The cochlear nerve and ganglion appeared to be normal, if allowance be made for the presence of meningitis. Corti's organ was desquamating (a possible *post-mortem* change), but the acoustic papilla was well formed and the membrana tectoria was in the normal position. The bony spiral lamina was well filled by the nerve, and the stria vascularis appeared to be normal. The spiral ganglion was infiltrated with pus cells from the internal meatus. A few pus cells were present in the scala tympani in the lower part of the basal coil, near the opening of the perilymph aqueduct. There was a little curdled lymph just internal to the footplate of the stapes; the neuro-epithelium of the utricle showed desquamation, possibly a *post-mortem* change. The sacculle appeared rather dilated and the otolith membrane was in parts separated from the neuro-epithelium. The ductus endolymphaticus was healthy. The crista and ampullae of the canals were normal except for desquamation of epithelium. The subarachnoid space of the internal meatus was crammed with pus cells; the meningitic infiltration surrounded the vestibular nerve to the utricle and superior and lateral canals, and extended along the seventh nerve almost as far as the geniculate ganglion.

Middle-ear suppuration alone, even when bilateral and dating from earliest childhood, does not produce such a severe degree of deafness as to give rise to mutism in a child of 4 years. The cold caloric test, carried out on the operating table, had shown that on both sides the vestibular apparatus reacted promptly, and that in consequence a former labyrinthitis might almost certainly be excluded as the cause of the deaf-mutism. Consequently one of us (J. S. F.) expected to find on the microscopic examination of the right ear those changes usually associated with sporadic congenital deafness—namely, malformation confined to the cochlear canal and sacculle. Such examination, however, indicated an apparently normal inner ear, if allowance is made for *post-mortem* changes and for the results of basal meningitis. The cause of the deaf-mutism, therefore, remained a mystery until the histological examination of the brain, carried out by one

of us (S. H. N.), revealed abnormality of the auditory sensory areas in the cortex on both sides.

On microscopical examination of the auditory paths and centres a basal meningitis of pneumococcal origin was seen to be present, and this confused to some extent the histological picture. A "foamy" degeneration of the nerve cells was observed throughout the brain; this was presumed to be due to the meningitis. Haemorrhages were noted in the eighth nerves, but no degeneration, as shown by Weigert's method, was seen. The posterior quadrigeniculate and mesial geniculate bodies were well developed.

In the cortex the pathological process was more of a meningo-encephalitis, as perivascular infiltration was observed. The transverse gyri of Heschl (auditory sensory areas) showed marked changes. The cells of the cortex in these regions were represented by small rounded elements, which were nerve cells deprived of cell body and processes. This degeneration caused the topography of the cortex to be lost. The pathological condition was present on both sides, and was in marked contrast to the histological picture of the outer borders of the superior temporal gyri (auditory psychic areas), Broca's area, pre-Rolandic areas, angular gyrus, and the area round the calcarine fissure, which showed normal development.

The case was one of acute pneumococcal meningitis, with the existence of a more chronic lesion in the transverse gyri of Heschl. The fact that the auditory psychic areas were developed presumed the normal development at one time of the auditory sensory regions. It is probable that the auditory sensory areas were subsequently destroyed by some disease process.

REFERENCE.

¹ *Journ. of Laryngol. and Otol.*, vol. xxxvii, 1922, p. 137.

PREVENTION OF EAR DISEASE BY REMOVAL OF TONSILS AND ADENOIDS.*

BY

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THE answer to the question to what extent the removal of the tonsils and adenoids prevents ear disease is of some importance. I have been accustomed to believe and to preach that, in the very great majority of cases, chronic middle-ear disease in the adult has its origin in childhood. I have also thought that infection associated with enlarged tonsils and adenoids is responsible for such disease in an overwhelming majority of cases, and that excision of these should largely prevent or arrest the middle-ear infection. The removal of tonsils and adenoids by operation has now been widely employed for at least twenty years, and it occurred to me that it might be interesting to try to ascertain to what extent this proceeding was actually diminishing middle-ear deafness in the adult. For this purpose I have made a somewhat laborious statistical examination of the records of my private cases from 1910 until 1926. In this period a total of 1,077 cases of middle-ear disease were dealt with. In judging the result many factors, no doubt, must be taken into consideration, but I believe that, taken as a whole, my practice can be considered as presenting typical results. I have done no particular work in any one direction which would lead to an undue proportion of any particular type of case being referred to me.

My first step was to see to what extent I could demonstrate a variation in the incidence of middle-ear disease as a whole. I was surprised to find that, over this period of sixteen years, there was no sign of any diminution in the relative number of cases. As a check I worked out the average age of the cases of middle-ear disease, and again found that this was practically constant. Being unwilling to believe that our efforts at prevention were entirely fruitless, I analysed the figures under three separate groups—namely, chronic non-suppurative, chronic suppurative, and acute suppurative middle-ear conditions.

Taking first the chronic non-suppurative cases, the curve indicating the incidence of these cases does show quite an appreciable downward tendency—that is, cases do seem to

be diminishing in frequency (Chart 1). In support of this the next curve (Chart 2), giving the average age of cases, shows an upward tendency, which would suggest that cases are now being chiefly drawn from the period prior to that in which tonsils and adenoids

Charts showing the incidence and average age in cases of chronic non-suppurative, chronic suppurative, and acute suppurative middle-ear disease.

were removed. In the chronic suppurative group there is a less marked diminution in the incidence (Chart 3), and a less marked rise in the average age (Chart 4). Acute suppuration, on the other hand, shows a decided increase in the number of cases, without any obvious change in the age incidence (Chart 5). This increase in the number of cases of acute suppuration is, I suggest, due to the recent prevalence of influenza.

To sum up: There is a decided diminution in the incidence of cases of chronic non-suppurative middle-ear disease, but this is balanced by an increase in the cases of acute suppuration, due to influenza, so that the gross total of cases of middle-ear disease is unaltered. Fortunately,

* Read in the Section of Laryngology and Otology at the Annual Meeting of the British Medical Association, Edinburgh, 1927.

however, acute suppuration seldom leads to deafness. There is, therefore, a diminution in the number of cases of adult deafness, and this decrease should be progressive, owing to the increased frequency with which tonsils and adenoids are removed in childhood.

RADIOGRAPHY IN MASTOID DISEASE.*

BY

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THIS paper is based on the study of the radiographic pictures of over 500 cases, normal and abnormal.

Before dealing with the radiographic study of the mastoid, it is necessary to consider the normal mastoid development at the various ages and the normal mastoid structure. According to Wittmack's researches, the development of the temporal bone may be divided into three periods: (1) Formation of the tympanum, epitympanic recess, and the mastoid antrum, continuing to the end of the first year. (2) Formation of mastoid cells from these three cavities, which ceases between the fourth and the sixth year. (3) Further formation of cells, which continues throughout life.

Cheatle's researches go to show that the acellular structure of the infantile mastoid is diploëtic tissue, the only cells in addition to the tympanic antrum being a layer on its outer wall. It is stated that this acellular type persists throughout life in 15 per cent. of people. In the second type (cellular or pneumatic) the diploë is replaced by air spaces which have extended from the middle-ear tract. Between the infantile acellular diploëtic mastoid and the cellular or pneumatic mastoid several intermediate varieties of bone are recognized. In the adult bone these represent an arrest of development corresponding with a definite age in the child. This is of special interest in the consideration of asymmetry in the mastoid and its possible etiology.

In the standard x-ray projection we can trace the gradual pneumatization and the approximate normal for the age. The standard projection used gives practically a lateral projection, and the following landmarks should be studied and recognized. We first of all recognize the external and the internal auditory meatus; just a little superior and posterior to this is located the mastoid antrum. Directly posterior to the canal at a variable distance is the groove for the sigmoid sinus. Passing downwards and forward through the mastoid process to the jugular fossa—below and in front of the mastoid tip—the sharp angle or knee of the sinus groove can be recognized, and it is especially important to note the anterior line of this groove. Below this is the tip, and just behind the canal is an opaque area forming the posterior meatal wall with the facial nerve underneath. Above the mastoid antrum and middle ear can be seen the tegmen of middle ear and antrum. The superior line of the squama may be indicated. In front of the meatus we have the temporo-mandibular articulation with the glenoid cavity and the condyle of the lower jaw. Frequently the emissary vein is seen as a worm-like shadow situated anywhere between knee and tip. The area enclosed between the posterior meatal wall in front, the tegmen above, and the anterior wall of the sinus groove forms roughly an inverted triangular area, with the tegmen as base; for descriptive purposes this has been called the triangular area.

Returning to the radiographic studies of the normal mastoid in children, this is found to correspond more or less closely with Wittmack's stages of mastoid pneumatization. (1) From birth to one year the only cell development is seen in the mastoid antrum, which occupies a more superior position to the auditory meatus than in the adult and is of comparatively large size. (2) From the first to the sixth year cell development begins and is confined to the triangular area previously described and forward towards

the zygoma in some cases. (3) From the sixth year to the sixteenth we notice gradual cell development beginning posterior to the anterior sinus groove, starting first at the lower posterior part and tip. (4) The complete pneumatization extends eventually to the upper posterior part and permeates completely the mastoid process.

The pneumatic mastoid in the adult may show cell development corresponding closely to these four stages. Another feature of interest is that cells laid down early in the triangular area are smaller as a rule than those developed at the tip and posterior part of the mastoid later; this is well shown in some of the radiographs.

Symmetry of Mastoids.

By symmetrical mastoids is meant that they are either both pneumatic or both diploëtic in structure. Asymmetrical mastoids would thus mean a diploëtic mastoid on one side and a pneumatic mastoid on the other; a case revealing an extensive pneumatization on one side with a very limited pneumatization on the other is not in the true sense an illustration of asymmetry, but rather symmetrical mastoids with arrested pneumatization on one side.

In their investigations Beck, Law, Reverchon, and others report consistent symmetry. Turner and Porter, in their examination of 1,000 crania, report 12 per cent. asymmetrical. Plum suggests that some of these might possibly indicate arrested development. With regard to the present series, in the normal cases I have examined I have found the mastoid processes consistently symmetrical. Where there was no ear complaint and the x rays revealed apparently asymmetrical mastoids, investigation has shown without exception the presence of either a mastoiditis or a healed condition, often previously unknown to the patient. This apparent or false asymmetry due to some previous pathological condition is a very common occurrence.

We now come to the question of the influence of an inflammatory process on mastoid development and thus indirectly on the question of asymmetry.

Macewen in 1893 stated that: "In chronic cases of inflammation of the mastoid an osteoplastic formation may be set up in the neighbouring bone which results in an eburnating sclerosis and an actual obliteration of many of the mastoid cells." This well expresses the old view regarding the sclerosed mastoid frequently found at operation.

Cheatle has more recently stated that in infancy, with the exception of the mastoid antrum and a few cells on its outer wall, the mastoid consists of diploëtic structure; further, that this so-called infantile type persists in 15 per cent. of people. Cheatle's researches tend to show that the sclerosis produced at first round the antrum is not the effect but the cause of the chronic suppuration, the acellular condition being thus primary. Wittmack, on the other hand, believes that hyperplasia of the mucosa with incomplete or arrested pneumatization is caused by the entrance into the tympanum of amniotic fluid, meconium, etc., during foetal life or at birth, or the entrance of vomitus during the first year of life. Wittmack's theory is supported by Pierce and others.

As I have already stated true asymmetry has not been found in the present series of cases—that is, apart from a previous pathological condition of the mastoid. In addition, I have not been able to find a case presenting normal ears with a sclerosed or ivory mastoid. Assuming Wittmack's theory to be correct regarding the production of the acellular type of mastoid, I have found the acellular mastoid to give the x-ray appearance suggesting a diploëtic mastoid rather than a sclerosed mastoid. Law in 1920 stated that it was impossible to distinguish between a sclerosed mastoid and a diploëtic one.

In the present series of films I have found that the appearance of a sclerosed mastoid is different from that of a diploëtic one. Further, cases of chronic mastoiditis on x-ray examination reveal all degrees of thickness of cell trabeculae, in some cases so thick that the mastoid cells are almost obliterated. This thickening is shown also in the cases of healed mastoiditis, whereas in the normal pneumatic mastoid the trabeculae are of a very uniform degree of fineness and the cells distinct and well marked.

* A paper communicated to the Section of Laryngology and Otology at the Annual Meeting of the British Medical Association, Edinburgh, July, 1927.