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DR. W. FREUDENTHAL *in the Chair*.A STUDY OF THE ANATOMIC RELATIONS OF THE OPTIC NERVE TO
THE ACCESSORY SINUSES OF THE NOSE.

BY HANAU W. LOEB, M.D.

(1) The sphenoidal sinuses vary as follows: antero-posterior diameter 2 to 42 mm., supero-inferior 4 to 36 mm., lateral 2 to 35 mm., averaging, respectively, 21.5, 22.8, 18.4.

(2) The opening of the sphenoid into the nose, in the great majority of cases, is about midway between the floor and the roof of the sinus. In some instances it is much closer to the roof.

(3) The diameters of the ethmoid labyrinth and its component parts, the anterior and posterior ethmoid cells, vary as follows: labyrinth, antero-posterior 22 to 54 mm., supero-inferior 17 to 59 mm., lateral 9 to 28 mm.; anterior ethmoid cells, antero-posterior 9 to 40 mm., supero-inferior 7 to 57 mm., lateral 7 to 29 mm.; posterior ethmoid cells, antero-posterior 13 to 32 mm., supero-inferior 6 to 38 mm., lateral 8 to 28 mm.

(4) The diameters of the frontal sinuses vary as follows: antero-posterior 9 to 33 mm., supero-inferior 14 to 51 mm., lateral 7 to 42 mm.

(5) The diameters of the maxillary sinuses vary as follows: antero-posterior 17 to 42 mm., superior inferior 17 to 47 mm., lateral 7 to 33 mm.

(6) The optic chiasm is usually in relation with one or both sphenoid sinuses, in no instance, in these skulls, with the ethmoid. In more than half of the skulls it lay posterior to the sphenoid cavity.

(7) The optic nerve may be divided into a sinus portion and a free portion, of which the former is usually the larger, as shown by the variation, as follows:

Optic nerve 34 to 55 mm., sinus portion 17 to 32 mm., free portion 12 to 28 mm. As far as could be ascertained there is nothing in the extent and shape of the sinuses to account for the variation in the length of the nerves.

(8) In five instances (one third) one sphenoid was in relation with both optic nerves, the other sphenoid not participating; in two the other sphenoid participated in the relation, and in one there was no relation between either sphenoid and one of the optic nerves.

(9) There is a considerable variation in the distance between the optic nerve and the level of the lower margin of the nasal opening of the sphenoid, from 2 mm. above to 14 mm. below. In four instances the opening was at the level of, or above, the optic nerve.

(10) As a rule the last posterior ethmoidal cell (sometimes there are two) has a very slight relation with the optic nerve at the postero-external angle just at the roof, and from this point the nerve passes externally to the bulbus, gradually increasing the distance which separates it from the labyrinth. In one instance an anterior ethmoid replaced the posterior ethmoid cell and assumed the usual relation of the last posterior ethmoid cell. When the last posterior ethmoid cell replaces the sphenoid the optic nerve runs along the external wall of the ethmoid.

(11) The frontal is not in close relation with the optic nerve, except when it extends posteriorly in the region of the ethmoid cells. It is commonly in relation with the bulbus, but sometimes it is far removed from it.

(12) The roof of the maxillary sinus, forming the inferior wall of the orbit, is below the bulbus, and does not reach a distance nearer than 7 mm. from the optic nerve.

Clinical Deductions.—(1) Optic nerve involvement without peri-orbital abscess, although heretofore thought to be an infrequent sequela, is common enough to merit consideration in sinus affections.

(2) There have probably been many unreported cases.

(3) In all likelihood many minor symptoms resulting from transitory involvement have been overlooked.

(4) Whether the infection be lymphogenous or hæmatogenous, or by contact, the smaller the distance from the infecting focus the greater will be the chance of the involvement of the nerve.

(5) It, therefore, is uncommon for frontal or maxillary sinusitis to be accompanied by optic nerve disease without peri-orbital involvement. However, from their relation to the bulbus, disease by extension through it is not to be overlooked.

(6) Sphenoidal sinusitis would naturally be called to account as the prolific cause of the infection, but the sphenoidal is less

commonly affected than the other sinuses, and, except in closed empyema, the pus is evacuated in a large measure through its nasal opening. Stagnant and decomposing pus is more or less common on the floor, in sphenoidal empyema in that part farthest removed from the optic nerve; but this factor becomes more potent where the orifice is at the level or above the optic nerve, as shown in the four skulls, and the likelihood of trouble is greatly increased by the immediate propinquity of the stagnant and decomposing pus, which, in these cases, is separated from the nerve only by a thin lamina of bone and the nerve-sheath.

The six skulls out of fifteen, shown and described in this paper, in which one sphenoid is in relation with both optic nerves, afford sufficient explanation for contra-lateral optic neuritis when caused by sinus disease.

(7) The anterior ethmoidal cells, which are so commonly affected with suppurative inflammation, are so far from the nerve that they are not likely to influence the optic nerve except through the effect on the peri-orbita adjoining. However, where an anterior ethmoidal cell is extensive enough to come into relation with the nerve by replacing a posterior ethmoidal cell trouble is more likely to occur.

(8) The posterior ethmoidal cells, also frequently affected, have very little influence on the optic nerve. But when the cell replaces the sphenoidal and the optic nerve passes along the external wall, then the posterior ethmoid becomes the most potent factor of all, for the nerve is closer to the mass of pus and for a greater distance than under any other circumstances, even though the nasal opening may be in the dependent portion of one part of the cell.

(9) It, therefore, becomes necessary to study more carefully the cases in which the sphenoid orifice is near the optic nerve and in which the sphenoid is replaced by a surmounting ethmoid cell.

Dr. ROSS HALL SKILLERN (Philadelphia) said that if the practical interest in this subject was as great as the scientific, blindness or severe eye affections from disease of the posterior ethmoidal cells or sphenoidal sinus would be a thing of the past. Owing, however, to the surgical inaccessibility of the pituitary region and the almost irreparable damage done the moment the disease progressed beyond the borders of the accessory air cavities of the nose, the future seemed to offer little in the way of treatment once this region had become infected. As far as the practical interest is concerned it was of the greatest importance to know that this nerve may lie in direct communication with the sinus. This ex-

plained why a certain virulent empyema of the sphenoid sinus will run its course with only nasal and post-nasal symptoms, while another of less virulent type suddenly assumes grave symptoms after a mild course of weeks or months. The thickness of the bony walls between the sinus and the brain is responsible for these vagaries. In one case the drainage is good and the walls thick enough to withstand the attacks of the disease. In another, perhaps, a sudden cold is acquired, the ostium of the sphenoid becomes occluded, resulting in stagnation of secretion, infiltration of leucocytes and pathogenic germs through the diploë, with subsequent meningitis, brain abscess, and death. As far as the eye symptoms as a complication of sphenoidal disease are concerned, the question is whether these symptoms are due directly or indirectly to the sinus disease—in other words, whether they are not due to some other condition dependent on the sinus disease, such as thrombosis of the cavernous sinus, in which the ophthalmic and retinal veins practically always participate. Of course where the optic nerve or commissure lies in direct apposition to the affected sinus one would expect its involvement. On the other hand, derangement of sight may occur in connection with empyema of those sinuses and be totally independent of it. After all, the main point is the early recognition of the condition. Congestion of the retinal veins is suspicious of involvement of the ophthalmic vein, and is of the highest importance. Œdema of the infra-orbital region points to congestion of the ophthalmic and ethmoidal veins, which should indicate disturbances in the sinus cavernosus. Many fatal cases could be saved if this condition is recognised and a radical operation on the sphenoid instituted.

Dr. WARD A. HOLDEN said a search for an optic nerve affection of sphenoidal origin led to his finding two cases of blindness of this kind. In one operative measures were refused, while in the other a most thorough opening up of the sinuses caused no improvement in vision. The anatomical studies of Onodi, and his subsequent collection of cases showing the relations between the ethmoid cells and the optic nerve, taught that many obscure cases of retro-bulbar neuritis might be explained and cured. A flood of reports of cases treated successfully had since come from all parts of the world. Retro-bulbar optic neuritis was the name given to an affection of the optic nerve behind the eyeball, characterised by a loss of vision in the centre of the field of vision (central scotoma), while the peripheral limits of the field were at first normal. The defect in the centre of the field enlarged until the entire field was involved, and

the eye became blind. The optic disc was in some cases œdematous and swollen. Acute retro-bulbar neuritis followed grippe, simple coryzas, etc. In acute cases ethmoidal disease was looked for always but was not always obvious. There were many records of cases in which nothing abnormal was found, yet removal of the middle turbinate restored lost vision.

Dr. COFFIN was not sure that he was fully willing to accept all of Dr. Loeb's clinical deductions, especially the statement that the infection is directly as the distance. Dr. Loeb did not refer to the possible bulging of the sinus and consequent pressure upon the nerve, but rather to an infection. It must be either through the lymph or venous channels, and that part of the sinus nearest to the nerve might be as regards the lymph or venous channels the farthest away. The frequent association of exophthalmos and ptosis with sinus disease in which no necrosis of the orbital walls had occurred led him to feel that the trouble about the eye was brought about most frequently by some blocking of the venous channels. It had occurred to him that there might be a phlebitis in the ophthalmic veins, of a greater or less severity, not developing an actual thrombosis. All the clinical symptoms were present in cases of cavernous thrombosis. He had lately been in the habit of sending suspected sinus cases to the eye department for examination, and the following was a typical report. The patient, a young man, about eighteen or nineteen years of age, upon whom a diagnosis of ethmoiditis and sphenoiditis had been made, stated that he had no trouble with his eyes. "Right eye—vision 20; optic disc engorged, especially the descending veins; œdema of the left disc less marked; lower veins engorged." In a case he had seen there was a swelling about the size of a hazelnut on the forehead over the frontal sinus. Through a skin incision he was able to pass a silver probe directly through necrotic bone into the frontal sinus. The case showed the initial signs of optic atrophy.

Dr. PERCY FRIDENBERG observed that a broad division of the cases had been made into three groups. First, those in which distension of a sinus with inflammatory or other exudate encroached on the space of the orbit, causing exophthalmos, limitation of motility and interference with sight. In these conditions the accessory disease was apparent. In a second type the inflammation of the sinus extended to the soft tissues of the orbit by lymph or blood channels and caused an orbital cellulitis or abscess, or septic phlebitis of the orbital veins, with involvement of the optic nerve either by extension of the inflammatory process or by com-

pression of the nerve by the exudate. In these cases the accessory sinus disease was detected without much difficulty. In the third class of cases there were no orbital symptoms and no inflammatory reaction at all. The symptoms were subjective—a loss of a small part of the central visual field, the central scotoma. This defect was due to loss of function in the macular fibres of the nerve which supplied the point of fixation and area of clearest vision, and was explained by the course of these fibres, from the chiasm in the lower nasal quadrant of the trunk of the nerve. Dr. Loeb's specimens showed how distension or inflammation of the sphenoidal or posterior ethmoidal cells would be nearest this aspect of the nerve. The nerve head in such cases might show very little change. Functional examination would show up the scotoma, which was often unsuspected. Vision in the rest of the field might be good. No doubt there were other obscure affections of the optic nerve dependent on accessory sinus disease. There were cases with bi-temporal hemianopsia indicating pressure on the anterior commissure of the optic nerve at the chiasm. The diagnosis of a tumour of the pituitary body was sometimes made, even when there were no symptoms of involvement of the hypophysis, such as acromegaly and nervous symptoms. Such cases might be explained by distension of the sphenoidal sinus directly backward. In all the groups mentioned ocular symptoms were striking, so that the patients were more apt to consult the ophthalmologist than the rhinologist. The rhinologist could aid by making a diagnosis of accessory sinus disease, often a very difficult matter, and one which could not be settled by a simple rhinoscopic examination. As to treatment, some cases even of marked blindness had been relieved and cured by simple re-establishment of nasal drainage and local treatment without any operation whatever. In others, advanced disease of the mucosa, granulations, pus accumulation, dead bone or polypi had to be removed by external operation, which demonstrated how futile any attempt at endo-nasal probing or application would have been. The orbital route enabled us to determine the extent of the diseased area and to remove it thoroughly.

Dr. W. W. CARTER related a case of glaucoma of seven years' duration associated with pan-sinusitis of fourteen years' standing.

Dr. CHAPPELL said that he had seen only one case of sphenoidal disease that had any effect on the optic nerve. The case was a woman with nasal discharge, who began to lose her sight from optic neuritis accompanied by a great deal of frontal and occipital headache. She lost the sight of her left eye, and the occipital

headaches continued. He opened the sphenoidal sinus and got twelve to fifteen drops of foul-smelling pus and much granulation tissue. Her headaches disappeared in a week, and in a month her eyesight improved, and she recovered the eyesight in the right eye.

Dr. FREUDENTHAL asked how the skiagraphic picture of the sphenoidal sinus was taken.

Dr. SKILLERN said that Dr. Pfahler, of Philadelphia, took it from above the occiput so that it would come down through the nares, and that he would get the large nasal opening as the point of least resistance. In every other direction one encountered either bone tissue or other more or less dense structures, but taking it from the vertex proved very satisfactory. In a number of cases one could see very distinctly a dark shadow where sphenoidal trouble had already been diagnosed.

Dr. LOEB, in closing the discussion, said that from his anatomical studies he had made a few deductions based on the anatomical relations and the fact that whether the infection was lymphogenous or hæmatogenous and by contact, or both, the nearer the focus the greater the likelihood of infection. The relation between the nasal opening of the sphenoid cavity and the optic nerve, as demonstrated, signified that when the sphenoid contained pus there was more danger in some cases than others. In those cases where the opening was high up and near the level of the optic nerve only a thin layer of bone lay between the stagnant pus and the optic nerve. Under such circumstances a skiagraph of the sphenoid with a probe introduced into its nasal orifice would point out the danger. The skiagraphs were of great service, and it would doubtless be possible to determine the distance intervening between the sphenoid orifice and the optic nerve *intra vitam*. Considering that ordinarily the relation between the ethmoid and the optic nerve was so slight and that drainage through the nasal orifice was so likely to occur, it was easy to understand how infection from the ethmoid to the optic nerve was uncommon in spite of the frequency of ethmoidal inflammation. But where the ethmoid replaced the sphenoid the picture was changed, for then the nerve ran along the external wall and the relation was such that it was closer to the mass of pus than under other circumstances, and the possibility of infection was therefore greater.