OBSERVATIONS AND RESULTS FROM INTRACRANIAL SECTION OF THE GLOSSOPHARYNGEUS AND VAGUS NERVES IN MAN.

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THE exact function of the glossopharyngeus and vagus nerves in man, especially as to their sensory values, has not as yet been definitely established. These two nerves are so intimately connected at their origin in the medulla oblongata, and after their exit from the jugular foramen, that experimental physiology has not as yet succeeded in isolating the functions of each. Pathological conditions frequently affect both of these structures simultaneously, not only in their central but also in their peripheral relations, giving rise to uncertain conclusions.

The observations noted in this paper have been derived from two cases; one in which the *intracranial root* of the ninth nerve was sectioned alone, at a point where its true components are assembled to compose the root, and are therefore the expression of the actual function of this nerve itself, before anastomotic fibres have been added from the neighbouring vagus. In another case, the *intracranial root* of the vagus was sectioned alone and its manifestations studied.

This paper affords the opportunity of confirming in the human being the sensory determinations established by Sherrington¹ in the macaque. In fact, the means of study has been strikingly similar to his own by the use of residual areas of sensation after destruction of the adjoining sensory fields.

I have been unable to find any similar cases relating to man, where sensory studies have been made after careful section of the intracranial roots of the ninth and tenth nerves, with obliteration of the adjoining sensory fields also, by destruction of the posterior roots involved. I believe this to be the first presentation of sensory studies after isolated intracranial section of the glossopharyngeal and vagus roots in man, in this manner.

Heretofore information as to their function has been derived chiefly from pathological lesions situated near these two structures, but their separate functions have not been definitely established. Oppenheim² states regarding the glossopharyngeal: "affections limited to this nerve have practically never been observed, and the vagueness which obtains as to its physiological position and its functions has not hitherto been elucidated by pathology. So far as I am aware, an injury limited to this nerve has not yet been observed." In

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speaking of the vagus he states : " it is usually affected in common with other cranial nerves, especially with the glossopharyngeal, accessory and hypoglossal."

Although an abundance of observations exists regarding extracranial involvement of these two structures, especially the vagus (Hirsch, Oppenheim, Kohnstamm, Lemon) by pathological processes and intracranial root involvement (Weisenburg³) as well as experimental evidence (Kriedl, Kohnstamm, Sherrington, Grabower), combined with surgical extracranial section (Sicard, Robineau, Adson), exact information regarding the part assumed by each of these nerves has not been definitely demonstrable. The reason for this uncertainty is evident from the intimacy of the structures as they enter the jugular foramen and pursue their early extracranial course. Individual involvement, except by careful surgical selection, is almost impossible.

Figure 1 diagrammatically represents the relations and connections of these nerves as they leave the medulla and progress toward their peripheral destinations. Their communications and branches have been faithfully

Portio major N.
Trigemini
N. Facialis
N. Intermedius
Gang. geniculi
N. Glossopharyngeus
Chorda tympani
Ramus auricularis
N. Vagi
Gang. superius
Gang. petrosum
Gang. jugulare
N. Tympanicus
N. Vagus
N. Accessorius
N. Hypoglossus
Gang. nodosum
Plex. pharyngeus
N. Jugularis
N. Caroticus internus
Gang. cervicale superius

Gang. semilunare
Gang. ciliare
N. Petrosus
superficialis minor
N. Petrosus
superficialis major
N. Petrosus
profundus
N. Vidiani
Gang. sphenopalatinum
Gang. oticum
A. Carotis interna
N. Glossopharyngeus
N. Laryngeus
superior
N. Recurrens

FIG. 1.

Diagrammatic reconstruction of the seventh, ninth, tenth and eleventh cranial nerves showing their intercommunications and the general distribution of their many peripheral branches. Accurate determination of the functions of each is only possible by section of the intracranial root, because of the addition of new fibres from one to another in their extracranial relations.

recorded from anatomical authorities such as Spalteholz, Piersol, Pitres and Testut⁶, Zander⁷, and others. Anatomical relations in this diagram have not been maintained because of their complexity.

It is at once evident that section or destruction of either of these nerves, extracranially, produces an impure and misleading result because of a large branch given off from the vagus to the glossopharyngeal within the jugular foramen. The only certain means of determination lies in the careful selection of the roots as they emerge from the medulla to compose the intracranial portion of the root and thus represent the individual function of each. This has been possible because of the rapid advance of neurosurgery and the technique devised by Adson⁸. It has been undertaken to relieve the extreme pain encountered in cases of metastatic carcinoma of the mouth and neck.

INTRACRANIAL SECTION OF THE GLOSSOPHARYNGEUS.

The case (E.B.) is unique in the following respects: (1) Isolation and section of the ninth nerve intracranially, without disturbing any fibres of the tenth or eleventh; (2) cervical rhizotomy of the second and third posterior cervical roots so as to produce an adjacent anaesthesia of the head and neck; (3) section of the posterior root of the fifth, so as to produce an adjacent anaesthesia of the face and forehead.

CASE 1. Mrs. E. B., age 41. Admitted to the Neurosurgical service of the Episcopal Hospital, March 25, 1926. Referred by Dr. Eugene Pendergrass.

Diagnosis. Carcinoma at the base of the tongue on the left, with metastasis to the anterior cervical lymphatics.

Chief complaint: Severe pain in the region of the left ear, behind the ear, and extending to the vertex. Pain deep in the throat, greatly aggravated by eating and swallowing. Pain at times confined to the lower jaw and tongue; only slight relief of pain even from large doses of morphine.

Operation: March 27, 1926. Cervical rhizotomy and intracranial section of the glossopharyngeus on the left (Dr. Fay). Recovery, with relief of all pain *excepting* that confined to the throat and ear.

Operation: June 26, 1926. Section of the posterior root of the trigeminus, on the left (Dr. Fay). Recovery. Pain in the throat and ear not relieved.

The result of the first operation (Fig. 2) was to produce only the same anaesthesia which I⁹ have observed in other cases of cervical rhizotomy.

There was no demonstrable change in the area of anaesthesia as a result of section of the ninth nerve, as well as the upper two cervical roots (C2 and C3). The zone of sensory supply attributable to the upper cervical posterior roots as determined in a series of five cases by Spiller and myself¹⁰ showed slight disturbance of pain perception as far forward as the hair line of the forehead, an overlap of one half the area of the first division of the trigeminus. The extension from below over the angle of the jaw invaded the field of the third division of the fifth, and showed some slight disturbance of pain sense to the border of the second division. The distribution of pain sense was found to correspond more closely to the segmental pattern. The second cervical posterior root (the first is rarely present in man and when found quite small) was found

to overlap the trigeminal field and closely followed in its anterior limits the hair-bearing portion of the scalp and bearded area of the face, the posterior border overlapping into the field of the third cervical root.

Our findings are in close accord with Sherrington's¹ on the ape, and the anatomical dissections of Zander⁷.

The third cervical root zone shows a generous overlap from the fourth below extending for tactile sense as high as the angle of the jaw. The overlap for temperature is not as great as for light touch, and the overlap for pain is quite limited.

The region of the ear is of extreme interest. The auricle receives a quadruple sensory supply, and if the claims of some observers for the seventh and the ninth be accepted, there would be no less than six separate supplies for this structure. The *trigeminus* supplies the tragus, crus helicis, the anterior border of the helix and the anterior wall of the external auditory canal. This relationship has been carefully determined by Cushing¹¹, Pegler¹², and many others, and corresponds to the findings in the above case. The *ramus auricularis nervi vagi*, demonstrated by Arnold, whose confines were established by Sherrington (Fig. 6) for the macaque, supplies chiefly the cavum conchæ and the cyma, extending its zone to include the anthelix, the antitragus and a portion of the lobus. The supply also includes a small triangle below and behind the lobe in the fossa anterior to the mastoid, and extending on to the eminentia conchæ posteriorly, a finding which has been constantly present in our¹⁰ series.

The second cervical posterior root.—This supply has not been definitely demonstrated in the human being as no case has appeared where section of the fifth and tenth, and third and fourth cervical roots has permitted the study of the residual areas of anæsthesia. However, the work of Sherrington includes this zone of the external ear in the distribution of the second cervical root and the dissections of Zander⁷ and Froesch¹³ indicate the presence of these fibres. We¹⁰ have been able to show slight hypalgesia over the posterior aspect of the eminentia scaphæ in the region of the fossa triangularis, as well as along the upper posterior border of the helix, but owing to the extensive overlap no anæsthesia could be demonstrated.

The third cervical posterior root.—When sectioned in conjunction with the second, there appears a definite area of anæsthesia over the helix and the upper posterior aspect of the scapha, and extending into the posterior border of the anthelix (Fig. 3). Our¹⁰ observations have shown that the fourth cervical posterior root sends some fibres to the region of the helix, since after inclusion of this root the area became completely anæsthetic for touch.

It is, therefore, evident in Case 1 that three of the contributing nerve supplies were destroyed, leaving the field of the vagus alone, which retained acutely all forms of sensation in the concha.

Section of the ninth nerve produced no demonstrable sensory change in the remaining field, and, as will be seen in Case 2, ablation of the vagus showed

no demonstrable sensory function attributable to the seventh or ninth, which remained undisturbed (Fig. 5) in this area.

These findings would seem to justify the conclusion in this case that the glossopharyngeal (intracranial root) supplies no cutaneous sensory elements to the region of the ear, face or neck.

I feel, after repeated careful studies, that these observations are convincing as regards the non-participation of the glossopharyngeus in a cutaneous sensory supply.

FIG. 2.

Operative approach for intracranial section of the ninth nerve as well as for cervical rhizotomy (undertaken in Case 1). Ninth nerve sectioned at its point of exit and the upper two cervical posterior roots crushed and ligated.

Determination of the sensibility of the pharynx after section of the ninth was striking. No demonstrable change in touch, pain or temperature could be established. Unfortunately this case was complicated by the primary carcinoma of the base of the tongue, involving the region at the base of the tonsil. Observations were difficult (pain in the ear and throat persisting), and definite conclusions must be avoided. The following observations seem justified :

(1) Pressure against the pharyngeal wall and the introduction of a sharp object produced pain. This same reaction was obtained persistently after section of the fifth posterior root, the anæsthesia from this operation including half of the tongue, anterior pillar of the fauces and roof of the mouth, but not the posterior margin of the soft palate.

(2) The 'gag' reflex remained intact.

(3) The motility of the soft palate was impaired by the growth on the left, but there was no added relaxation or loss of alignment.

FIG. 3.

(a) Disturbance of sensation produced by the first operation in Case 1. The area includes the dermatomes of the second and third cervical posterior roots. Note overlap of the fourth cervical root into the area of the third for touch sensation. The field of the second cervical root overlaps the trigeminal area to the hair-line on the forehead and slightly on the cheek, as determined for pain sense by the comparative method. The findings are similar to those in a series of cervical rhizotomies, and there is no demonstrable zone attributable to the ninth.

(b) Field of anæsthesia after second operation, following complete destruction of the posterior root of the trigeminal. Note the residual area of sensation in the region of the ear.

(4) There was no added difficulty in swallowing, or involvement of the swallowing reflex.

(5) The sense of taste on the left, which had been present prior to operation, was lost over the posterior aspect of the tongue, and greatly impaired on

the anterior lateral margin. Salt was recognized but other flavours were not correctly appreciated and were frequently unobserved.

(6) Salivation appeared on the left in increased quantity for several weeks.

(7) The pain complained of in the throat and ear persisted although all pain referred to the tongue, lower jaw, mastoid region and vertex was relieved, and it was possible to maintain the patient comfortably without morphine, by the use of allonal instead.

It would seem justifiable perhaps to assume from these findings that the glossopharyngeus in its intracranial root does not carry sensory fibres to the external ear, nor is there evidence that sensation of the common type is disturbed within the pharynx after its ablation. Its only demonstrable function has to do with the reception of taste impulses and perhaps the regulation of salivary and secretory responses. Whatever sensory fibres appear in the extracranial or peripheral course of the nerve must be added to it from some neighbouring source, undoubtedly chiefly from the vagus.

INTRACRANIAL SECTION OF THE VAGUS NERVE.

The next case presents even more interesting findings. I believe it to be unique from the standpoint of study in the following respects: (1) Subtotal avulsion of the posterior root of the trigeminus; (2) intracranial section of the posterior roots of the vagus.

CASE 2. J. C., age 48. Admitted to the Neurosurgical service of the Episcopal Hospital, October 25, 1926. Referred by Dr. Eugene Pendergrass.

Diagnosis: Carcinoma of the tongue with metastasis to the anterior cervical glands on the left.

Chief complaint: Severe pain in the ear and throat. Pain in the lower jaw and tongue.

Operation: October 29, 1926. Subtotal avulsion of posterior root of the trigeminus, on the left (Dr. Fay). Recovery, with complete relief of pain in the tongue and lower jaw. No relief of pain in the ear and throat.

Operation: November 12. Suboccipital craniectomy, section of vagus roots on the left. Complete relief of all pain in the ear and throat. Paralysis and anæsthesia of the pharynx and vocal cord on the left. Patient, sitting up, died suddenly from inhalation of fluid on the fourth day.

This patient also suffered from carcinoma of the tongue with invasion of the floor of the mouth, and metastasis to the anterior cervical glands. His pain was confined to the throat and ear as in the former case. He also had pain in the third division of the fifth nerve. The first procedure was the subtotal avulsion of the posterior root of the fifth nerve supplying the area of the tongue and jaw involved by pain. It was possible to destroy the root of the third, as well as a portion of the second division, leaving intact the fibres of the first, so as not to endanger the trophic supply to the eye. This method of subtotal resection is that of Frazier.¹⁴ The patient recovered from the operation readily. The pain complained of in his tongue and lower jaw disappeared following the operation, and anæsthesia was demonstrated

in the third and in the lower two-thirds of the second division (Fig. 5). He still complained of the pain in the throat and ear, as in the case reported previously.

Because of the failure in the former case to relieve this type of pain by section of the ninth nerve, it was thought that section of the tenth nerve would bring about relief, in view of the findings in the former case, where after section of the fifth, the ninth and upper cervical roots this type of pain still persisted. It seemed logical, therefore, to attempt intracranial section

Fig. 4.

Intracranial approach to the vagus through a hemi-suboccipital craniectomy and partial laminectomy. The fan-shaped fibres of the vagus can here be easily distinguished and sectioned at their point of exit without disturbing the ninth or eleventh (Case 2).

of the tenth. Two weeks after the original operation on the posterior root of the fifth an intracranial approach to the vagus was made through the posterior fossa. As in the former case, a suboccipital craniectomy was performed under local anæsthesia, exposing the cerebellum and lifting the cerebellar hemisphere on the side of the pain, exposing the jugular foramen, with the ninth, tenth

and eleventh nerves emerging through it (Fig. 4). Careful selection was made of the tenth fibres only, and these were sectioned. During the sectioning of the vagus on the left side the anaesthetist noted that the pulse dropped to forty. Following section, there was no further evidence of vagus stimulation.

The patient was carefully observed and repeatedly studied immediately after the operation, which was made possible as the operation was performed under local anaesthesia. He was co-operative and showed no evidence of shock. Examinations on the second and third days were most satisfactory.

After carefully determining the area of anaesthesia produced by section of the outer and lower two-thirds of the posterior root of the fifth, it was found that analgesia was complete over the tragus, anterior wall of the internal auditory canal, over the cheek in the third divisional area, and including almost, but not quite, all of the conventional area for the second division. The tactile overlap from the cervical field was slight. Temperature areas conformed closely to pain, though they were slightly less distinct near the periphery (Fig. 5a).

Following section of the vagus root, several observations of extreme importance were made. The cutaneous area of anaesthesia for the ear had enlarged from the base of the tragus and anterior wall of the internal auditory canal to include the posterior wall, the concha and, to a slight degree for pain only, the anthelix and antitragus (Fig. 5b). There was also a small area behind the ear, over the base of the scaphoid and in the region of the auricular mastoid fossa, close to the point of attachment, where all forms of cutaneous sensation were lost and pain sense greatly impaired in the neighbouring field (Fig. 5c). Comparing this area with the residual zone remaining in Case 1 (Fig. 3b), there appears to be no doubt that the major supply to this area is by means of the vagus. The findings are extremely like those of Sherrington on the macaque (Fig. 6).

It was striking to note the relief obtained from pain by the patient. He was profuse in his gratitude and insisted on sitting up in bed to express himself a few minutes after the close of the operation, in spite of instructions for absolute quiet following a posterior fossa exploration.

My experience has been that there is little reaction following this type of operation, where pressure from a tumour is not a complicating factor, if the procedure is done under local anaesthesia, and the approach to the undersurface of the cerebellum is made extra-arachnoidally, until the root is reached. Careful freeing of the arachnoid from the dura is possible, and if this be done no spinal fluid escapes from the cisterna magna into the wound and no blood is allowed to enter the subarachnoid space; failure to prevent this is, in my opinion, one of the causes for the postoperative crises seen in some cases of posterior fossa exploration.

The patient was immediately examined for motility of the pharynx and muscles of swallowing. The soft palate was seen to be paralysed; there was great difficulty in swallowing, and the voice was very husky, due to paralysis of the left vocal cord. The patient choked on a small draught of water. He

was carefully instructed in swallowing during the act of expiration, and after several attempts was able to take fluids by mouth slowly, without choking or coughing. The 'gag' reflex was found to be absent on the left. There appeared to be no recognition of pain or touch on the left side of the mouth, tongue, cheek (trigeminus), pharynx, or base of the tongue (vagus). The pain had completely disappeared from the ear and throat. Deep pressure on the left side of the neck against the mass had always produced extreme pain. He was no longer conscious of this procedure and except for the mechanical difficulty in swallowing there was no pain attached to the act. There was no further pain referred to the ear. Morphine was discontinued and he accepted the difficulty of swallowing and phonation without complaint. Relieved of his pain he fell asleep and slept soundly for fourteen hours.

The following day he was examined again and the findings carefully checked. The sense of taste was present on the left. He recognized salt, sweet and bitter substances, though he had difficulty in determining the position of the stimulus. The tongue and inner surface of the mouth were intact in this case ;

FIG. 5. Case 2,

(a) Anaesthesia produced after first operation, following subtotal avulsion of the posterior root of the fifth but leaving intact the upper fibre so as not to impair the trophic supply to the eye.

(b) Resultant anaesthesia after section of the intracranial root of the vagus. Note the extension of the zone of anaesthesia into the concha and on to the anthelix.

(c) Small triangle at back of ear which became anaesthetic following section of the vagus. This zone is supplied by the ramus auricularis nervi vagi. As all pain was relieved after section of the vagus it is probable that the pain referred to the region of the ear arose from involvement of the pharyngeal and laryngeal branches of the vagus, with manifestations referred peripherally through the ramus auricularis nervi vagi.

the primary lesion having been cauterized had disappeared, leaving deep metastases in the floor of the mouth and throat through the lymphatics.

The nurse states that on the morning of the fourth day, as the patient sat up and taking a glass of water drank freely, he choked and died before she could summon aid. It is probable that he forgot momentarily the difficulty in swallowing and inhaled a large amount of liquid.

DISCUSSION.

The two cases offer an extremely interesting physiological study even in the presence of the pathological lesion. The infiltrating character of the lesion probably accounts for the lack of disturbance of the sensory factors prior to operation, and aside from some hyperalgesia and the pain, there was no demonstrable neurological involvement of the areas under consideration.

Case 1 presented the possibility for isolated study of the tenth nerve in a surrounding field of anæsthesia, as well as the loss of glossopharyngeal function.

Case 2 presented the possibility for isolated study of the ninth nerve in a surrounding field of anæsthesia, as well as of the functions lost through destruction of the vagus.

These studies would suggest that the glossopharyngeal nerve in its true root components has to do primarily with the sense of taste, and in some way regulates secretory impulses arising from gustatory stimulation. It may well be considered as a nerve of special sense similar to the optic and the auditory.

The vagus in all probability supplies common sensation to the pharynx and larynx, dispersing these fibres in their extracranial course directly by its own branches and indirectly by filaments carried by the extracranial trunk of the ninth. It also supplies common sensation to a portion of the external ear. It is undoubtedly the chief motor supply to the pharynx and larynx and probably to the soft palate. It is responsible for the 'gag' reflex and for reflex pain in the ear, due to involvement of its pharyngeal branches. The motor fibres which supply the vocal cord leave by the vagus root and not the vagus accessory, as has been claimed by some.

Section of the ninth nerve was undertaken in Case 1 because of pain in the throat and ear, a syndrome which has been described by Doyle¹⁵, and given the name of glossopharyngeal neuralgia. Operative intervention for this type of pain has been undertaken successfully by Adson⁸, their studies and work being based upon that of Sicard and Robineau¹⁶. I owe to Adson the technique and inspiration for intracranial section of the ninth nerve. He first pointed out the possibility of intracranial section of this structure in 1923, and since that time has had three cases, the results of which will no doubt be published in the near future.

In his first case of intracranial section, he cut the ninth nerve along with a few fibres of the tenth. The sensory factors of this case were not published

in the report of the surgical procedure⁷. In his second and third cases, the ninth nerve was sectioned, but because of the condition of the patients opportunity did not permit observations on the sensory results obtained.

Four cases of extracranial section of the ninth and tenth nerves for glossopharyngeal neuralgia were reported by Adson⁸. One of this series, reported originally by Doyle¹⁵, included section of the posterior root of the fifth, along with extracranial section of the ninth and the superior laryngeal branch of the tenth. The sensory findings were carefully charted. As is evident from the anatomical reconstruction shown in Fig. 1, the section of this nerve peripherally gives little information as to its individual root component, because of added fibres acquired upon leaving its cranial origin.

In the four cases of extracranial ablation of the ninth and tenth sensory factors Adson states that in the first case the fifth posterior root was resected and the extracranial approach made to the region of the petrous ganglion of the ninth, and the jugular ganglion of the tenth. The pharyngeal branches of the ninth and tenth were sectioned, with relief of pain in the throat. In the second case, the branches of the ninth were apparently not cut. The tenth was avulsed by mistake. In the third case the branches of the ninth and the nerve itself were avulsed, but no final reports or sensory determinations were available, although the patient was free from pain. In the fourth case, both the ninth and tenth pharyngeal branches were avulsed, and pain developed in the eye with lachrymation and manifestations of rhinorrhœa. It is evident that Adson's work is the most extensive on this subject, but as far as the determination of the actual sensory component of the ninth and tenth nerve roots is concerned the four extracranial cases do not permit of accurate analysis, because of the possibility of fibres having been given off from the tenth to the ninth, as they leave the posterior fossa, and thus the combined supply destroyed.

The results of Adson's successful case of intracranial section of the ninth nerve have not as yet been published. I understood from a conversation with Doyle that the patient was relieved, but that section of the ninth had been attended by some destruction of the fibres of the tenth, so that the relief of pain and the findings in this case are not clear-cut. Nevertheless, the relief of pain in this instance, as well as in the extracranial cases, points to the fact that the glossopharyngeus probably carries these sensory fibres in its extracranial course, or that the branches and roots of the vagus, which were sectioned, destroyed the pain arcs. Thus it becomes of great importance for future methods of relief to determine the exact functions of each of these structures, so that operative methods may be devised that will deal solely with the structures involved.

In my case, individual section of the ninth nerve intracranially failed to relieve the pain in the ear and throat, so that it was thought necessary to section the posterior root of the fifth nerve, believing that the auricular temporal branch of the fifth was responsible for the pain that occurred. Following section of

the posterior root of the fifth, all pain was relieved *excepting* the pain in the ear and throat which persisted and has persisted for the past thirteen months, during which time the patient has been under repeated study. Though the progress of her carcinomatous invasion has been greatly delayed by deep X-ray therapy, she is gradually becoming weaker and the growth is enlarging.

In both of these cases, pressure over the lateral aspect of the neck, in the submaxillary region and that of the superior laryngeal nerve, produced sharp pain in the throat and also pain referred to the ear. No sensory loss in the peripheral skin areas was present before operation. In both cases, it was difficult to determine why the patient should have pain in the ear, when the growth itself was situated in the floor of the mouth and in the upper portion of the neck. Unless we assume the extension of the carcinoma backward and upward, far beyond its confines as determined clinically, there appeared to be no explanation for the pain referred to the ear. However, after the destruction of the superior laryngeal portion of the tenth, as well as of the ramus auricularis nervi vagi, represented in the intracranial section of the tenth nerve, the pain disappeared.

FIG. 6.

The "completely delimited area of auricular of vagus" determined experimentally for the macaque (Sherrington). Compare the areas obtained in man (figs. 3 and 5).

It would therefore seem that carcinoma invading the floor of the mouth is capable of involving the ear through the distribution of the superior laryngeal nerve and the pharyngeal branches of the vagus. Irritation of these structures, both by pressure and the act of swallowing, produces a reflex pain through the same nerve, *i.e.*, the tenth, referring that pain cutaneously to the distribution of the ramus auricularis nervi vagi, within the ear.

From my observations, therefore, it would seem that the sensory fibres of pain, distributed to the pharynx and to the region of the ear, in the zone of so-called glossopharyngeal neuralgia, do not correspond to a function of the ninth nerve in its intracranial representation; this syndrome is in reality a manifestation of involvement of the tenth nerve in its sensory components. The term 'glossopharyngeal neuralgia' does not designate either the exact location of the pain, or the structures which transmit the painful impulses. A

better term, inclusive of both factors, would in my opinion be 'vagal auricular-pharyngeal neuralgia,' the manifestations of which are those of so-called glossopharyngeal neuralgia.

CONCLUSIONS.

(1) The glossopharyngeus is probably a nerve of special sense, devoted to gustatory and secretory function.

(2) The vagus nerve supplies a small cutaneous area in the region of the concha of the ear, as well as common sensation to the pharynx and larynx. It contains in all probability the major motor fibres which supply the soft palate and pharyngeal wall, and it is the motor nerve for the regulation and motility of the vocal cord. The 'gag' reflex is a function of the vagus.

(3) Intracranial section of the root should determine the nuclear functions of these nerves, and further establish the exact physiology of each.

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