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THE DIFFERENTIAL DIAGNOSIS BETWEEN DISEASES OF THE SOUND CONDUCTING AND SOUND PERCEIVING APPARATUS.

—BY—

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THE DIFFERENTIAL DIAGNOSIS BETWEEN DISEASES OF THE SOUND CONDUCTING AND SOUND PERCEIVING APPARATUS.

By Edward B. Dench, M. D., *New York.*

While the physical examination of the organ of hearing has been practised since the earliest days of otology, the functional examination seems to have been neglected until a comparatively recent period. While I do not wish to, in any way, underestimate the value of otoscopy, I think all will agree that, in chronic cases, the information obtained by ocular inspection is often entirely insufficient to enable the observer to determine the degree of impairment of function. We not infrequently find evidences of either a slowly progressive inflammatory process within the middle ear, or the results of a previous acute inflammation. The otoscopic picture may differ widely from the normal standard, yet, the hearing may be scarcely affected, and any impairment which exists may cause the patient no inconvenience. Careful tests will, of course, show in these cases, diminished audition for certain sounds; for instance, the watch may be heard less acutely than by the normal ear. The voice, however, may be well heard, notwithstanding the changes which have taken place in the conducting mechanism. On the other hand, an examination with the otoscope may reveal no deviation from the normal standard. The drum-membrane appears natural in color, position, lustre, and structure, and yet, the hearing may be greatly impaired. Thanks to the labors of Bezold, Schwabach, Rinne, Wolffe, and

others, the otologist no longer relies upon the information obtained by physical examination.

For convenience in the location of the pathological processes met with in the organ of hearing, the ear may be divided into two parts, first, the conducting mechanism, and second, the perceptive mechanism. The conducting mechanism comprises the auricle, external auditory meatus, drum-membrane, and the tympanic cavity and its contents. The perceptive apparatus includes those parts lying beyond the foot-plate of the stapes, namely, the bony and membranous labyrinth, the terminal filaments of the auditory nerve, the nerve trunk itself, the basal nuclei, the cortical auditory areas, and those collections of nerve fibres which join these nuclei to one another and afford communication between them and other cerebral ganglia. It is well known that any affection of the conducting mechanism is upon functional examination characterized by certain definite signs. This is true without reference to the precise situation of the pathological process. In other words, obstruction to or interference with sound conduction always produce the same phenomena. These signs may be slightly modified, according to the location of the lesion, but remain essentially constant. On the other hand, diseases of the perceptive mechanism give rise to a series of phenomena which differ entirely from those produced by diseases of the conducting apparatus.

In order to locate any pathological process in either the conducting or perceptive portion of the organ of hearing, it is necessary, in the first place, to know what may be termed both the quantitative and qualitative audition of the the normal ear. It is a well-known physical law, that the intensity of sound varies inversely as the square of the distance from the sounding body, hence, the quantitative audition is easily determined by comparing the distance at which any sounding body is heard by the normal ear,

with the distance at which it is perceived by the patient. Many attempts have been made to devise an instrument which would produce a sound, the intensity of which would be invariable. The ideal instrument has not yet been found, and the quantitative test is ordinarily made either with the watch or with the acoumeter of Politzer, the percussion note of this instrument being fairly uniform.

In order to determine the qualitative audition, the ear is tested by a series of musical tones. The normal ear perceives as a musical note the tone emitted by a sounding body, the vibrations of which are repeated at regular intervals sixteen times each second. This is the lowest note recognizable by the normal ear and is called the lower tone limit. Under normal conditions, increased rapidity of vibration of the sounding body is recognized by an elevation in pitch of the note, until the vibrations are repeated more than 32,500 times each second. Beyond this limit, the sound is no longer heard, the rate of vibration being too rapid to make any impression upon the organ of hearing. The note produced by 32,500 vibrations each second may, therefore, be called the upper limit of audition, or the upper tone limit.

A careful examination of a series of cases shows that when the conducting mechanism is affected, not only is quantitative audition impaired, but also that qualitative audition is affected in the following manner: the ability to perceive the lowest tones of the musical scale is interfered with in direct proportion as the quantitative impairment increases. In other words, the lower tone limit is elevated. This is true, no matter where the obstruction to sound conduction exists. The interference may be caused simply by the occlusion of the auditory canal by a mass of cerumen, or it may be due to increased tension in the ossicular chain. In all cases, low tones will be poorly heard, and the lowest notes may not be per-

ceived at all. On the other hand, if the disease lies in the perceptive mechanism, the lower tone limit may be perfectly normal, although quantitative audition may be greatly diminished. When we observe the effect of disease of the conducting and perceptive mechanism upon the upper tone limit, we find a similar reversal. In diseases of the conducting mechanism, the high tones are heard exceedingly well, the upper tone limit being, in some cases, above the normal standard. Where the nervous portion of the organ is involved, the reverse is true, the upper tone limit being considerably reduced. This is particularly the case, where the affection of the perceptive apparatus is secondary to an inflammatory process within the middle ear.

The lowering of the upper tone limit, in these cases of secondary labyrinthine involvement, is easily explained, as the portion of the labyrinth immediately adjacent to the middle ear is concerned in the perception of the highest notes of the musical scale. In primary labyrinthine disease, however, a considerable lowering of the upper tone limit is usually found. The reason for this has always been largely a matter of conjecture, but it has seemed to me that it might be explained by the fact that the lower part of the labyrinth being more freely supplied with blood vessels than the upper portion, is consequently, more susceptible to the circulatory changes. Any obstruction to the venous return current would, therefore, be more pronounced in this portion of the cochlea than near the apex. The presence of tone gaps is so classical a symptom, that it needs simply to be mentioned. It should be borne in mind, however, that complete deafness for certain tones is not an absolute indication of an organic lesion of the labyrinth.

In addition to the qualitative tests, much information is gained by the determination of bone conduction. As we

all know, in diseases of the conducting apparatus, the bone conduction is exaggerated, the reverse being true when the perceptive mechanism is affected. Certain facts must be kept in mind, however, in determining bone conduction, in order to avoid erroneous conclusions. I am aware that certain investigators have declared that the conduction through the solid media of the skull, is practically unaffected by the age of the patient. My own experience, which has been rather large, convinces me that such is not the case. In almost all patients over 40 years of age, in whom the hearing is perfectly normal, the vibrating tuning-fork placed upon the mastoid will be heard for a considerable shorter period than in younger patients. After the age of 50, unless there is some obstruction to sound conduction, the tuning-fork placed upon the forehead, in the median line, may not be heard at all, although it is perceived fairly well over the mastoid process. A slight diminution, therefore, in bone conduction should not be considered as absolute evidence of organic disease of the perceptive mechanism in patients who have passed the fourth decade.

Some care is necessary in choosing a proper fork for the determination of bone conduction. The one I usually employ makes 256 double vibrations per second, and is, I think, best adapted to the large majority of cases. If a fork of lower pitch is chosen, the vibrations are apt to be felt rather than heard, while, if the pitch is more than one octave higher than this, the perception of the note by air conduction is apt to interfere, unless the patient is very hard of hearing.

In cases where a certain amount of labyrinthine involvement has followed a chronic non-suppurative or suppurative otitis media, it is often of value to determine exactly how much of the impairment of function is due to middle ear inflammation, and how much depends upon

labyrinthine disease. This can be determined in a fairly accurate manner by a comparison of the air and bone conduction, for various notes of the musical scale. It will be found that, where the defective audition depends principally upon the middle ear lesion, the point in the musical scale at which air conduction becomes greater than bone conduction, will be directly in proportion to the degree of auditory impairment for the whispered voice, that is, if the whisper is very poorly perceived, a tuning-fork making 512 vibrations per second will be heard when placed upon the mastoid, after it is no longer heard in front of the ear. With an extreme amount of impairment of hearing, dependent upon labyrinthine changes, air conduction will be greater than bone conduction, excepting for the very lowest notes. I have found this means of diagnosis extremely valuable in determining the advisability of middle ear operations in these cases. Perhaps a single case, taken from my records, may illustrate this point more clearly:

A gentleman about 45 years of age, consulted me for the relief of a distressing tinnitus, and marked impairment of hearing in the left ear. Speculum examination showed a previous inflammatory process within the middle ear. The drum-membrane in the upper and posterior portion was quite thin, and the incudo-stapedial articulation could be easily seen through the membrane. The appearance was strongly suggestive of the development of adhesions about the stapes, as the result of the previous middle ear disease. In addition to the tinnitus and impairment of hearing, the patient suffered quite frequently from attacks of vertigo. He had been treated by a prominent otologist by means of catheter inflation, without relief; in fact, according to his own statement, the condition was growing steadily worse. Upon functional examination, I found that the lower tone limit was

64, although the whisper could be heard only at about 12 inches from the ear. The Eustachian tube was perfectly patent, and the air entered the tympanum without the least difficulty. Inflation failed to improve the hearing. I decided at once that the middle ear affection had run its course, so to speak, and that the patient was suffering from an increased pressure upon the labyrinth, due to the previous middle ear inflammation. From the history of the case, the indication seemed to be to relieve labyrinthine tension, without reference to the previous condition of the middle ear. The man was put upon pilocarpine, in increasing doses, until the constitutional effects of the drug were obtained. Under this plan of treatment the whisper increased to 12 feet, and the watch, which could not be heard at all when I first saw him, could be perceived at 18 inches from the ear, the vertigo disappeared, and the tinnitus was slightly diminished, although less relief was experienced from this symptom, than from the others. The subsequent history of the case shows that the effects of the treatment have been permanent. Here, the physical appearance of the parts was so strongly indicative of a middle ear lesion, as to warrant the institution of measures for the relief of this condition, and it was only upon functional examination that the true nature of the lesion was discovered.

It may not be out of place, in this connection, to mention certain precautions necessary in conducting a functional examination. When we come to deal with tuning-forks of a very low pitch, that is, with those making less than 64 vibrations per second, it is often difficult to obtain the fundamental tone of the fork, on account of the presence of overtones. If the fundamental tone is not obtained, the patient will, naturally, hear the overtones, and an error will be made in determining the lower tone limit. For this reason, the surgeon should always hold the fork be-

fore his own ear before making the test, in order to ascertain that he has secured a perfectly true tone. If overtones are present, they may be "cut off" by applying the fingers to the limbs of the fork, close to their junction. In the determination of the upper tone limit, it is always well to give the patient no suggestions as to the sort of sound which he is expected to hear. As the Galton whistle is the instrument ordinarily employed, it is well to have the patient close the eyes, and then to begin the test sufficiently low in the scale to obtain a clear and distinct whistle. The tube is then shortened to almost the zero mark, the bulb compressed, and the patient asked to describe the sounds. He will probably say that the first was a whistle, the second, a puff. It is now very easy by increasing the length of the tube to discover the point at which the sound ceases to be a puff, and becomes a musical note. If this is not done, the result is often erroneous.

I hope that I may be pardoned for bringing such an elementary subject to the notice of this distinguished Society. It has often been my experience, however, that, while difficult and obscure subjects are zealously studied and mastered, elementary principles are often neglected, and serious errors are the result.