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LOYOLA UNIVERSITY SCHOOL OF MEDICINE

THE SPHEN-O-PALATINE GANGLION OF THE ALBINO RAT

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THESIS

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Introduction

The purpose of this paper is to describe as fully as possible the anatomy of the spheno-palatine ganglion of the albino rat. So far as is known no one has yet attempted a study of this structure in the animal mentioned, and this fact alone would be sufficient reason for the present undertaking. If we further consider, also, the fact that the albino rat is a widely used laboratory animal, thus meriting intensive study, and that it is easily bred and handled, an investigation such as the present becomes desirable.

Appreciation is hereby gratefully expressed to Dr. Strong for direction of the work; to Dr. Essenberg for his interest and suggestions; to Mr. Warren for his help, suggestions and interest; and to Miss Bakehouse for her aid in making the photographs.
Though the trigeminal and facial nerves as well as a part of the sympathetic nervous system were recognized as early as the second century by Galen (150-200 A.D.), it was not until the middle part of the eighteenth century (1748), that the sphenopalatine ganglion was described by Johann Friedrich Meckel. One hundred and twenty three years later in 1871, G. Sapolini of the Royal Court of Italy added the connection of the ganglion with the facial nerve, as well as the cervical sympathetic trunk.

The literature concerned with the minute structure of the ganglion is scant indeed, and is referred to in papers by Carpenter (1912), and Larsell and Fenton (1928). Retzius (1880) appears to be the first one to undertake a histological study of the sphenopalatine ganglion not only in man, but also of the sheep and the cat. By a process of teasing, he was able to demonstrate multipolar cells in the sphenopalatine ganglion of the sheep, and bipolar cells for this ganglion in the cat. He was not able, however, to determine by this method, the morphology of the ganglion cells in man. Von Lennhösssek (1894) appears to be the next one concerning himself with the minute structure of this ganglion. Since no access could be had to his paper, others must be depended on for a resume of his work. Carpenter says, "in 1894, V. Lenn-
Hossek described Golgi preparations of the sphenopalatine ganglion of the mouse, and gave us the only account of fibrillar end-baskets around the ganglion cells. Larsell and Fenton state that V. Lennhossek, "working with older stages of embryos of the chick and the dove, found cells of the multipolar type." Müller and Dahl (1910) working with the sphenopalatine ganglion of the horse, sheep and man, and employing the Bielschowsky technique demonstrated multipolar cells in the sphenopalatine ganglion of the sheep. In the second edition of "Die Levensnerven", Müller (1924) states that the ganglion is made up entirely of multipolar cells, in man. Larsell and Fenton (1928) working with kittens of the age of two weeks and employing the pyridine silver method, demonstrated multipolar cells in this ganglion. From the histological viewpoint, then, there seems to be a unanimity of morphological findings among the various workers, even though different staining techniques and several types of animals, in addition to man were used.
Material and Methods

The material consisted of albino rats, Mus norvegicus albinus, obtained from our colony. Mature rats were used in all work with one exception. In this latter case, ten day rats were used to facilitate decalcification.

Several methods were very useful in the localization of the ganglion and in tracing out its connections. These methods were Langwell's method, the use of HNO₃ for softening the bone, and Rhinehart's method. Langwell's method for the investigation of the peripheral nervous system consists in placing the material to be dissected in 5% HCL icewater for twenty-four hours and washing with cold tap water. This method was especially useful in tracing the Vidian nerve. Where bone had to be removed in the tracing of the Vidian nerve and the Great Superficial Petrosal nerve, it was found that placing the rat's head in 5-7% HNO₃ for forty-eight hours, softened the bones and enabled an easy tracing of these small filaments without danger of breaking them. A method which was of great value in the exact localization of the ganglion was that used by Rhinehart (1918) in his work on the facial nerve of the mouse. This method consists of decalcification of whole heads of rats and serial sectioning. Two heads of mature albino rats were decalcified in 7% HNO₃, imbedded in celloidin and sectioned serially. One whole head was
sectioned in a horizontal plane; the other head was divided into two equal lateral halves, one of these being sectioned in a sagittal plane and the other in a transverse plane. The portion reserved for transverse sectioning, however, was discarded, and in its place one whole head of a ten day albino rat was decalcified by the rapid phloroglucin method as given by Guyer. It was found, however, that the time allowed for decalcification by this method— one half hour— did not prove sufficient and additional treatment in 7% HNO₃ for forty-eight hours was necessary before sectioning could be done. All of the serial sections were stained with hematoxylin and eosin.

Having located the ganglion the next step was to determine the morphology of its component cells. Here various methods were used, iron hematoxylin, methylene blue, Nissl's stain, carmine, Bielschowsky's silver pyridine, Golgi silver impregnation, alcoholic silver nitrate suggested by Davenport of Northwestern University, but none yielded the desired information. Teasing was also done; the teased tissue being stained by several of the above methods without results. Maceration in 30% alcohol was performed on several specimens, these being kept in the alcohol from twenty-four hours to three weeks. The filtrate was then stained by Nissl's stain carmine and methylene blue, but no cells could be noted. Mashing the fresh and fixed ganglionic tissue between
slides to a thin film and then staining did not yield any information about the morphology of the constituent cells.
Discussion

The main mass of the sphenopalatine ganglion of the albino rat, in freshly dissected, unfixed material, appears as a greyish, translucent, somewhat stellate shaped, flattened mass of ganglion cells, measuring 2-3 millimeters in the antero-posterior diameter, 1.5-2 millimeters in the vertical diameter and 0.2-0.3 millimeters in the lateral diameter. The qualification "main mass" is used because the ganglion begins some distance - 6-7 millimeters - posteriorly, as an accumulation of ganglion cells about the Vidian nerve. The anterior extremity of the ganglion is forked and appears flattened in transverse sections. The fork is placed in a vertical plane. There is a present superior smaller limb and an inferior larger limb. Between the limbs there is lodged a fairly good sized blood vessel, this vessel being a constant feature in all sections. The inferior limb is situated ventro-medially below the superior maxillary division of the trigeminal nerve. It lies partly in a foramen connecting the orbito-temporal fossa with the nasal cavity, and partly beneath the mucosa of the nasal cavity. From the apex of this latter portion arise three nasal branches of the ganglion, which pursue a course rostrally, beneath the nasal mucosa, with accompanying blood vessels. The superior limb is smaller and lies in contact with the ventro-medial aspect of the superior division of the
trigeminal nerve. This portion of the ganglion lies wholly in the infraorbital groove. The remainder of the ganglion, also, lies in the infraorbital groove, in the arito-tempo­ral fossa, somewhat anteriorly and ventro-medially, at about the level of the upper second molar tooth. This portion which extends posteriorly, for a distance of about 5-7 millimeters, to the point of junction of the Vidian and Spheno-palatine nerves, appears oval or circular in trans­verse sections.

For purposes of orientation it would be well, perhaps, to say something about the anatomy of the arito-temporal fossa. This has for its lateral boundary the zygomatic arch, for its medial boundary the frontal, parietal, squamosal, and maxillary bones. Superiorly it is limited by the crests of the frontal and the parietal bones; inferiorly, by the upper molar teeth and the lower border of the alveolar process of the maxillary bone. Anteriorly, the fossa is limited by the maxillary bone and its zygomatic process; posteriorly by the squamosal bone and its zygomatic process. Two fissures and four foramina com­municate with this fossa: only those immediately related to the ganglion, however, will be considered. The first one is the arito-sphenoid fissure by means of which the fossa communicates with the cranial cavity as well as with the anterior lacerated foramen. This fissure transmits
the superior maxillary and ophthalmic divisions of the trigeminal nerve, the oculomotor, trochlear, and abducens nerves, blood vessels, as well as the Vidian nerve. Inferiorly this fissure is continuous with the anterior lacerated foramen and it is thru this foramen that the Vidian nerve passes from the nasal cavity into the orbitosphenoid fissure to meet the superior maxillary division of the trigeminal nerve. In the maxillary bone, and directed rostrally and ventrally, is the second foramen concerning us. Thru this foramen, the inferior limb of the ganglion passes from the orbito temporal fossa, and comes to lie beneath the mucosa of the middle third of the nasal chamber. In the alveolar process of the maxillary bone, and directed ventrally, is a foramen transmitting the palatine nerves. It may also be stated that dorsally the alveolar process of the maxillary bone is grooved to form the infraorbital groove in which the greater extent of the ganglion is situated.

The ganglion, exclusive of the inferior fork, is located in the infraorbital groove on the dorsal aspect of the alveolar process of the maxillary bone. Here it is related medially to the medial wall of the orbit, formed by the perpendicular lamina of the frontal bone. Superiorly the ganglion is overlapped by the superior division of the maxillary nerve; inferiorly it rests on the alveolar pro-
cess of the maxillary bone in the infraorbital groove. Anteriorly a good sized artery is located between the limbs; posteriorly the ganglion tapers to the junction of the Vidian and sphenopalatine nerves.

Connections.

By way of the great superficial petrosal, great deep petrosal and the sphenopalatine nerves, the ganglion is connected with the facial nerve, cervical sympathetic trunk, and the trigeminal nerve respectively. The majority of the sphenopalatine branches, leave the ganglion almost at once as the anterior palatine nerve. Several of the sphenopalatine branches, however, can be seen running thru the ganglion as white filaments which contrast strongly with the grey color of the ganglion. These filaments become incorporated in the nasal branches of the ganglion.

The great superficial petrosal nerve arises from the geniculate ganglion. Its course and relations in the cranial cavity have not been worked out in this investigation. In the mouse, the course and relationships of this portion of the great superficial petrosal, have been thus described by Rhinehart. "From its origin this (great superficial petrosal) nerve passes anteriorly for a short distance along the lateral side of the ventral surface of the ganglion semilunare. After a short course it
bends at almost a right angle and passes medially, ventral to the internal carotid artery and the sympathetic plexus which surrounds it. At a point just medial to the artery the nerve bends anteriorly and is joined along its medial side by the great deep petrosal nerve, the two uniting to form the nervus canalis pterygoidei (Vidian nerve). In my dissection a short, fine twig, connecting the internal carotid artery and the great superficial petrosal nerve was noted. This was the great deep petrosal nerve. Rhinehart states that in the mouse, two small bundles are given off from the internal carotid plexus to join the great superficial petrosal nerve, the combined trunk being termed the Vidian nerve or nerve of the Pterygoid canal.

This trunk emerges from the cranial cavity thru the Eustachian (periotic) aperture, "a slit-like fissure between the tympanic and periotic bones," and pursues and antero-medial course for a short distance, along the ventral aspect of the sphenoid bone. It then turns and runs directly rostrally in the angle between the sphenoid bone and the internal pterygoid process, beneath the nasal mucous membrane. It finally reaches the anterior lacerated foramen thru which it passes, and joins the superior maxillary division of the trigeminal nerve, passing with the latter as well as the ophthalmic division of the trigeminal nerve, and the trochlear and abducens
nervea to the posterior portion of the orbito-temporal fossa via the orbito-sphenoid fissure. At first the Vidian nerve lies on the dorso-medial aspect of the superior maxillary division of the trigeminal nerve for a short distance. Then it pursues an oblique and ventrally directed course, on the medial aspect of the above nerve. At about mid-point of this latter nerve, the Vidian nerve is joined by the sphenopalatine branches of the superior maxillary division of the trigeminal nerve. In this course, i.e., from the place where the Vidian nerve first comes into contact with the superior maxillary nerve, to the place of union of the sphenopalatine and the Vidian nerve, the latter nerve measures about three millimeters.

Branches.

No attempt was made to trace the various branches of the ganglion to their termination, nor to study them in detail. For a study of these branches and their distribution the reader is referred to the paper on the facial nerve of the albino mouse by Rhinehart.

Histology.

Acid hematoxylin and iron hematoxylin sections of the isolated ganglion as well as the serial sections showed the ganglion surrounded by a fibrous capsule, and consisting of an interlacement of myelinated and unmyelinated axis cylinders, and the ganglion cells. In the anterior
extremity of the ganglion, especially in the inferior
horn, the ganglion cells in transverse, horizontal and
sagittal sections, appeared massed closely together.
Posteriorly the ganglion cells appeared less numerous,
the myelinated and unmyelinated fibers predominating.
Ganglion cells were noted for a considerable distance
posteriorly in the Vidian nerve.
Summary

1. The spheno-palatine ganglion of the albino rat, in freshly dissected material, appears as a greyish, translucent, mass of ganglion cells, stellate shaped and flattened anteriorly; club shaped, and oval to circular posteriorly, measuring approximately 8-9 millimeters in the antero-posterior plane. It is situated for the most part in the infraorbital groove on the dorsal aspect of the alveolar process of the maxillary bone.

2. The anterior extremity of the ganglion is forked: an inferior, larger limb of the fork lies partly in the infraorbital groove, partly in the foramen connecting the orbito-temporal fossa with the nasal cavity, and partly beneath the mucosa of the nasal cavity. The superior smaller limb lies wholly in the infraorbital groove in contact with the ventro-medial aspect of the superior maxillary division of the trigeminal nerve. A good sized artery is found between the limbs.

3. The upper and lower limbs, especially the lower, and the posterior continuation of the ganglion for a distance of about 2-3 millimeters, appears to contain the largest concentration of the ganglion cells.

4. The branches of the ganglion, so far as they have been noted, correspond to those found in man.

5. Histologically, the ganglion consists of ganglion
-15-
cells, myelinated and unmyelinated fibers, surrounded by a fibrous capsule.


10. Müller, L. R. 1924.


Fig. 1A. Showing the course of the Vidian nerve. (X) indicates the orbito-temporal fossa.
Fig. 1B. Lateral view of the skull of albino rat. (1). Foramen connecting the orbito-temporal fossa with the nasal cavity. (2). Infra-orbital groove on the dorsal aspect of the alveolar process of the maxillary bone. The orbito-temporal fossa is also shown between the zygomatic arch, partially broken, and the medial wall of the orbit.
Fig. 2. Horizontal section thru the sphenopalatine ganglion, showing the forked anterior extremity (1), and the blood vessel (2) between the limbs of the fork.