ULTRA-STRUCTURE OF TRIGEMINAL GANGLION IN HUMAN

Dimo Krastev, Paloff A., Krastev N., Apostolov A.*, Ovtscharoff W.
Department of Anatomy and Histology,
**Department of Forensic medicine and deontology,*
Faculty of Medicine, Medical University - Sofia, Bulgaria

ABSTRACT

The trigeminal ganglion (TrG) is built of pseudounipolar neurons, their fibers and satellite cells. Neurons that are different in size have been visualized using electronmicroscopic method. It is particularly interesting that stored pigments are a result of age alterations. Pseudounipolar neurons in (TrG) are sensory cells and they receive nerve impulses from sensory nerve terminals. In conclusion, (TrG) is a related station that receives information, arranges it and transmits the signal to the central nervous system (CNS).

Key words: trigeminal ganglion, pseudounipolar neurons, sensory cells

INTRODUCTION

The (TrG) is a main generator of information from the orofacial complex in the human as well as in different types of mammals, and it maintains a constant control upon the transmitted information from the peripheral to the (CNS). Many investigations of the sensory ganglia confirm their similarity in ultra-structure aspect. An exception from this common rule may be observed in the vestibular and spiral ganglia where the bipolar form of the neurons is kept - Van Gehuchten (1897). Two of the authors working on the problems of the trigeminal system and especially on (TrG) in cats Allen (1924) and monkeys Maxwell (1967) in their studies on ultrastructural level show that the (TrG) is a limitant zone situated between the central and the peripheral nervous systems.

Comparing the specifics in the structure of (TrG) with those of other sensory ganglia the authors state that there are a number of common characteristics. There are as well common features in the character of the peripheral inervational fields with which they are linked.

From the systemical studies în ultrastructural level it is clear that in all sensory ganglia there are two types of neurons: large and small, light and dark. The big neurons in (TrG) have a light cytoplasm due to the fact that Nissl bodyes are represented by small diffusely-situated isles of small cisterns of the rough endoplasmic reticulum. It is specified in ultrastructural observations that they are surrounded by a light zone composed of microfilaments. In percentage the light neurons are considerably higher in comparison with the dark ones which is type-specific. Their higher differentiation comes early, during the ontogenetic development.

The darker colour of the small neurons is due to the fact that the Nissl granules are represented bó bigger isles composed by the longer cisterus of the rough endoplasmatic reticulum and dispersed free ribosome in between them. Using imunohistochemistry it is proven that 46% of the small and medium-sized neurons situated in the (TrG) are immunoreactive and have a darker color in tested animals (Ichikawa et al. 2006). They usually occupy the space of the peripheral parts of the ganglion. The differentiation of the small and dark neurons begins later during the ontogenetic development. Beaver (1967) states that "The human (TrG) resembles in common traits the ganglion in mammals as structure. . ."

After proving the heterogeneity of the cell populations in the nervous system, the researchers focused on the secrets of the transmission of nervous processes and the importance of the neurotransmitters in this process. Stoyanova (2004), Stoyanova, Lazarov (2001) studying the vegetative ganglions of an animal state that 20% of the neurons are GABA-ergic. The localization of GABA is in the small afferent neurons which are noniseptive, it is thought that GABA is pain transmitter and modulator.

The morphologic difference between the neurons corresponds to the functional difference. The experimental studies of different types of animals are a basis for known histologist like Cajal, Nissl, Cox, Lugaro and others to “classify the ganglion cells according to the differences in the repartition of the Nissl granulations, later called type A and type B. (Andres 1961).

Using imunocytochemical differences in the two type cells Kai-Kai (1989) divides them on subclasses. On histological section it is visualized that the perikarya of the pseudounipolar cells are tightly enveloped by small satellite cells with tightly linked neurolemmas. They are called satellites by Cajal (1907) and are described as cells with flattened shape. Their stricter division on cell subtypes is possible only on the base of contemporary ultrastructural and histochemical methods. The description of primary

sensory neurons in the (TrG) and the bulbus is seen in the works of Cajai (1907), Lazarov (2002), Marani and Usunoff (1998). According to Darian-Smith (1973) the (TrG) represents an analogue of the spinal ganglia of the peripheral nervous system. Studying the structure of the human (TrG) Komer (1937) în the base of different impregnation techniques makes it àn objective to classify them as:

A. Large cells with light cytoplasm which are found regularly and diffusely situated granules from the endoplasmatic reticulum, electronmicroscopically they look transparent.

B. Large cells looking electronmicroscopically light, but intracellular there are rougher and dense heaping offish granulations.

C. Small cells whose cytoplasm looks ultra-structure with peripherically situated Nissl granulations.

D. Small cells with dark cytoplasm and rough diffusely situated Nissl granulations.

The variety of the structure of the peripheral nervous system and in particular of the (TrG), in the human and in the animals, has been a subject of many studies and a source to manó discussions on the existence of different correlations between morphology and function.

Consequently the question is still disputable, whether it exists a certain type of correlation between some types of sensory nervous endings and a certain type of sensory nerves, situated inside a ganglion.

The mechanisms of transformation of an outside stimulation into à nervous impulse from the level beginning with the receptors, passing through the sensory ganglia and reaching the cerebral cortex, probably are similar in the different types of mammals (Wang and Wei 2006; Murata and Masuko 2006; Deguchi, et al, 2006).

The aim of the study is to establish the ultra-structure of the (TrG) in human.

MATERIAL AND METHOD

The material is taken from the Pathology department. After extracting the brain in toto and carefully removing the dura mater în the front part of the pyramid and cutting the three branches of the trigeminal nerve, the (TrG) is preparated, situated in trigeminal. The studies have been carried out on 10 (ten pairs of trigeminal nerves) of people of different age between 35 and 72 years. The study of cyto- and myeloarchitectonic of the slices passes through the following stages:

a. Differentiation of the separate nests of neurons with varying magnifications and photographing them.

b. Defining the cytological characteristic of the bodies of the pseudounipolar neurons as shape, size and density in the separate neuronal nests. The description of this technology is given by Mayhew and Momoh (1973).

RESULTS

1. Ultra-structure study of (TrG)

The ganglion could be separated into three separate nests, delicately separated one from another with fibers passing between them. Each of the nests is composed from a concentration of pseudounipolar neurons diffusely situated and responsible for the three branches of the trigeminal nerve.

On the Nissl preparation in low magnification each of the nests can bå separated in two parts dorsomedial and venterolateral. The cells in the dorsomedial compartment are more densely packed in comparison with the cells in the venterolateral compartment and are smaller in size.

The cells situated venterolaterally are with bigger perikarya and have a more distinguished distance between them, this is the place where exit the branches of the three parts of the fifth nerve (ophtalmic, maxillary and mandibular).

In the beginning of the ramification of the first and second branch there are frequently positivated singular perikarya covered with layer of satellite cells.

Despite the monotonous cell picture represented in à bigger percentage of small to medium-sized pseudounipolar cells above 80%, in a closer view we could see cells with a varying in shape body: round, ellipsoid, polygonal and elongated. The size of the cell bodies again varies in a large scale. Apart from this they vary in particular in their nucleus and cytoplasm, as well in their proportion. Generalizing our resu1ts of the study of (TrG) from the rostral to the caudal side we differentiate the following types of neurons according to their shape and the size of their perikarya:

1. Large light neurons
2. Medium light neurons
3. Medium dark neurons
4. Small light neurons
5. Small dark neurons
6. Neurons with elongated body
7. Neurons with polygonal shape

The medium sized neurons are the largest population of diffusely situated neurons in the three nests of the (TrG). Their perikarya is oval. The nucleus is situated approximately in the centre of the cytoplasm and also has an oval shape. According to the color of the cytoplasm they can bå divided into two types: medium light neurons with light cytoplasm and medium dark with darker cytoplasm.

The large light neurons are situated near the places where the three branches of the trigeminal nerve exit, but they are also found inside the nests. They are typical pseudounipolar neurons with light cytoplasm and big hypochromic oval nucleus. The small neurons are situated everywhere and are also divided into light and dark according to the color of their cytoplasm. They have à defined nucleus with slight1y oval shape situated excentrically.

There could be seen neurons with polygonal shape which are medium in size, but they could be found bigger situated mainly centrally and sometimes in the first segments of the three branches of the nerve. Near the nest there are neurons with long cell body.

DISCUSSION

In general our study is in agreement with the resu1ts of numerous authors working on animals and human.

The sensory nerve cells situated in (TrG) known as pseudounipolar or unipolar neurons are situated on the path between the receptors and the central nervous system. The ganglion serves as a relay station which is reached by rich information from the periphery to be resend on a higher level and to be transformed in a conscious perception în the level of the cerebrum. This constant flow coming from the sensor receptors in the periphery and transmitted through the sensory nervous impulses effectuates the homeostasis of the organism and assures the regular and in-time comportment and reaction of the individual towards any outer or inner change. Independently from the many Nissl studies (Stoyanova 2004, Wang, Wei 2006) and other methods rarely used for pseudounipolar neurons and routinely used in other cerebral structures - Golgi (Spasova 1987, Malmierca et al. 1993, Stoyanova 2005).

In order to be able to represent à stricter classification of the neurons in the complicated ultra-structure picture of the (TrG).

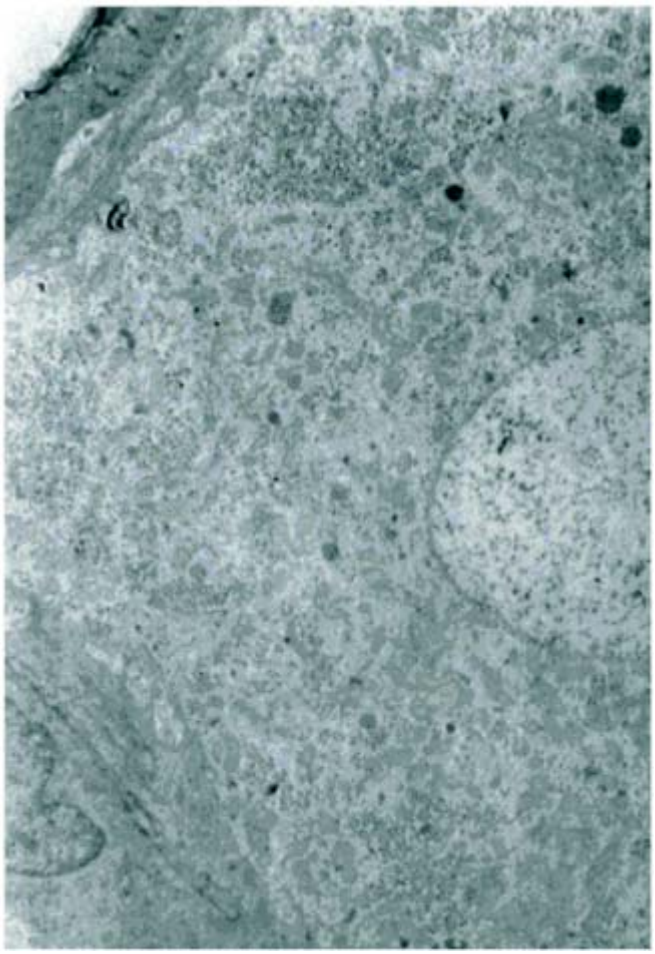

Fig. 1. Pseudounipolar neurons with different size localized in separate nests, and responsible for the three branches of the trigeminal nerve. x 12000.

Fig. 2. At a medium magnification is seen a line of neurons surrounded by fibers. In some of them is seen an accumulation of a pigment. x 12000.

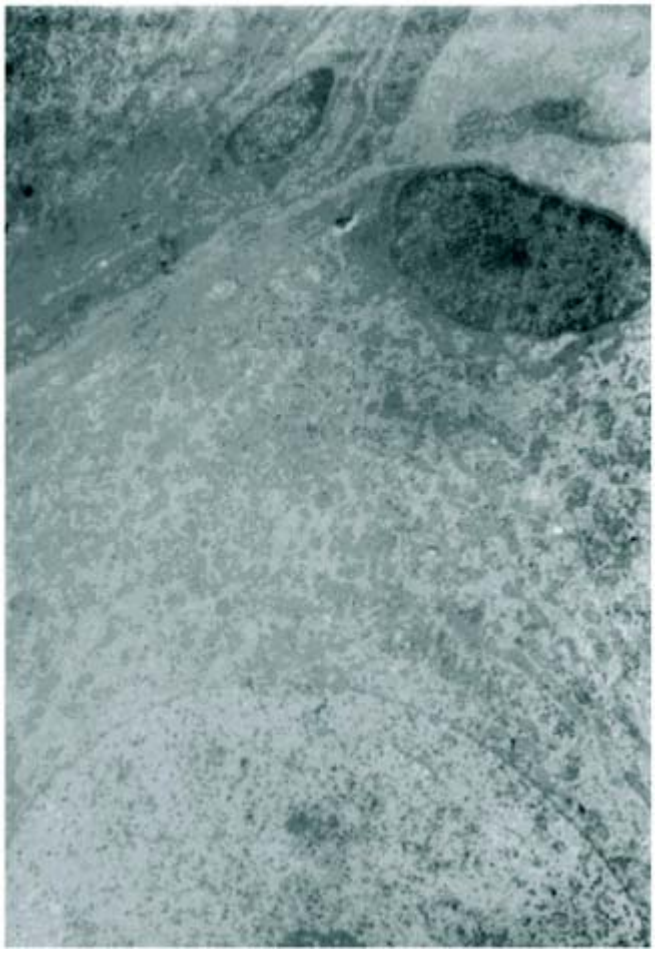

Fig. 3. There are seen neurons with polygonal shape. X 12000.

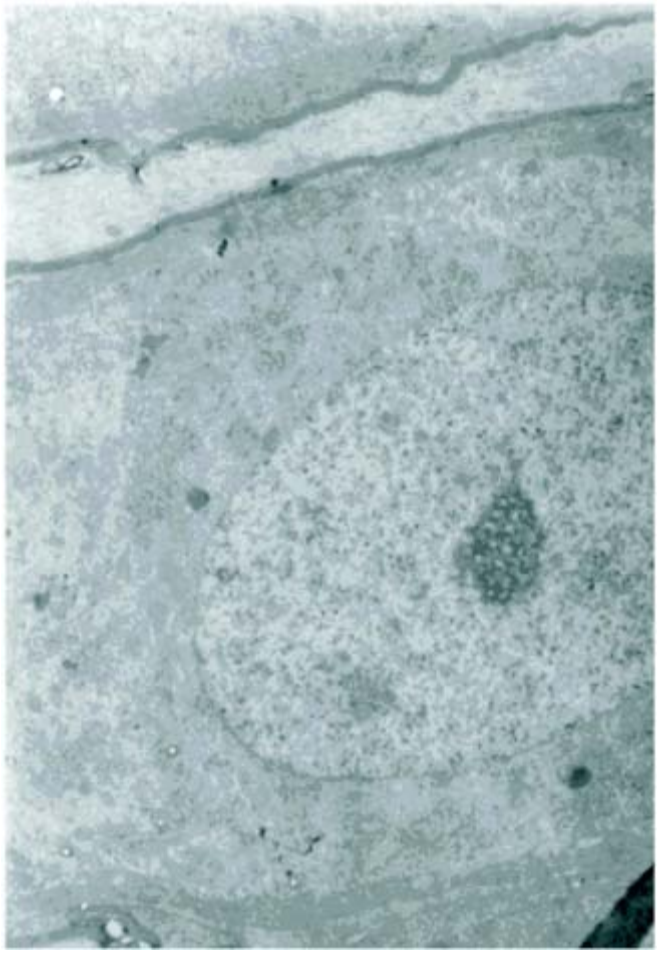

Fig. 4. Alongside the neuro branches are seen neurons with elongated body. x 12000.

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