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# OTALGIA CONSIDERED AS AN AFFECTION OF THE SENSORY SYSTEM OF THE SEVENTH CRANIAL NERVE.<sup>1</sup>

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(*With two illustrations on Text-Plate III.*)

## INTRODUCTION.

THE object of the present study is to show the relationship of otalgia to the seventh cranial nerve; not of the facial nerve proper, but of its sensory system, which consists of the nerve of Wrisberg, the geniculate ganglion, and the petrosal nerves (great and small superficial petrosal, great and small deep petrosal, and the external petrosal nerves); also that otalgia bears the same relation to the facial nerve as does prosopalgia to the trifacial, and that in the facial nerve is to be found a sensory and reflex factor of great importance in the innervation of the auditory mechanism. Save for an uncertain relation to the taste fibres of the chorda tympani, the sensory mechanism of the facial has played no rôle in symptomatology, and has not had attached to it any definite sensory functions.

In nearly all modern treatises on otology are to be

<sup>1</sup>Read in abstract before the Section on Otology, New York Acad. Med., Oct. 11, 1907.



found descriptions of the various clinical forms of otalgia, a large group of non-inflammatory earaches. These have been subdivided into primary otalgia, reflex otalgia, and secondary or herpetic otalgia. The pain is neuralgic in character and sharply circumscribed to the structures of the ear; it may be localized in the auricle, the auditory canal, or in the depths of the ear. Following the distribution of the pain, various groups of nerves are supposed to represent the underlying anatomical basis. Thus there are described neuralgia of the tympanic plexus; of the plexus of the Eustachian tube; of the auricular branches of the trigeminus; and of the auricular branches of the cervical nerves. A pain, if situated in the depths of the ear, is referred to the tympanic plexus; when on the anterior surface of the auricle, to the trigeminus; and when on its posterior surface, to the cervical plexus. While it cannot be denied that pain in the auricle may accompany the paroxysms of tic douloureux and occipito-cervical neuralgia, it would seem rather forced to ascribe to either of these large distributions a sharply circumscribed otalgia which shows no tendency to diffusion or extension into other areas.

A careful consideration of the prevailing views will show that the subject of otalgia is by no means clear, and that a well defined anatomical basis does not exist; furthermore, that we are very far from having a satisfactory understanding of many reflex aural neuroses described in otological literature. I believe that the introduction of the facial nerve into the realm of otalgia, and its evident sensory importance in the auditory mechanism, will supply an important key to the solution of these problems.

My attention was first directed to this subject by a study of the herpetic pain in cases of herpes zoster of the ear. This group of cases described under the title of Herpes Zoster Auris, or Herpes Zoster Oticus, is dependent upon a specific inflammation of the geniculate



ganglion of the facial nerve, situated in the depths of the internal auditory canal.<sup>1</sup>

In this localization of zoster the pre- and post-herpetic pains are often very severe and intractable; so severe in some cases, that trained otologists have incised the tympanum suspecting a middle-ear complication. These pains are variously referred to the surface of the auricle, the auditory canal, or the depths of the ear,—the same distribution, approximately, as occurs in idiopathic and reflex otalgia.

Should there exist anywhere in the nervous system a sensory ganglion, the peripheral or surface representation of which was unknown or doubtful, the distribution of the pains following a circumscribed lesion of this ganglion would serve as a most valuable guide. Such a ganglion of unknown representation have we in the geniculate; and such a circumscribed lesion have we in herpes zoster—an affection dependent upon a specific inflammation of sensory ganglia of the spinal type. It is for this reason that I attach paramount importance to the distribution of the pain in herpes oticus, as giving the cue to the pain distribution and representation of this sensory system. I would particularly emphasize the fact that these pains are referred to the auricle, auditory canal, and depth of the ear; in other words, in the same area of localization as is found the otalgia of idiopathic or reflex origin, which heretofore have been relegated to the trigeminus, the cervical, or the tympanic plexuses.

#### ANATOMICAL CONSIDERATIONS.

I would here give in brief a few facts from anatomy and embryology bearing on the sensory mechanism of the facial nerve, which serve to emphasize its close relation to the auditory mechanism. The facial nerve, in the

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<sup>1</sup> "Herpetic Inflammations of the Geniculate Ganglion. A New Syndrome and its Complications." By J. RAMSAY HUNT.—*Jour. of Nerv. and Ment. Dis.* (Feb., 1907), and *ARCH. OF OTOTOLOGY*, vol. xxxvi., No. 4, 1907.



primitive forms of life, is the nerve of the first branchial or ear cleft (the spiracle). From the ear cleft are developed the structures of the middle and external ear. Not only is there this relation to the conducting mechanism of the ear, but both the 7th and 8th nerves spring from a common ganglionic outgrowth of the neural ridge (the ganglion acustico-facialis). From the ganglion acusticum, which joins the otic vesicle, are developed the ganglia of Corti, Scarpa, and the auditory nerve. The ganglion faciale is represented at a later period of development by the geniculate ganglion, from which is developed the *pars intermedia* or nerve of Wrisberg; so that in developmental processes there is found a most intimate relationship between the facial nerve and its ganglion, the ganglia of the acoustic nerve, and all those structures which go to form the auditory mechanism.

Anatomically, the facial is a mixed nerve, as are the 5th, 9th, and 10th nerves, having a motor and a sensory root and ganglion. Its ganglion, the geniculate, is situated at the entrance to the aqueduct of Fallopius, in the depths of the internal auditory canal. This structure contains cells of the so-called spinal type, and is the homologue of the Gasserian ganglion and the posterior root ganglia of the spinal cord. There passes from it centripetally the nerve of Wrisberg (Fig. 2) on its way to the medulla oblongata, lying between the 7th and the 8th nerves. This represents the sensory root of the 7th. The distal or peripheral branches of the ganglion are three in number (Fig. 1).

1. The great superficial petrosal nerve; passing to Meckel's ganglion on the second division of the 5th, giving off in its course a branch which enters into the formation of the tympanic plexus (*the great deep petrosal nerve*).

2. The small superficial petrosal nerve; which passes to the otic ganglion on the third division of the 5th, likewise giving off in its course a branch to the tympanic plexus (*the small deep petrosal nerve*).



3. The external petrosal nerve, which enters into the formation of the carotid plexus of the sympathetic system.

In addition to these three divisions on the distal side of the ganglion, sensory fibres are also found coursing in the facial nerve proper in its passage through the Fallopian canal (I would recall, in this connection, the frequency of ear pain in cases of Fallopian neuritis of the 7th nerve). Furthermore, the nerve of Wrisberg, just above the ganglion, is connected with the auditory nerve proper by several fine filaments (Fig. 2).

*The Plexus Tympanicus* (Fig. 1), in addition to the great and small deep petrosal nerves, both of which stand in relation to the geniculate ganglion, has entering into its formation the tympanic branch of the glosso-pharyngeal nerve (*Jacobson's nerve*), so that the tympanic plexus is composed of the terminal branches of Jacobson's nerve—from the 9th, and the small and large deep petrosal nerves of the sensory mechanism of the 7th.

In the medulla, the nerve of Wrisberg enters the fasciculus solitarius and terminates in the same manner and in close relation to the sensory roots of the 5th, 9th, and 10th nerves.

#### *Zoster Zone.*

The Zoster Zone of the geniculate ganglion, as shown by an analysis of the cases of herpes oticus, is to be found on the tympanic membrane, in the auditory canal, in the concha, and in an adjacent marginal area of the external ear. It is not to be inferred that this entire area in question is represented by the geniculate alone. The innervation of the interior of the auricle is a very complex one, the auricular branches of the trigeminus, of the cervical nerves, and the vagus participating; so that overlapping and great variability must necessarily result, but a study of the distribution of the eruption in



geniculate zoster teaches us that it must participate to a greater or less extent in the innervation of this area.

From this brief resumé it will be seen that the 7th nerve has the following sensory relations with the structures of the auditory mechanism:

1. With the *internal ear* by connecting filaments with the auditory nerve.
2. With the *middle ear* by petrosal branches to the mucous membrane of the tympanic cavity.
3. With the *external ear* by cutaneous fibres passing to the tympanic membrane, the auditory canal, and the interior of the auricle.

I therefore believe that the geniculate and its peripheral divisions play a central and important part in the innervation of the structures of the auditory mechanism; at the same time recognizing the part played by the auricular branches of the trigeminus, glosso-pharyngeal, vagus, and cervical nerves in the complex innervation of the same area.

#### *Symptomatology of Otalgia.*

Otalgia, as its name implies, is a neuralgic affection of the ear. The pain may be more or less constant in character, with exacerbations, or it may assume a distinctly intermittent type (*otalgia intermittens*). It may be localized in the depths of the ear, in the auditory canal, or on the surface of the auricle itself, and in some cases has been associated with hyperæsthesia and vaso-motor changes. A *Valleix* tender point is occasionally present in front of the anti-tragus.

Some general idea of the frequency of this affection may be obtained from the statistics of Schwartze, who gives the relative frequency of nervous to inflammatory earache as 1.8 per cent. The recognized clinical types are: *primary* or *idiopathic*, *reflex* or *referred*, and *secondary* or *herpetic*.

*Idiopathic Form.*—These primary cases are apparently quite rare, only a few observations are found scattered



through literature. The etiological factors mentioned in the recorded cases were as follows. Scarlet fever (Nottingham), malaria (Delcourt), influenza (Eitelberg), lead (Kretschmann), trauma (Szenes), and exposure to cold. A case of otalgia intermittens has been described by Eitelberg in the case of a man aged twenty, who for three months suffered from a periodical pain in the ear, coming on at ten o'clock every morning and lasting one hour. It responded promptly to quinine. A classical description of idiopathic otalgia was given by John Nottingham as early as 1857, under the title of *tic douloureux* of the ear, from which I quote as follows. "A very interesting case of neuralgia of the tympanum, or *tic douloureux* of the ear, has lately come under my notice in a young gentleman of ten years of age. The patient has a highly nervous temperament, sensitive and excitable, characterized by a fine cerebral development, and very superior intelligence. The painful affection of the right ear from which he now suffers followed an attack of scarlet fever which he had about seven months ago. Watching the case attentively, a few days since it was observed that a violent although momentary attack of pain occurred nearly every five minutes. Occasionally the interval was less, sometimes a little more; the pain is most lancinating and acute, causing the patient to jump up in his chair, and often to bound across the room, and to throw himself into the arms of his mother in the most frantic manner possible. As soon as the shock of pain is felt, a blush of redness displays itself upon the external ear, which gradually passes off before the next paroxysm occurs. The attack of pain is remarkably sudden, and its cessation is equally so, and it is particularly worthy of notice that the patient is in an instant completely freed from his agony, and at once resumes his previous occupation or amusement, as if no recollection continued of the writhing torture which has just passed off. This sudden attack, and as sudden arrest of



the pain, are very unlike any of the ordinary phenomena of otitis, and are not accompanied by the anatomical appearances or physical signs which characterize inflammatory affections of the ear."

*Reflex Otalgia.*

This is a very common affection, and generally accompanies and is dependent upon some gross lesion in the buccal cavity or naso-pharynx. Perhaps the most frequent cause is a carious molar tooth. Among the other numerous etiological factors of this reflex pain may be mentioned: periostitis, and deep-seated inflammatory affections of the teeth—especially the molars and wisdom teeth; tonsillitis, and other inflammatory and ulcerative affections of the throat; tumors and ulcerations of the tongue and epiglottis; retro-pharyngeal abscess. Affections of the articulations of the jaw also may give rise to otalgia, and Kretschmann in 84 cases found 20 of articular origin. In these cases, on the side of the lesion there is felt pain in the depths of the auditory canal. This may be aching or neuralgic in character, and is not infrequently exaggerated by making pressure on the diseased part. It disappears, often with great rapidity, after the removal of the local cause. Sometimes with the pain there is a feeling of fulness and discomfort in the ear. Gradenigo, in his studies, found that the reflected pain from otalgia was not centred in the depths of the ear, but was localized near the tragus, and occasionally in the auricle.

*Double Reflex Otalgia* has been observed by Wagenhauser (*A. f. O.*, vol. xxvii., p. 171) in ulcerative affections of the throat and epiglottis. A curious and, so far as I am aware, a unique case has been described by Delavan, of a persistent *crossed* reflex otalgia. In this case a right-sided otalgia of long duration was relieved by removing the diseased roots of a left lower molar tooth. It will be observed that the area giving rise to reflex otalgia is in the distribution of the second and third



divisions of the trifacial nerve. It will be remembered that both of these divisions stand in relation anatomically with the geniculate ganglion of the facial; this being affected through the medium of the great superficial petrosal nerve (which passes to Meckel's ganglion on the second division of the 5th) and the small superficial petrosal (which passes to the otic ganglion on the third division of the 5th). It is by these anatomical routes that the stimuli reach the geniculate ganglion and the pain is then referred to its peripheral representation. Examples of referred or reflex pain are to be found in many other nerve distributions, and I would particularly emphasize in this connection the occurrence of referred pain in diseases of the viscera. It seems to me very probable that in this form of otalgia we are dealing with a referred visceral pain, the focus of irritation being situated in the mouth or naso-pharynx in the trigeminal area, and the pain being reflected into the sensory area of the geniculate ganglion; the connections mentioned between the second and third divisions of the 5th, Meckel's, and the otic ganglia, and through these ganglia with the geniculate by way of the great and small petrosal nerves, serving as an anatomical basis.

*Secondary Otalgia* (Herpetic Otalgia).—As its name implies, these cases are secondary to an organic lesion of the nerve or its ganglion, and in the case of herpes oticus is dependent upon an herpetic inflammation (posterior poliomyelitis) of the geniculate ganglion. These pains, as in idiopathic or reflex otalgia, are referred to the depths of the ear, the canal, and the auricle. It must, however, be emphasized that more than one ganglion is frequently involved in zona, so that herpetic pains may also occur in the other nerve distributions of the auricle, and be dependent upon lesions in the Gasserian or 2d and 3d cervical ganglia.

*Tabetic Otalgia*.—As the 7th nerve is a mixed nerve in the sense of the 5th, 9th, and 10th cranial nerves, it would



only be natural to look for its involvement in cases of tabes dorsalis, especially in the cephalic or bulbar types of this affection. In the event of such a localization, one would expect lancinating pains in the depths of the auditory canal. The occurrence of lancinating pains in the ear is mentioned in the comprehensive studies of Topinard (*De l'ataxie locomotrice*), and by Pierret (*Essai sur des symptômes céphaliques du tabes dorsalis*).

I have, with this symptom in view, examined a large number of tabetics, and succeeded in finding three cases in which sharp shooting pains were felt in the depths of the auditory canal, having the same character as the lancinations in other distributions. In all these cases organic affections of the ear were excluded. These observations are only clinical, but it seems to me very probable that careful studies of the nerve of Wrisberg will show degenerative changes when this symptom is present. Of course, as the 9th, 10th, and 5th cranial nerves, as well as the auricular branches of the cervical plexus, are also concerned in the innervation of this area, ear pains may accompany degenerative changes in them as well, but sharply defined recurrent lancinations in the depths of the ear may very justly give rise to a suspicion of degenerations in the nerve of Wrisberg.

*Reflex Aural Neuroses.*—Under this heading are described in otological literature some peculiar symptoms, centred about the auditory mechanism and apparently of reflex origin. They are sensory, vaso-motor, and trophic in their nature. In one group the source of irritation is in the auditory mechanism, and the symptoms are projected into the trigeminal area. In the other the irritative focus is in the trigeminal distribution, and the symptoms are referred to the auditory mechanism.

I will not take up a discussion of these symptoms in detail, but will again emphasize the anatomical relations existing between the facial nerve and ganglion and the trifacial nerve and its ganglion, through the medium



of the great and small superficial petrosal nerves. I would, however, call especial attention to a relation which exists between the teeth and the sense of hearing. It is an old observation that loud and shrill sounds are accompanied by a sensation of pain or discomfort in the teeth; *vice versa*, there has also been noted (Hesse, Risien Russell, and Mummery) deafness accompanying affections of the teeth; the auditory disturbance disappearing promptly on removal of the diseased focus. Gruber observed also hyperacousis, which disappeared on removal of the affected teeth. Here is a very interesting connection between the function of hearing and the second and third divisions of the 5th nerve. It will be recalled that the geniculate ganglion has also filaments of communication with the acoustic nerve in the auditory canal, and the same path which conveys the referred pain in affections of the teeth may also carry stimuli inhibiting the functions of the auditory nerve.

REMARKS.

In the foregoing pages I have given a brief resumé of the literature of otalgia, its recognized clinical types, and the prevailing views regarding its origin and anatomical relations. Very briefly, too, I have touched upon the embryology and anatomy of the facial nerve and its close relation to the auditory mechanism. Although the mixed character of the facial nerve has been accepted by anatomists for a number of years, no definite sensory functions have been attached to its sensory mechanism. At the present time we have not a clear and definite conception of that peculiar localization of neuralgia termed otalgia. Because of the complexity and overlapping of the auditory innervation, certain mixed forms of otalgia must occur. These belong rather to the auriculo-temporal neuralgia of the trigeminus, or are occipito-cervical otalgias; not, however, otalgia in the pure sense of this term. The pure and more sharply



localized form of otalgia is, I believe, essentially a manifestation of the sensory system of the facial nerve.

It may be said that the glosso-pharyngeal nerve, which sends a tympanic branch to the tympanic plexus, may also be one of the underlying factors in otalgia. In answer, I would mention the other sensory branches of the 9th nerve: to the tonsil, to the palatal arch and pharynx, and the fact that this area is not involved in the pure forms of otalgia. Of course, I cannot deny that the sensory system of the glosso-pharyngeal nerve may be the seat of a neuralgic affection, either alone or in conjunction with that of the facial. In such an event, however, one would naturally look for the distribution of pain in the throat as well, and not in the ear alone. The vagus, on the other hand, has only a small cutaneous representation on the auricle, and could therefore hardly be brought within the realm of otalgia except in a secondary or subordinate sense.

From our knowledge of the anatomy of the sensory system of the facial, together with the distribution of the pains and herpes, in cases of inflammation of the geniculate ganglion, the circumscribed aural distribution of this nerve may be fairly well assumed. Its branches to the auditory nerve, the tympanic cavity, the tympanic membrane, auditory canal, and interior of the auricle, cover fairly well the pain area in the pure form of otalgia, whether primary, reflex, or herpetic. The relation of pure otalgia in the referred type to the sensory system of the facial is quite apparent from the communication of the geniculate with the second and third divisions of the fifth nerve.

I would say in conclusion that the central and peripheral connections of the 5th, 7th, 8th, 9th, and 10th nerves are so numerous and so intimate that many careful clinical analyses will be required before deciding the exact rôle played by any one of these nerves in the production of otalgia. It, however, seems to me clear that



while the facial nerve may be by no means the sole factor, it is the preponderating one in the production of otalgia.

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Illustrating Dr. Hunt's article on Otalgia

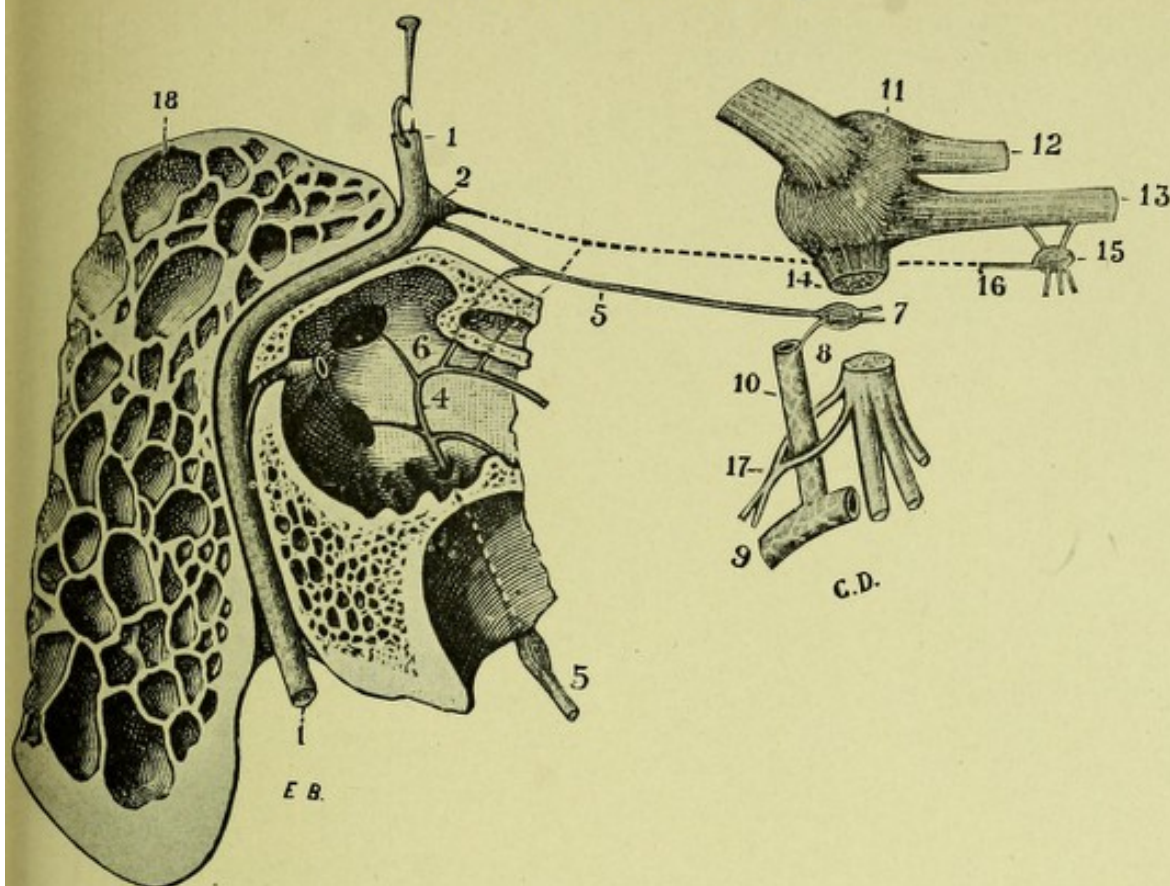


FIG. 1.—(*Testut's Anatomy.*) Showing relation of geniculate ganglion to Meckel's and the otic ganglia, and to the tympanic plexus.

- |                                |  |
|--------------------------------|--|
| 1. Facial.                     | 9. Internal maxillary.   |
| 2. Geniculate ganglion.        | 10. Middle meningeal.  |
| 3. Glosso-pharyngeal.          | 11. Gasserian ganglion.  |
| 4. Jacobson's nerve.           | 12. Ophthalmic branch.   |
| 5. Small superficial petrosal. | 13. Superior maxillary.  |
| 6. Small deep petrosal.        | 14. Inferior maxillary.  |
| 7. Otic ganglion.              | 15. Meckel's ganglion.   |
| 8. Sympathetic ramus.          | 16. Great superficial petrosal and great deep petrosal nerves. |

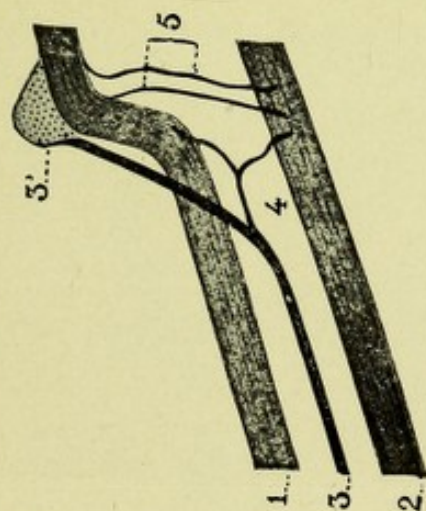


FIG. 2.—(*Testut.*) Showing anastomoses of the facial and auditory nerves.

- |                                 |
|---------------------------------|
| 1. Facial.                      |
| 2. Auditory.                    |
| 3. Pars intermedia of Wrisberg. |
| 3'. Geniculate ganglion.        |
| 4. Internal anastomoses.        |
| 5. External anastomoses.        |











