THE RELATION OF OPHTHALMOLOGY TO
DISEASES OF THE NOSE AND ITS
ACCESSORY SINUSES

WALTER R. PARKER, B.S., M.D.

Professor of Ophthalmology, University of Michigan
ANN ARBOR, MICH.

The possibility of involvement of the orbit or its contents in diseases of the nose and accessory sinuses has been so well established from an anatomic point of view as to need no further proof. It is only necessary to study the investigations of Onodi, Birch-Hirschfeld and Loeb to be convinced of this fact. When considered from a clinical point of view, however, the frequency of the association is less constant than the anatomic investigations might lead one to suppose. While in many cases the causal connection is obvious, there are others in which a relation is difficult or indeed impossible to establish.

Diseases are excited in the eye through the nose by direct communication, in the orbit through the anatomic relations of the accessory sinuses, through nervous reflex action, and as a result of general toxemia. It is not always easy from subjective symptoms alone to determine whether the origin of the symptoms-complex is in the eye, the nose or the sinuses. The fact that an eye lesion coexists with a sinus infection is not in itself evidence enough to establish a causal relation. I have seen for instance, a case of tobacco-alcohol amblyopia, giving all the classical symptoms of retrobulbar neuritis, in a patient who had a chronic sinus involvement. Operation was advised, but postponed for various reasons. Alcohol and tobacco were discontinued and the patient made a good recovery. The operation on the sinus was not performed.

The enthusiasm manifested in the reports of cases following the publication of the work of Onodi lead, I believe, to conclusions that are not altogether warranted by the history of the cases reported.

A study of the reports of well-authenticated cases, however, leads to the conclusion that many of the diseases of the orbit or its contents can have their origin directly or indirectly in diseases of the nose, the accessory sinuses or the ethmoidal cells.

These diseases have been classified by McKay as follows:

1. Mucocoeles of the sinuses.
2. Acute and chronic sinusitis with external signs of orbital cellulitis, orbital abscess, tumor growth, edema of the lid or dacryocystitis.
3. Sinusitis without external signs of orbital inflammation, but with ophthalmoscopic signs, as optic neuritis, neuroretinitis, retinal thrombosis or phlebitis; or without ophthalmoscopic signs but with visual disturbance as scotoma, visual-field defects, ocular muscle paralysis or fifth nerve disturbance.
4. Cases in which the association of sinus disease has been asserted but questionable glaucoma, iritis, uveitis, keratitis, cataracts and vitreous opacities.

This classification should be modified possibly in some of its details, but the scheme in general is excellent. I shall not speak of the first two groups, but rather confine my remarks to the third and fourth.

The involvement of the optic nerve is said to be due to mechanical pressure by inflammatory exudation in the neighborhood of the sinuses, to distention of the sinus wall, to toxemia, or to occlusion of the central vessels, by embolism or thrombosis. The ophthalmologic

examination may reveal hyperemia, a congestion with or without edema, a neuritis or a general atrophic process including the whole or part of the nerve. The patient may complain of dimness of vision in one or both eyes, vertigo, headache and other head symptoms. One or both eyes may be affected.

One of the most serious nerve affections depending on sinusitis is the retrobulbar neuritis, in which the papillomacular bundle becomes affected. The reasons often given for this early involvement (as shown by a central scotoma at first relative and later absolute) are pressure on the exposed portion of the particular bundle, pressure due to vascular changes in the central retinal artery, or toxemia. When one considers the position of the papillomacular bundle in the nerve and its relation to the central artery, it is difficult to see how pressure symptoms can play so important a part as is often assumed.

The macular bundle occupies the peripheral portion of the optic nerve for a distance of about 13 mm. from the globe. It then enters the nerve and soon becomes axial, where it remains throughout the remainder of its course.

The central artery enters the nerve at about the point at which the macular fibers begin to enter. At no time are the macular bundle and central artery in intimate relation.

Because of the proximity of the sinuses to the orbit, a general toxemia may be overlooked in our desire to establish a direct communication as the course of infection. The character of the infection or lack of resistance of the individual to the particular strain may be the cause of the optic nerve involvement, rather than anatomic proximity of the source and dominant symptoms of the infective process. This belief is substantiated by the statement of Onodi that there seems to be no relation between the sinus involved and the nerve affected. Is it not possible that chronicity rather than the location of the infection has most to do with the possibility of optic-nerve involvement, and that a toxemia rather than pressure is responsible for the eye symptoms? This might explain the oft-quoted saying: "The worst sinus cases seem to show the least eye involvement."

Whatever the source of the eye symptoms may be, some brilliant results have been obtained in retrobulbar neuritis through treatment of the sinuses, and no examination of these cases is complete which does not include that of the rhinologists.

The possibility of optic atrophy from posterior ethmoidal suppuration, or from pressure dependent on some sinus involvement, cannot be denied; but to establish a causal relation between the two is most difficult. I have never seen a case of optic atrophy, the origin of which I could prove was due to disease of the sinuses or ethmoidal cells.

That there should be wide variations in the experience of different observers is not to be wondered at when one considers the relation of the optic nerve as given by Onodi. He says:

The optic nerve may come in relation with the sphenoidal sinus or ethmoidal cells, and the wall of the sphenoid may be very thick. The variation in thickness ranges between 1 and 12 mm. It is evident that even destruction of bone may occur in accessory sinuses and yet no visual disturbance result.

While there is no form of visual field contraction which can be considered pathognomonic, there is scarcely any variation in the field that may not be produced by

disease of the eye secondary to accessory sinus infection. The most common deviation from the normal occurs in cases of retrobulbar neuritis in irregular central scotomas with or without ophthalmoscopic findings. The attempt to establish a diagnosis of the sinus involved by the quadrant of the field affected has not been successfully established. That there is no uniformity of opinion in this whole subject is shown by the opposing statements of such men as Birch-Hirschfeld and Onodi. Birch-Hirschfeld asserts that central scotoma is an early and important symptom of tumor or suppuration in the posterior sinuses, due to damage to the papillomacular bundle, while Onodi has observed the absence of these phenomena in similar cases and also in one case of sarcoma filling up the nasal cavity. He also asserts that the visual fields are not narrowed in cases of ethmoidal cell suppuration. The more one studies clinical perimetry, the more one hesitates to base any diagnosis on the field findings alone.

The enlargement of the physiologic blind spot has received much attention recently as of diagnostic value in retrobulbar neuritis, but as yet our knowledge of the normal limits of the blind spot is too vague to warrant definite conclusions.

While paralysis of the extrinsic ocular muscles is of exceedingly rare occurrence in sinus involvement, parietic conditions may complicate mild cases of sinusitis, and become manifest as an insufficiency of one or more of the ocular muscles. The muscle itself or the nerve supplying it may become involved. The function of the muscle may be but slightly interfered with, and diplopia may not be present. The binocular vision may be reduced considerably, while the vision in either eye taken separately may be normal. The diminished binocular vision arises from the inability on the part of the patient to fuse the two images because of the muscle imbalance rather than from any deterioration in his visual acuity. As the impairment of muscular action becomes more marked, a diplopia will appear which, however, may have been present from the first in the extreme field of action of the muscle affected. Muscular insufficiencies are usually seen in cases showing acute inflammatory processes. Marked displacement of the globe may be found in cases in which the false position is assumed so gradually that the desire for monocular vision keeps the visual axes in their proper relation and the muscles adjust themselves to the changing position. Owing to their anatomic relationship the levator, the superior rectus, the superior oblique, the internal rectus, the inferior rectus and the inferior oblique are most exposed and therefore most often affected in sinusitis. The particular muscle involved may suggest the sinus affected, but as the lesion is often multiple too much reliance cannot be placed on this finding.

In certain cases the ocular symptoms may be the only demonstrable manifestation of the sinusitis, the results of nasal examination being negative as well as those obtained by transillumination and roentgenography. If all other etiologic possibilities can be reasonably eliminated, it is becoming common practice to operate on the sinuses in cases showing ocular symptoms which have been proved to exist, such as an infection of the orbit, or retrobulbar neuritis. On the other hand, in cases which show optic atrophy or true paralysis of the extrinsic muscles, confirmatory local symptoms should be present before surgery is resorted to.

I have had occasion to study only two cases of thrombosis of the central vein with reference to sinusitis, and in neither case was I able to establish a causal relation.

The sinuses were not explored by operation, however, and as no satisfactory etiologic factor was determined in either case, the real source of trouble may have been overlooked.

In regard to the fourth group in our classification, cases in which the association of sinus disease has been asserted but is questionable, I should make some change. Included in this group are glaucoma, iritis, uveitis, keratitis, cataracts and vitreous opacities. I can see no reason why iritis and also uveitis should not result from an infection of the sinuses, just as they result from a similar infection in the alveolar process or the prostate.

The number of diseases remaining in the last group may be even less when their etiology is better known.

ABSTRACT OF DISCUSSION

DR. R. BISHOP CANFIELD, Ann Arbor, Mich.: I agree with Dr. Parker in many of the points he has made. As he said, it is important to understand that "the fact that an eye lesion coexists with the sinus infection is not in itself sufficient evidence for the establishment of a causal relationship." Enthusiastic believers in the intimate clinical relationship of the eye and accessory sinuses have found that many patients have been relieved from distressing headache and other symptoms of eye-strain after the refractive error has been corrected and the sinus operation performed. They have not always been able to tell to what procedure to attribute the result. I have often heard it stated that those who do not believe in the intimate clinical relationship between all the diseases of the eye and pathologic conditions in the accessory sinuses either were not able to make an exhaustive examination of the sinuses or did not care to do so. On the other hand, conservative men are now of the opinion that the most ardent supporters of the theory are being led away by their enthusiasm. The danger of operating on healthy accessory sinuses must not be overlooked. In my opinion, an operation on a healthy sinus is productive of more bad results than operation on the diseased sinus. I have under observation at present patients whose healthy sinuses have been operated on and whose condition is unsatisfactory; indeed, a great deal worse than before the sinuses were interfered with.

Indiscriminate exploration of the accessory sinuses without special indication and in the absence of corroborative Roentgen-ray and transillumination findings is to be deplored. Although there is no argument but that orbital suppuration and infection of the uveal tract are generally due to extension of disease from the accessory sinuses, trustworthy evidence to the effect that optic atrophy or glaucoma is dependent on sinus disease is, so far as I know, lacking. I do not believe that the sinus involvement can be determined by the character of the muscle insufficiency in view of the fact that some tremendous change in both sinuses and orbit does occur without the occurrence of any muscle anomaly. While I firmly believe in the occurrence of fundus lesions as the result of sinus disease, even as the result of so-called cryptic sinus disease, I am strongly of the opinion that operative exploration of the sinuses should be undertaken only after the most exhaustive and repeated clinical and laboratory examinations have been made. In this connection we must bear in mind that the orbit and its contents may become involved not only as the result of direct extension, but also as the result of toxemia or sepsis caused by the accessory sinus disease. The importance of this last group of cases must not be overlooked. In case exploration is decided on, it should be made in the most conservative manner possible until the extent of the sinus involvement has been learned, and it should be borne in mind always that operative interference with a healthy ethmoid, antrum, frontal or sphenoid may be followed by very unsatisfactory subjective results.

I have come to the conclusion that the average laryngologist knows less about the anatomy of the ethmoid than he does about the anatomy of any of the other accessory sinuses;

yet he attacks this region with impunity and ventures blindly into what is to him practically an unknown country, yet it is this region which is most intimately associated anatomically with the orbit and its contents.

Finally, while accessory sinus disease is certainly an important factor in the causation of fundus lesions, it is by no means so universal as one would be led to suppose by perusal of the literature.

DR. JOHN B. PORTS, Omaha, Neb.: I should like to report one case. Dr. Parker mentioned that an eye lesion was rare when there was sinus trouble. I have had one case that exemplifies that point nicely. A woman had a cold and a severe, persistent headache. It was thought that there was some involvement of the frontal sinus, the antrum or the ethmoid. Drainage seemed to be fairly good. The discharge was clear. Refraction seemed to cure the headaches except over one eye. The glasses were changed once, and atropin was used frequently, but with no effect on the persistent pain in the left eye. The middle turbinate of the left side seemed to be involved and enlarged. It seemed to me that the drainage from the ethmoid was good. I removed the turbinate and found a cellular condition. The pain in the left eye then ceased and has not returned since. What was the relation between the eye and the condition found?

DR. GEORGE E. SHAMBAUGH, Chicago: I should like to report in this connection three unusual cases of accessory sinus trouble that have come under my observation during the past year. The first was a case in which the diagnosis of a phlegmon of the orbit had been made, but in which an exploratory incision had failed to discover any pus. An examination of the nose showed a narrowing nasal passage on the affected side with a very slight alteration in the floor of the ethmoid. Tissue removed from this region demonstrated the presence of an epithelioma. The second case was that of a young man who had suffered for several years from severe headache and for a couple of years from severe hemorrhage from the nose. An examination of the eyes by Dr. Wilder disclosed nothing abnormal. The patient died from a severe hemorrhage from the nose. At necropsy a sarcoma was found involving the sphenoid sinus and the postethmoid cells. The third case was that of a woman in middle life who had suddenly lost the sight in one eye completely and in the other eye partially. Her trouble had lasted but a few weeks when I saw her. She could scarcely recognize fingers before the better-seeing eye. The eye symptoms had been preceded a couple of weeks by a severe cold in the head and headache. On examining the nose I could not make sure of any accessory sinus trouble. The history of the case led me to suspect an accessory sinus condition as the cause of the blindness. I opened the sphenoid sinuses and postethmoid cells. The operation had to be done under ether. I could not recognize any positive evidence of disease at the time of the operation. The patient recovered the sight completely in one eye and partially in the other.

DR. CORYDON G. DWIGHT, Madison, Wis.: The one point I wish to raise is the possibility of an association between sinus disease and brain-work. I have in mind a senior at the university who during his sophomore and junior years had trouble with his eyes and came to me for refraction. The glasses ordered gave him no relief whatever. I did not make a nasal examination then, but later I did and found a large middle turbinate and necrotic bone and involvement of the entire ethmoid. Many of these brain-users with accessory trouble complain more of their eyes.

At the same time I had a domestic, but one who did not do any brain-work. She had perisinusitis and absolutely no ocular symptoms.

In the clinical department at the University of Wisconsin Dr. Evans carried on a painstaking research and he reported that nearly 80 per cent. of the persons seeking treatment were either nasal or eye sufferers.

There is an acute ethmoidal trouble, which I believe was named by Dr. Sluder vacuum sinusitis, in which this condition exists. There is some hyperemia which produces symptoms and in many of these cases operation is not necessary.

I believe that in 75 per cent. of the cases cited to-day the patient can be relieved by thorough washing out of the nose and keeping it clean. I do not think that patients must always be operated on. I believe in watching them, however, with great care. I have seen a great number of these cases and I am convinced that in many of them operation is not necessary. In some instances, however, it may be necessary to remove the turbinate. If there is a large middle turbinate, the region cannot be ventilated without operation.

DR. H. W. LOEB, St. Louis: A great deal of enthusiasm centers about the relation of the eye, ear and nose. My understanding of the subject was fairly well brought out in the anatomic specimens which were shown at the New York Academy of Medicine some years ago. In the great majority of cases the sphenoid is in relation with the optic nerve at its roof, and the opening of the sphenoid is in the middle third of the anterior wall, which allows a fair column of air between the level of whatever pus is present and the optic nerve. In five of the specimens presented, however, the optic nerve was either above or on the level of the orifice of the sphenoid. This naturally suggests the increased likelihood of infection in such cases, when pus is present.

With respect to the ethmoid, ordinarily the optic nerve passes close to the posterosuperior external angle of the last posterior ethmoid cell. This explains why, although suppurative inflammation of the ethmoid is common, it is seldom accompanied by disturbances of the optic nerve. In two instances, however, in which the ethmoid cells either displaced or surmounted the sphenoid the relation was different and the optic nerve ran along the external wall of the posterior ethmoid cell. Any disease of that particular cell would be far more likely to affect the optic nerve than the usual conditions.

The following case is of interest. A boy, aged 15, overgrown, hale and hearty, was taken with some affection of the eye. He noticed that his eyes lacrimated a great deal, that he had headaches and could not see well. After five weeks he was practically blind. The ophthalmologist referred him to a neurologist and the neurologist in turn referred him to me. There was swelling of the disk amounting to about 4 diopters on one side and 6 diopters on the other. There was a slight amount of vision on the left side. I found an acute ethmoiditis on both sides. The patient was sent to the hospital for operation. Forthwith the swelling decreased in one week, the vision increased, the headaches disappeared and the patient left the hospital entirely free from symptoms. He has been examined since and continues to have clear vision.

I think that in this type of case the posterior ethmoid cell extends posteriorly over the sphenoid to a greater extent. This patient had an acute ethmoiditis and the optic nerve was involved.

DR. F. P. EMERSON, Boston: I wish to relate two cases in which there were eye symptoms with apparently no evidences of any catarrhal process in the nasal mucosa, and yet that was the region in which the trouble was located. A woman, aged 38, had suffered from constant left supra-orbital headaches for twenty years and they occurred about twice a week. She was examined by the best men in the country. One treated her for faulty metabolism for one year. An eye man treated her eyes for a year. She was unable to find anyone who could alleviate her sufferings. Her headaches were very severe. She had clean nasal mucous membranes and no catarrh, but she did have nasal symptoms. Anything which produced nasal turgescence, such as sweeping, automobile riding or the menstrual period, would start this pain. These were distinct nasal symptoms. In looking into the nose you could see that she had what has been described so accurately by Dr. Sluder in writing of the conditions necessary to produce negative-pressure headaches, a septum deviated to the left side high up; the middle turbinate was close to the outer nasal wall and there was an enlargement or hyperplasia of the anterior end. Ewing's sign was present; that is, she was sensitive under the supra-orbital arch. I removed a portion of the turbinate and opened one or two

cells in the uncinate process to free the nasofrontal duct and she has had only two attacks of headache in two years.

The other case was that of a young woman who was supposed to have had a nervous breakdown and who had constantly recurring headaches, with pain through the right eyeball. She was constitutionally nervous, but it was thought that there was some other underlying cause for the headaches. The examination of the nose showed the same anatomic conditions presented in the other case. The middle turbinate was slightly enlarged and the region under the supra-orbital arch was very sensitive. The patient was cured by establishing drainage in the region of the nasofrontal duct.

I have seen several cases of the type Dr. Shambaugh describes in which there seemed to be a cellulitis, but in which nothing was found when an incision was made in the orbit. Here the trouble seemed to be in the posterior ethmoid region. In these cases, especially those described by Dr. Sluder, there are conditions which we overlook. If we have definite nasal symptoms and can find the anatomic conditions exactly as outlined, we shall be able to relieve these apparently intractable cases of headache or eye-pain.

DR. C. F. WELTY, San Francisco: I agree heartily with the criticism by Dr. Canfield. I have seen extensive disease of the sinus with few or no eye lesions. I wish to speak of the importance of the cerebellar pontine-angle tumors. This new work of Barronies makes possible an almost absolutely certain positive diagnosis. I have had four or five of these cases, a report of which will appear in the literature shortly.

I wish to speak also of an unusual condition, the association of cerebral tumors with mastoid conditions. I have had a case of this kind. It was one of acute mastoiditis with characteristic symptoms including facial paralysis and paralysis of the external rectus, which I did not recognize at the time. It was an ordinary case and operation was done. The paralysis was supposed to have been cured in a few days, but the patient did not recover. The man gave the history of having some growth in the mouth, which he had noticed three months previously and which was evidently postpharyngeal and hard. It filled the postnasal fossa. Four or five days after the mastoid operation the facial paralysis continued and the man complained of more headaches. I diagnosed brain abscess. The man would not submit to an operation and he died in a short time. Post mortem a sarcoma was found which extended from the postpharyngeal space of the pharynx, filling the entire middle fossa. I thought we were justified in assuming that this man had a brain abscess. I have never known nor read of such a tumor as that.

DR. GEORGE L. RICHARDS, Fall River, Mass.: We should be quite certain of the indications for operation before doing anything very extensive in the nose. There is such a thing as a proper conservatism. Not every patient is bettered by a nose operation, and we dwellers in the smaller cities where the end-results over a long period of time are known to us have to choose our operative cases with more care than the surgeon in the metropolitan center who never sees the patient after the operation and loses sight of him immediately after treatment is finished.

DR. J. C. BECK, Chicago: It is a wonder to me that no text-book speaks of any relationship between our specialty and neurology. I should like to report two cases. The first is a particularly interesting one. A young woman, a nurse, was referred to me by an ophthalmologist in Chicago. He said "I am sending to you a young woman who has a mental condition that is said to be catalepsy; please examine her and see what you find." I went over the case carefully. She had had a frontal sinus operation and a mastoid operation, and the hole in her nose was big enough to place a finger in, yet there were no evidences of suppuration, except that the parts were somewhat crusty. She appeared sallow, but not sickly. She was taken to the hospital and five different men made examinations of the blood, etc. I was asked to watch the patient. She would go to sleep at 5 a. m. and continue in a cataleptic state from which she could not be awakened; even sticking a pin in her would not awaken her. She had a slight twitching of the eyes. A diagnosis of hysteria was

made. An external operation on the mastoid was done and she has since been absolutely normal, except for pain, which is now the only symptom of which she complains.

The other case is an important one from a neurologic point of view. This was a case of tumor in the region of the pontine cerebellar angle. It was a glioma which was observed by the best surgeons in New York, Philadelphia and Chicago. The patient was a man, 40 years old, who died from respiratory paralysis. A tumor was found post mortem at the base of the occipital lobe far inward. This patient had severe pain or headache which was referred to the front part of the head. One diagnosis made was syphilis of the brain; another doctor said it was possibly a tumor in the anterior portion of the brain. This shows how difficult it sometimes is to make a diagnosis. I believe that we should have a society in which neurologists, otologists and laryngologists can get together and discuss these matters so that we shall be able to understand these subjects better and to make better diagnoses.

DR. WILLIAM L. BALLENGER, Chicago: I have not heard it stated that we should verify our diagnoses by roentgenoscopy. In private work it is exceedingly rare to have a patient operated on without having from two to four pictures made to help verify the diagnosis and get an exact location of the sinus disease. By using the skiagram we are enabled to open the sinus at the exact point indicated in the plates.

DR. HOWARD F. PYER, Norristown, Pa.: In small cities we are called on to do eye work as well as nose and throat work. My experience has been that the condition in the sinus which gives the patient trouble is due not to a large amount of pus present, but to a hyperplastic degeneration of the mucous membrane of the sinus. A radical operation is seldom necessary. Fracture of the middle turbinate toward the septum will often bring results. Many patients come to me for an ophthalmoscopic examination with the retinal veins congested and the disk hazy and injected. A rhinologic examination frequently shows that the diseased condition is in the nose.

Dr. Adams of Trenton states that many children complain of their eyes when the symptoms are produced by adenoids. Usually they have been sent by doctors, parents or teachers for glasses. A weak spherical or cylindrical glass gives partial relief, but Dr. Adams has shown that it is not the refraction that is at fault but the adenoids.

The State Hospital for the Insane is located at Norristown. An examination of the ears of the patients is frequently made and the resident physician sends immediately for the otologist if any ear complications are noticed. Despite these precautions and examinations, at necropsy a brain abscess otitic in origin is frequently discovered.

Dr. Dercum has said that a brain abscess can be present with no symptoms. Can he show us how a brain abscess may always be diagnosed?

DR. JOHN B. PORTS, Omaha, Neb.: I should like to second what Dr. Ballenger said regarding the use of the Roentgen ray as an aid in diagnosing these conditions. The condition of the eye is a troublesome one and closely related to the conditions found in the nose with a peculiar formation of corneal ulceration. Here we find intense pain and photophobia. These ulcerations will heal up in two or three days or a week, but they will recur. They are most likely to occur on the periphery of the cornea and not at the center. They recur a week or months apart and will recur in spite of all that may be done for them. An examination of the nose might disclose a deflection of the septum to one side and a pinching of the middle turbinate; an enlarged vomer, or ethmoid trouble, etc., may be found. In most of the cases there is not any distinct ethmoiditis. The correction of the deflected septum, however, will cause the ulcerations to clear up at once. This condition is usually associated with blepharitis. There is ciliary congestion. This is very painful to the patient; he cannot use his eyes at all and the condition will continue to recur unless this operative procedure is resorted to. I should like to cite a case referring to what Dr. Welty said about not seeing indications from the nose: A patient was

taken with acute ethmoiditis following a cold which he contracted in St. Louis. He came to Omaha. I found complete blindness in the right eye and that he could count the fingers with the left eye at not farther than 2 feet. The skiagraph showed both sphenoids filled with pus. On opening both sides the condition at once cleared up.

DR. W. R. PARKER, Detroit: Dr. Shambaugh's cases illustrate well the point I wished to make. Two patients were without eye symptoms and one undoubtedly showed eye symptoms of sinus origin. I think these conditions are possible, but rare. I did not include in the paper inflammatory conditions of the conjunctiva or cellular tissue of the orbit, nor did I include reflex headaches, or cases of corneal ulcerations which depend on affections of the lacrimal apparatus. Cases of this kind are more common and well understood. My experience agrees with that of Dr. Dwight. In large student bodies we do meet cases of reflex headaches due to eye or nose affections. In these cases congestion of the mucous membrane of the nose, of the sinus and of the ethmoid cells may be found. A low-grade retinitis or a "fluffy chorioid" may also be found. You may refract and re-refract in these cases, but you will not cure them. If you relieve the nose and sinus condition, the patient will at once feel better. The trouble is not, it seems to me, due to the use of the brain, but rather to a relaxed condition of the mucous membrane incident to sedentary life. Get these persons out in the fresh air, with exercise and good food, and their symptoms will disappear.

THE MEASUREMENT OF AUDITORY ACUITY*

WALTER A. WELLS, M.D.

WASHINGTON, D. C.

The measurement of auditory acuteness is generally construed to be synonymous with the quantitative estimation of hearing and at first thought it would seem to be all that is implied by the term, and all that need be attempted in this method of examination. But a more comprehensive interpretation would compel us to include a qualitative as a really necessary part of a quantitative exploration of the auditory function, for in order that measurement of auditory acuity be complete, it should not be confined to the estimation of the power for the perception of one or even several tones, but the entire scale. According to the Helmholtz theory, each tone is separately perceived by its own particular cell and fibers which respond to this and no other. Therefore, the quantitative measurement in the usual restricted sense would test but a limited part of Corti's organ, leaving the rest unexplored.

Conversely, it is equally illogical to consider that the qualitative method can be completely divorced from the quantitative method of examination. Indeed, I maintain that actually it is impossible to do so, because we know, in both health and disease, the capacity to perceive tones of different pitch in different degrees of power, so that it can never be a question of perception only, but must also be a question of the amount of energy necessary to produce an excitation at the threshold of each and every tone.

At the two extremities of the scale points will be reached, of course, at which tone perception fails, no matter how powerful the stimulus, because the organ of Corti contains no elements which are capable of responding at all to sound-waves slower than twelve or sixteen or twenty, or more rapid than thirty or forty or fifty thousand vibrations per second, as the case

may be, and, therefore, amplitude of the waves beyond such limits are of no concern.

Occasionally too, in the midst of the scale a hiatus will exist where perception for certain tones is completely lacking. But we believe that in reality the hiatuses are seldom absolute, but consist rather in a lessening of the auditory power for the tones in question, which might be still excited to auditory perception by sound-waves of adequate amplitude.

Let us consider specifically the most commonly used methods of examination of auditory capacity with a view to determining their value and their relative advantages and disadvantages.

SPEECH

The voice in speech is regarded by many authors as the ideal instrument for the measurement of hearing on the ground that we thereby test the auditory organ in what is really its chief function.

The singing voice of an average individual has a compass of about two octaves; the average speaking voice that of a few semi-tones. The normal audition, as we know, extends over a range of about eleven octaves. Speech, therefore, can test it in but a small proportion of its full extent. This being in the most used and perfected part of the cochlear organ, will therefore represent its most sensitive area.

If our purposes are merely practical, such consideration would recommend the speech test as a desirable method. But otologic science cannot be satisfied except by a more analytic method of mensuration. Moreover, the speech method of testing is of all the least accurate. As we have no means of graduating the intensity of the voice, we endeavor to start with a given vocal power and measure auditory acuity by varying the distance between patient and examiner.

But unfortunately such a method of testing audition is open to several sources of error. In the first place a uniform standard of intensity is not possible of realization. Voices differ not only in pitch, but also very materially in their clang-tint or quality, due to the presence of harmonics. Voices whose fundamental tones might be of the same intensity would, therefore, be heard differently according to their particular harmonic character.

It is not possible except in an approximate way to determine the dynamics of the voice. Our qualifying adjectives, "low," "soft," "loud," "ordinary conversational," as applied to speech, it must be admitted, constitute inexact expressions, which cannot serve as definite guides for intensity.

An ordinary conversational voice of one person may have a carrying power very different from the conversational voice of another, and even the same individual cannot be certain that it will be the same at different tests. It will not only fail, therefore, to serve as a standard comparable among different examiners, but even for the same examiner when testing the same case at different times.

In employing the voice as a means of testing hearing we may make use of phrases of sentences, of different words, of numbers, or of nonsense syllables.

The use of phrases or sentences is open to the obvious disadvantage that the individual examined will supplement his defect in hearing by his apperceptive faculties and guess what has been said by the context, aided by the emphasis and inflection of the speaker. Results, therefore, will depend greatly on the intelligence and education of the person being examined.

* Because of lack of space, this article is abbreviated in *THE JOURNAL*. The complete article appears in the Transactions of the Section and in the author's reprints.