types of cells and nerve endings found in the ciliary ganglion of man, using Cajal's silver impregnation method.

* Eight types of cells were recognized :

- 1) Those in which the dendrites were intracapsular.
- 2) Dendrites were partly intra and partly extracapsular.
- 3) Dendrites were chiefly extracapsular.
- 4) Dendrites anastomosed to form a fenestrated cell.
- 5) Uni and bipolar cells.
- 6) T-shaped cells.
- 7) Golgi type II cells.
- 8) Degenerating cells.

Cells of the first 3 groups, which were of the sympathetic type, formed by far the greater bulk of the ganglion; those of the 4th, 5th and 6th groups, which were of the spinal ganglion type, were comparatively rare. Nerve endings were classified into 4 groups : pericellular, pericapsular, peridendritic and intercellular. Cells of the spinal type must be regarded as sensory and the presence of type II cells would indicate that reflexes might be mediated by the ganglion without participation of the central system, not light reflexes probably, but possibly simpler forms concerned with tonus of

the pupillary muscles.

Givner (1939), noticed multipolar nerve cells in the sclera and along the course of the short ciliary nerves proximal to the sclera in ten eyes which he examined.

Nathan and Turner (1942), were of the opinion that episcleral ciliary ganglia not only supplied the choroid, but also supplied a mass of fibres to the ciliary muscles.

Warwick (1954), reported that examination of the ciliary ganglion in series of reptiles, birds and mammals (including mokeys, apes and man) confirmed the large size of its cells. In particular, comparison of the cells in the ciliary, sphenopalatine, superior cervical sympathetic and coeliac ganglia of rhesus monkeys showed that the ciliary ganglion cells were not only uniformly larger than those commonly found in the other autonomic ganglia, but also differed in other characters. In the central position of their nuclei and the distribution of their chromatin content, they differed from typical autonomic nerve cells and resembled cerebrospinal motor neurons. These peculiarities might be a reflection of functional differences and in that connection between the striated nature of the intrinsic ocular musculature of reptiles and birds might recalled.

Marwitt, Pilar and Weakly (1971), investigated the cellular organization of the avian ciliary ganglion with electrophysiological, histological and pharmacological techniques. Nerve connections in the pigeon ciliary ganglion were studied. The 2 cell populations which were described anatomically were found to distribute their axons separately in the choroid and ciliary nerves. There was no connection between the two groups of cells. Those findings were also applied to the chick ciliary ganglion. The mean ciliary population was 2953 ganglion cells with single myelinated axons. The mean choroid group was 3084 cells with myelinated axons. The conduction velocity of the presynaptic fibres which innervated ciliary cells was 6.9 m/sec. The conduction velocity of the presynaptic fibres innervating the choroid cells was 3.4 m/sec. at 22 - 24°C. It was found that the cells which send axons to the ciliary nerves possessed a dual chemical and electrical mechanism of synaptic transmission while the cells sending axons to the choroid nerves only had chemical transmission. Moreover, although chemical synaptic transmission was cholinergic for both cell groups, there was a pattern of selectivity by different blockers. That finding suggested that the properties of the cholinergic receptors of the 2 ganglion cell populations might differ qualitatively.

Watanabe (1972), studied the ciliary ganglion of the guinea pig by fluorescence and electron microscopy. The fine structure of the perikaryon of the ganglion cells was similar

to that previously described for sympathetic ganglion cells in various species of mammals. Every presynaptic nerve ending in the ciliary ganglion contained numerous agranular vesicles mixed with a few large granular vesicles, thus corresponding to the type which was generally considered to be cholinergic. Adrenergic nerve endings and catecholamine containing cells were not found in the present study. No adrenergic nerve elements were recognized even after the administration of nialamide. The ciliary ganglion cells of the guinea pig were innervated purely by cholinergic nerves. Adrenergic nerve elements were probably not involved in the synaptic transmission. The spinous protrusions emerging from the postsynaptic element did not intrude into the swollen nerve endings, but only covered their surface.

Mahran and Sakla (1975), studied the intraorbital ganglia of the albino mouse. They noticed the presence of multipolar nerve cells within the sclera and the short ciliary nerves. A complete ganglion formed of 20 cells was found along the inferior division of the oculomotor nerve. Also, they reported unipolar nerve cells along the nasociliary nerve.

Petela (1980), described proper and accessory ciliary ganglia in 34 wild boars. The accessory ciliary ganglion was located at a constant distance of 20 mm from the proper ciliary ganglion along the short ciliary nerve. The connecting branch of

the ciliary ganglion to the nasociliary nerve was found in 50 % of the preparations. The connecting branch from the internal carotid nerve to the ciliary ganglion was found in 3 preparations. The sympathetic branch was found to run together with the connecting branch to the ciliary ganglion from the nasociliary nerve. In all cases, a connecting branch from the zygomatic nerve to the proper ciliary ganglion was also observed.

Fiori and Mugnaini (1981), demonstrated by a light and electron microscopic studies of the ciliary ganglion of the chick a class of small cells characterized by the electron-dense appearance of both nucleus and cytoplasm, slender cell processes, paucity of mitochondria and microtubules, presence of elongated cisterns of granular endoplasmic reticulum with narrow lumina, free ribosomes, dense bodies of varying sizes and coated vesicles. The small elongated electron-dense cells lacked a basal lamina and occurred within the satellite sheath surrounding ganglionic perikarya as well as in the endoneurial connective tissue. Occasionally, the small electron-dense cells within the ganglion cell capsule contained phagocytosed cell debris. The small electron-dense cells of ciliary ganglion differed substantially from satellite cells. In their fine structure, they closely resembled resting microglial cells of the C.N.S. Apparently, the small electron-dense cells in the ganglion and microglia cells in the C.N.S. belonged to the same cell category.

Perez and Robert (1986), performed baseline cell body counts on 32 human ciliary ganglia obtained during 16 consecutive autopsies. The mean age of individuals was 34.4 years with a range of 17 - 97 years. The cell body count ranged from 1088 - 6835 cell bodies per ganglion. The mean cell body count was 2437 for specimens from the right side, 2316 for the specimens from the left side and 2394 for the combined sides. The mean count in men were 2837 for the right side , 2533 for the left side and 2685 for both sides. The mean counts in women were 2004 for the right side and 2036 for the left side and 2020 for the combined sides. The decreased number of cell bodies in women compared to the population mean was not statistically significant. There was no correlation between age and cell body counts. There were also no statistically significant difference between the cell body counts from individuals with systemic hypertension, myocardial infarction or cancer and the population mean.

Kuchiwa, Takao and Toshiko (1988), reported that in the cat, the accessory ciliary ganglion consisted of cells similar to those of the main ganglion, but they were distinguishable by their slightly smaller size and their irregular and slender shape. Most of those cells were labeled after HRP - WGA injection into the chamber of the eye. In addition, a few labeled cells were scattered among the fibres of the short ciliary nerves near the accessory ganglion. It was considered that the labeled neurons mediated the parasympathetic

outflow to the ciliary muscle and/or the sphincter pupillae. Neither the episcleral and scleral ganglion observed in man and rabbit nor the small ganglion on the nerve branch to the inferior oblique muscle reported in the rabbit was able to be identified in the cat preparations. Moreover, no evidence of direct innervation of the intrinsic eye muscle by the central nervous system reported in the monkey and rabbit were obtained in the present HRP - WGA experiment in the cat.