CEREBRAL AND OPHTHALMIC COMPLICATIONS
IN SPHENOIDAL SINUSITIS.A CONTRIBUTION FOUNDED ON TWO CASES WITH
AUTOPSIES.*By STCLAIR THOMSON, M.D., F.R.C.P.LOND.,
F.R.C.S.ENG.,PHYSICIAN FOR DISEASES OF THE THROAT IN KING'S COLLEGE HOSPITAL;
LATE PHYSICIAN TO THE THROAT HOSPITAL, GOLDEN SQUARE;
SURGEON TO THE ROYAL EAR HOSPITAL.

INTRODUCTORY.

THE frequent origin of intracranial complications from suppuration in the ear is now generally appreciated, but a similar association has not yet been fully established between the brain and the nose.

Scanty Researches of Cerebral Infection from the Nasal Sinuses.—Indeed, some researches would imply that such a relationship is comparatively rare. Gowers considers that nasal disease is an occasional but rare cause of cerebral abscess.¹ Treitel looked through the records of 6,000 autopsies, and found 21 cases of cerebral abscess. Of these, 7 originated from the ear, and 3 from suppuration in the frontal, or the frontal and ethmoidal, cavities.² Wertheim found 127 instances of intracranial suppuration in the records of 10,394 post-mortem examinations, and 14 were stated to be of nasal origin.³ Although an analysis of 9,000 autopsies in Guy's Hospital revealed 57 cases of intracranial mischief from ear disease, Newton Pitt could only find one case of cerebral abscess due to nasal suppuration.⁴

But we have only to recollect the frequency with which pus is met with in the nasal accessory cavities at post-mortem examinations, to prepare us for the possibility of this association being more frequently demonstrated, when the accessory sinuses of the nose are systematically examined in all post-mortem examinations with intracranial inflammatory lesions.

FREQUENCY OF NASAL SUPPURATION.

The post-mortem observations of Harke,⁵ E. Fraenkel,⁶ Lapelle and Martin,⁶ and Kiaer⁶ furnish us with statistics which show sinus disease in 30 per cent. of all subjects coming to the dead-house. T. S. Kirkland, of Sydney, examined 22 subjects who had died from pneumonia, and in 11 of these (that is, 50 per cent.) pus was found in one or more accessory cavities, and always in the sphenoidal sinus.⁷ Many statistics agree that the sphenoidal sinus is, next to the maxillary, the most frequently diseased; and, as Lermoyez observes, "sphenoidal suppuration is not rare; it is only its diagnosis which is uncommon." The relations of the sphenoidal sinus to the base of the brain, the orbit, the cavernous sinus and its contents, are well shown in the drawing of a transverse section, for which I am indebted to my friend C. R. Holmes, of Cincinnati. (Fig. 1.)

In the two cases which I am able to put on record, the sphenoidal origin of intracranial suppuration is fully established. In one case it assumed the form of acute

suppurative basic meningitis; and in the other, that of thrombo-phlebitis of the cavernous sinus. In both cases the diagnosis was made during life, and was confirmed by post-mortem examination. I will give the records of both cases, before offering any comments or deductions.

CASE I (No. 17 in the Bibliography, vide Appendix). *Sphenoidal Sinusitis. Acute Suppurative Meningitis. Death. Autopsy.*—F. D., a working man, aged 36, was sent to me at the Royal Ear Hospital on April 26th, 1901, by Dr. George Wale, of Croydon, for pain in the head, with a history of ear trouble. He said that the right ear drum had been ruptured by a blow two years previously. A month before admission to the hospital he was attacked with influenza and acute earache on the left side. Dr. Wale, on seeing him on March 26th, was struck by his look of extreme illness, and his marked sleeplessness. The left drum ruptured about March 29th, and he went on syringing it for a fortnight and returned to work. When seen on April 19th, he complained of intense frontal headache and also of a recurrence of deep-seated pain referred to his left ear; but Dr. Wale could find nothing there to explain it, and so sent him up to my clinic. He had not told Dr. Wale anything about nose trouble, but on admission to the hospital he gave a history of discharge from the nose for "as long as he could remember," with occasional severe headaches. The discharge ran chiefly into the back of his throat. He said there was no bad smell in his nose, but that the discharge had occasionally tasted bad, and for the previous fortnight—since he had felt so much worse and almost sleepless from pain—it had tasted worse.

His headaches had been chiefly frontal. They began about 9.30 in the morning and left him about 3.30 in the afternoon; recently his headaches had also been referred to the lower occipital and left temporal region. We heard, later, that his "pals" had looked upon him as "a bit off his head" at times. The first thing that struck me was his stricken look of severe illness. He was very pale. Pulse 92. Temperature 98.8°. The pupils were not dilated, but were equal and reacted normally. There was no vomiting, rigors, or staggering.

Ears.—The right drum was quite normal and showed an old inferior cicatrix. The left drum was perforated and exuded a slight, mucoid, non-fetid discharge. The posterior half was still bulging, and was therefore incised.

Nose.—The left nasal chamber was quite healthy. In the right the middle turbinal was

Fig. 1.—Frozen section of anterior half of head, cut immediately in front of chiasma. Viewed from behind. P. Orbital roof of frontal sinus. O. Ostium sphenoidale. Y.Y. Right and left sphenoidal cavities. I.M. Inferior and middle turbinates.

hypertrophied, with some inflammatory thickening in the ethmoid region, and there was curdy pus on the roof of the cavum pharyngeum on the right side.

The diagnosis was made of septic infection, and probably early meningitis, from suppuration in the right sphenoidal sinus.

Next day—April 27th—it was noted that he had hardly slept on account of the headache. The temperature was still normal, but on the following day it had gone up to 102.2°. He had not slept all night from the severe headache "behind the eyes and on top of the head." He complained of a "rotten egg" taste from the back of the nose, and the nasal conditions were confirmed on re-examination. His nose was well cleansed regularly, and he was given calomel and chloral.

On the third and fourth days after his admission, the temperature varied from 100° to 101° F. The pulse varied; it was noted once to be 62. The heart and lung sounds were normal. There was no tenderness over or below the mastoids, and the discharge from the left ear had, under antiseptic treatment, become very slight, and the drum was closing.

His mental condition was rapidly changing; he became irrational, dull, and indifferent, and the nurses found it difficult to keep him in order or "get anything out of him."

I decided that it was useless to open his sphenoidal sinus, as diffuse meningitis must have already started. I saw no reason to operate on either ear.

* Abstract of a paper published in full in the *Medical Society's Transactions*, vol. xxix, London, 1906.

On April 30th—his sixth day in hospital—his temperature was 101°. He had been restless all night, getting out of bed, and trying to dress himself. His cerebration was slow, and it was difficult to hold any communication with him. He complained of being deaf, and that everything was misty before him. There was diplopia, with left internal strabismus, and occasional nystagmus. The pupils were medium, the right somewhat dilated. The optic discs were slightly hazy. During the day the patient became very deaf, and only answered questions when roared at. The right membrana tympani remained as when previously examined. The left one was seen to be closing; it was not bulging or injected. There was no mastoid tenderness on either side. The tuning-fork appeared to be hardly audible by conduction, on the right side, but was still heard on the left. He could swallow well, and kept asking for drink. Marked right facial paralysis developed. The temperature was 102° to 103°; the pulse 98; the arteries were noted to be thickened. On the following day, May 1st, it was noted that the left pupil was more dilated than the right. He was intelligent at times, but gradually became more comatose and died that evening, a week after he had walked to the hospital.

I regret that there is no mention of the urine, but I think it must have been free from albuminuria, or the fact would have been noted.

At the *post-mortem* examination there was a large quantity of pus at the base of the brain, more copious on the right side, and tracking up to the vertex. Upon removing the brain there was no evidence of extradural abscess, or of caries or necrosis in the middle or anterior fossae of the skull. The nasal accessory sinuses were laid open by an antero-posterior saw cut, passing into the foramen magnum behind, and down to the glabella in front. The cut passed a little to the left of the middle line, and permitted the two halves of the skull to be opened like a book and the sinuses to be examined from above downwards. As the right sphenoidal sinus was opened a quantity of muco-pus escaped from it into the naso-pharynx, which was seen to be bathed in the same sort of secretion. The lining of the sinus was thickened, purplish, and sodden, instead of being thin, white, and glistening like the inside of an oyster, which is the condition in health, a condition which was found in all the other accessory sinuses on both sides.

The temporal bones were removed and the middle ear was subsequently found to be quite healthy. The brain was normal, except for the suppurative meningitis already described. The pus from the base of the brain was seen extending down the spinal canal. No evidence of disease was met with in the thoracic or abdominal viscera.

Although there was in this case no macroscopic evidence of direct meningeal infection, there can be no doubt that the patient died from infection of the meninges from pus in the right sphenoidal sinus, where there had long been a latent suppuration which had lately been reinforced in virulence by influenzal infection. In many of these cerebral infections—whether of aural, ophthalmic, or nasal origin—infection appears to spread by the lymphatics, so that instead of a local infection by contiguity, a veritable sowing of the cerebro-spinal fluid with microbes takes place.

CASE II (No. 21 in the Bibliography, vide Appendix). *Sphenoidal Sinusitis. Streptococcal Infection. Purulent Thrombosis of the Cavernous and other Venous Sinuses of the Skull. Marked Proptosis and Chemosis from Retro-Ocular Abscess. Death. Autopsy. Duration 33 days.*—A strong, healthy-looking scullery maid, aged 16, complained of pain on the top of her head on February 6th, 1905, and during the following days she was sick, had a shivering attack, and her eyelids were noticed to be swelling. On February 13th she was first seen by Mr. W. F. Lacey, of Sutton-at-Hone, to whom we are much indebted for his careful notes of the early stages.

The eyeballs were then prominent, and there was some chemosis of the right conjunctiva. Eyesight was normal. The pupils were equal and small. Both upper eyelids were

tense, discoloured, and oedematous-looking. There was tenderness on pressure at the upper and inner angle of the right orbit. Temperature 102° to 105°.

There was no history of blow, sting, or other local infection; no evidence of any ear mischief; and, although inquired for, there was no abnormal nasal discharge.

During the next five days the temperature remained high, even reaching 105°, while the pulse varied from 90 to 116. Stiffness of right side of neck, backache, and a general feeling of soreness were complained of, together with inability to turn over in bed. On the eleventh day of her illness distinct fullness and tenderness were detected along the right sterno-mastoid muscle, but no glands could be felt.

On the thirteenth day of her illness the patient was admitted to King's College Hospital, under Mr. Boyce Barrow. When left alone she lay perfectly quiet on her back; she appeared rather sleepy, but was quite rational, and all her senses were normal. Any attempt to raise her head or turn her to one side excited pain in the neck and back of the head. The proptosis and chemosis were so marked (Fig. 2) that the eyelids could not be closed. The right upper eyelid was reddish-purple and oedematous, while the chemotic conjunctiva projected above the lower eyelid, and was dry and commencing to ulcerate from exposure. The left upper eyelid was discoloured and less swollen, and the conjunctiva, although protruding slightly, was not ulcerated but simply dry. Optic neuritis was found by Mr. Cargill to be present in both eyes. The ears were examined by Mr. Arthur

Cheatle, and found to be quite normal. There was no swelling or tenderness over any of the nasal accessory sinuses, but on examining the nose I found pure pus on the right side far back in the middle meatus, and descending from the olfactory cleft. On the left side there was some muco-pus deep in the middle meatus. The general condition of the patient prevented an inspection of the post-nasal space, or the application of the tests by transillumination, posture, etc.

The patient was quite rational and very clear on the point that she had never had a discharge or any disagreeable smell from the nose, neither had she been subject to headaches.

Although the pus in the middle meatus might come from any of the accessory sinuses, I had no doubt, in view of the proptosis, that the right, and possibly the left, sphenoidal sinuses were diseased, and had caused purulent thrombosis of the cavernous sinus.

Examination of other organs added nothing to our information. There were no physical signs in the chest or abdomen; the spleen was not enlarged; the urine was healthy. The tongue was moist, and there was no sickness. The leucocytes numbered 36,000. There were two rigors within twenty-four hours of admission, the temperature running up to nearly 106°, while the respirations were 28, and the pulse 116 (vide chart).

As the large, smooth, elastic swelling in the upper part of the neck on the right side—under the sterno-mastoid—had become more marked, Mr. Barrow decided to explore it under a general anaesthetic. This was done on February 21st (that is, two days after admission and the fifteenth day of the illness). No definite abscess cavity was found, but a large number of glands with numerous points of pus in them were explored and removed. The right jugular vein was explored, and was not thrombosed. There were no symptoms on the left side of the neck.

While the patient was under the anaesthetic, Mr. Barrow kindly invited me to further explore the nose and carry out any procedure I thought desirable. With the aid of Killian's long nasal speculum the middle meatus and the olfactory cleft on the right side were cleaned and inspected. It was then quite easy to see the ostium of the sphenoidal sinus, with pure yellow pus oozing from it. The middle turbinal was therefore removed, the front wall of this sinus was broken down with Grünwald's forceps, and the opening further enlarged with Volkmann's sharp spoons. The sinus was seen to contain pus and thick mucus. This was all wiped out, and the cavity was lightly packed with a strip of iodoform ribbon gauze. It was not expected that the patient would allow this to remain in long, and she pulled it from her nose the next morning. However, she permitted the house-surgeon to syringe the sphenoidal

Fig. 2.—Thrombosis of the cavernous sinus (Case II). Shows the oedema of the eyelids, proptosis, chemosis, ophthalmoplegia, and commencing ulceration of the conjunctiva.

sinus twice daily, and he had no difficulty in introducing a large Eustachian catheter into it to a depth of 3 in. from the anterior naris.

The orifices of the sinuses on the left side—and particularly that of the sphenoidal—were inspected in the same manner, but only some slightly purulent mucus was seen, and as there was no recurrence when it was wiped away, it was decided to leave that side alone.

These procedures confirmed the diagnosis as to the original point of infection, but no improvement was expected to result from them—and none occurred. The proptosis and chemosis became more marked (Fig. 2). The pupils were equal and reacted to light; sometimes they were found widely dilated, and at other times they were medium-sized. The congestion of the upper lids became so intense that it was impossible to raise them, and owing to the proptosis it was difficult to estimate the amount of movement in the eyeball. But paralysis of the sixth nerve developed, and weakness of all the other ocular muscles on the right side. Ten days later (that is, on March 3rd) Mr. Barrow made incisions through the conjunctiva and evacuated pus from behind the eyeball on each side.

Bacterioscopic examination of this pus, made by Dr. Emery, showed a very large number of streptococci in long chains, which were matted together to form tangled skeins. No other organisms were seen. Swabs were inserted into the right sphenoidal sinus and removed covered with muco-pus. This

were found quite healthy—namely, both frontals, both anterior ethmoidal cells, and both maxillary antra. The left sphenoidal sinus was not much larger than a pea, and it and the adjoining posterior ethmoidal cells showed traces of apparently recent muco-pus. There was no visible alteration in the mucous membranes. The right sphenoidal sinus was big enough to hold the end of the little finger. (The sphenoidal sinus is not fully developed before the age of 20 to 25 years—this patient's age was 16). Its mucous membrane was discoloured, greyish, thickened, and studded with polypoid hypertrophies. Its bony walls were also greyish in colour, but not appreciably softened. It contained some pus, but most of its secretion had apparently drained into the post-nasal space, as the pharynx was full of yellow muco-pus. In its anterior wall was the free opening made during life. A portion of the bony wall and mucous membrane was removed for microscopic examination, and several cultures were taken. The adjoining posterior ethmoidal cells were not visibly altered and contained a little muco-pus. There was also pus at the back of both orbits. The thoracic and abdominal viscera were normal.

Pus taken from many situations—both sphenoidal sinuses, both cavernous sinuses, the right petrosal sinus, both orbits around the optic nerves, etc.—was found in all cases to contain streptococci similar to those seen during life. In film preparations they appeared quite pure, but a few contaminations occurred in the cultures. Sections of the sphenoidal mucosa,

was found to contain large numbers of streptococci, and a few staphylococci. Cultures of blood removed from the right basilic vein remained sterile.

In view of the fact that the original focus of infection was now freely drained, and that the purulent thrombosis was so extensive, it was deemed useless to try the effect of anti-streptococcal serum. There was no recurrence of vomiting or rigors, but, although conscious, the patient became more irritable, and apt to cry out with the pains "all over her." The conjunctiva commenced to ulcerate, and some opacity commenced in the right cornea. Weakness and drowsiness increased; the respirations became quick and irregular; and without any development of fresh symptoms the patient died on March 10th—about a month from her earliest symptoms, and a little over a fortnight from the opening of her sphenoidal sinus.

The post-mortem examination was made by Dr. Dalton twenty-one hours after death. On removing the skull cap there were no signs of meningitis, but a trace of pus was found below the membranes at the base of the cerebellum. This had probably escaped from the right petrosal sinus, which had been wounded in cutting through the tentorium. The cavernous sinuses, the petrosal sinuses, and the lateral sinuses were filled with almost undiluted yellow pus. The pus in the right cavernous sinus was mixed with red blood. The superior longitudinal sinus was normal. There was no disease visible in the floor of the middle or anterior fossae of the skull.

On opening the nasal accessory cavities the following sinuses

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REMARKS.

The evidence demonstrating the possibility of cerebral infection from sphenoidal suppuration is of recent date. Less than twenty years ago the very extensive researches of Berger and Tyrman only revealed one case in which death was due to this infection.⁹ I have, therefore, made a search through literature, and though doubtless incomplete, I trust the result may help to a more general recognition of the conditions under consideration. This would appear to be the first effort in English to demonstrate that a sphenoidal origin of cerebral infection is not uncommon, although in German we have the excellent monograph of R. Dreyfus,⁹ and for many references I am indebted to the very full article of my French colleague, Dr. Toubert.¹⁰

The present collection of cases is also the largest which has yet been made. Dreyfus, in 1896, recorded 13 cases, and Toubert, in 1900, gave epitomes of 24. My researches

have yielded 40 cases, in addition to my own, in which death from intracranial complications was due to septic infection from the sphenoidal sinus. In selecting these cases I have rejected all others in which the cerebral invasion was due to traumatism of the sphenoidal sinus, tumours originating in it or traversing it, syphilitic, tuberculous,¹¹ or other specific processes, or where there was any possibility of the intracranial complications being due to suppuration in any other accessory cavity.¹² I have also omitted those in which the sphenoidal sinus showed disease during the spread of infection from the nasal to the cranial cavity, as occurs in the course of sporadic or epidemic cerebro-spinal meningitis or meningo-encephalitis.

As regards the ophthalmic complications, only those have been considered which were associated with the cerebral invasion. I have not included cases where the sphenoidal sinusitis affected the eye only, and fatal consequences did not therefore ensue.¹³

These 40 cases are so extremely interesting and instructive that I have made a rather full abstract of them. But I have placed them in an appendix to this article, where they can readily be consulted by those who wish to verify the conclusions I have drawn from them.* They are arranged in chronological order, in different groups according to the most prominent intracranial lesion. With the addition of my own 2 cases, they yield 42 cases, which fall under the following headings:

Meningitis.—In 17 cases this was the only or the predominant lesion.

Thrombosis of the Cavernous Sinus.—In 4 cases, including my second one, this was the primary complication.

Thrombosis and Meningitis.—In 13 cases, although the thrombosis was the principal lesion, it was associated with basic meningitis. With the addition of the previous 4 cases of thrombosis, we see that either thrombosis of the cavernous sinus or basic meningitis may result with equal frequency as a complication of sphenoidal suppuration.

Intracranial Abscess.—One case.

Meningeal Septicaemia.—Two cases. This title is given by Toubert to cases where the anatomical changes are trifling or even entirely absent, and where cerebral death is due to sphenoidal affection, generally occurring rapidly (two to seven days).

Encysted Abscess of Dura Mater.—One case.

Haemorrhagic Encephalitis (part of a general septicaemia).—One case.

Phlebitis of the Cavernous Sinus (giving rise to pyaemia).—One case.

Intracranial Haemorrhage.—One case.

Suppurative Encephalitis.—One case.

SYMPTOMS OF SPHENOIDAL SINUSITIS.

Discharge.—The symptoms of sphenoidal suppuration can only be briefly referred to, and merely in so far as they lead up to the study of cerebral complications. In numerous cases the symptoms are vague, and many are common to pus in any of the accessory cavities. They may be grouped into three classes, as they affect (a) neighbouring regions, (b) more distant organs (digestive tube, lower respiratory tract, etc.), or (c) the general health.

As regards the sphenoidal sinus, the most common symptom is that of more or less purulent catarrh, frequently post-nasal.

There may be cacosmia or anosmia. The nasal discharge may never be profuse, or atrophic rhinitis may have been present for several years. But a very striking and important fact is that patients may deny any nasal or post-nasal discharge, although the diseased mucous lining found *post mortem* shows that the disease must have been of some standing. Still more noteworthy is it that expert rhinologists, to whom the idea of sphenoidal suppuration occurred, failed to detect it. Thus, Beek notes the absence of pus (Case 33), Toubert carried out anterior and posterior rhinoscopy with care, and no suspicion of sphenoidal disease was suggested (Case 11); while Bronner notes that there was "never much discharge from the nose, and on careful inspection absolutely no subjective or objective symptoms of disease of the sphenoidal sinus," except long-standing anosmia; yet the *post-mortem* examination showed both sphenoidal

sinuses to be full of pus and granulation tissue (Case 20). Doubtless the explanation of this is that the outpouring of pus from the sinus may be intermittent, and that in many cases it is difficult to sound and wash out the cavity without a preliminary operation on the middle turbinal.

Pain or neuralgia may be absent, intermittent, or severe. Occasionally it resembles migraine. The pain of suppuration in a sphenoidal sinus is not referred to any regular and definite point. It may be frontal, occipital, or temporal. It may even be referred to the side of the head opposite the affected side. Sometimes it is said by the patient to be "in the ear," but, as I have also been consulted by a patient with acute maxillary sinusitis for "earache," this location affords no definite help. Perhaps the only pain which is characteristic of sphenoidal disease is when the patient states that it is deep in behind the eyes. It may be so intense as to cause complete insomnia.

Pain may be entirely absent until the onset of endocranial infection. It is then rarely wanting, is generally acute, but varies much in distribution. This variation doubtless depends on the nerves involved in the extension. It may be on the vertex, at the back of the occiput, or deep behind the eyes. The latter is probably the only characteristic type. But extremely interesting, because so misleading in practice, are the cases in which the pain is distinctly located in some of the other accessory cavities. Thus in one case it was so fixed in the frontal sinus that the cavity was opened, only to be found healthy. In the case of Rouge (Case 36) the pain was referred to the maxillary antrum; this was opened and found healthy, and the autopsy showed the sphenoidal sinus to be diseased. Pain behind the ear was complained of in one case, while in no less than five cases it was located in the ear itself. This pain was so marked that in three cases it led to the mastoid being opened, and I would call particular attention to the fact that in each of these cases the operator was a skilled otologist. The symptoms were so suggestive of thrombosis of the sigmoid sinus that this vein was opened needlessly in two cases. It is to be remembered that otitis may coincidentally be present.

Fever is absent in chronic cases. It is generally present in acute or complicated cases.

General Symptoms.—The general health is more or less disturbed in all cases of nasal suppuration, either from direct absorption or from the penetration of pus into the respiratory or digestive tracts. Although one of my cases was described as a strong, healthy-looking girl, the other impressed his medical attendant, Dr. Wale, with this look of extreme illness, and, on his admission to the Royal Ear Hospital, this pale, stricken look of severe illness was most noticeable. F. Furet points out that even extensive fronto-maxillary suppuration never brings about the chlorotic hue, the livid pallor, which is often observed in females suffering from this form of sinusitis. He also calls attention to the fact that disturbances of general health are apt to be particularly noticeable in sphenoidal sinusitis, and are not in relation either with the quantity of pus absorbed or with the local lesions.¹⁴

Affections Simulated by Cerebral Infection from the Sphenoidal Sinus.—It is interesting to tabulate the cases where the name of the disease for which the patient was admitted is given. This I find in 13 instances is as follows:

- Phlegmon of cheek—1 case (No. 34).
- Solid tumour of maxillary sinus—1 case (No. 36).
- Ear disease—4 cases (Nos. 14, 17, 19, 50).
- Frontal sinusitis—one case (Case 32, sinus opened, no pus).
- Syphilitic periostitis of orbit—1 case (No. 23).
- Delirium tremens—2 cases (Nos. 22 and 24).
- Croupous pneumonia—1 case (No. 6).
- Acute miliary tuberculosis—1 case (No. 37).
- Tuberculous meningitis—2 cases (Nos. 31 and 42).
- Tonsillitis and possible diphtheria—1 case (No. 18).
- Tetanus—1 case (No. 3).
- Typhoid fever—1 case (No. 11).

SYMPTOMS OF CEREBRAL INFECTION.

Thrombosis of the Cavernous Sinus.—The onset of thrombosis of the cavernous sinus is indicated by various symptoms, which are well illustrated by the record of my own case. Frequently they are obscured by co-existing meningitis. Special attention might be directed to the following: Pyaemic temperature, rapid pulse, and profuse

* Full abstracts of these 40 cases are printed in the *Medical Society's Transactions*.

perspiration usher in the spread of infection. Rigors occur in many cases. Headache is common. It is generally acute, and sometimes the pain is referred to the side of the head, to the back of the ear, or to the frontal region.

Sickness may occur, and its absence has been noted (No. 20).

Hebetude and delirium may pass into drowsiness or a torpid condition and coma; or consciousness may be retained. Convulsions may occur. Dysphagia has been noticed (No. 26). Inflammation of the glands of the neck was a comparatively early symptom in my own case; swelling of the palate has been noted in one case, and swelling of the cheek occurred in several (Nos. 22, 25, 26, 31, and 33). In cases so rapidly fatal that death may occur within three days, any eye symptoms are limited to one side and are so slight that a diagnosis is hardly possible (Case 19). The cavernous sinus may contain pus, but if not thrombosed, there is an absence of chemosis, proptosis, and ocular paralysis (Case 16).

Eye Symptoms of Thrombosis of the Cavernous Sinus.—But, generally, the possibility of thrombosis of the cavernous sinus is first suggested by the condition of the eyes. The three chief ophthalmic changes are (a) papillary oedema, (b) chemosis, and (c) exophthalmos. They develop within 6, 10, 12, or 16 days from the onset of symptoms indicating the spread of infection. It is possible that neither proptosis nor chemosis may occur in a rapidly fatal case (No. 19), yet both were noted in 14 cases. In 3 cases the oedema and proptosis diminished during the progress of the case. This proptosis and chemosis may be present on both sides when it is first noticed, but it generally starts on one side and develops in the other, one, two, three, five, or six days later.

There may be anaesthesia, or ulceration of the conjunctiva, or opacity of the cornea.

Paralysis of the ocular muscles generally occurs, but in one case the movements were good (No. 31). In Case 25 (James Russell) the ocular symptoms developed under observation, and followed each other in regular order, the proptosis not making its appearance till several hours after the orbital paralysis had become complete.

The condition of the pupils varies. They may be normal, unequal, small and not reacting to light, dilated, dilated and not reacting, or, in medium dilatation, with only slight oscillation. Doubtless the explanation of these observations lies in the fact noted in my own case, that the condition of the pupils varies, for I sometimes found them equal and reacting, and at other times medium sized or widely dilated.

The fundus may be normal in rapid cases or at the commencement. Later on there may be congestion of the retinal veins, papillary stasis, papillary oedema, papillary atrophy, or optic neuritis. The absence of papillitis (Case 20), or of swelling or neuritis (Case 31), has been observed.

It is difficult in most cases to test the vision; it may be good (Cases 20 and 31), or there may be complete blindness (Case 25).

Tenderness of the eyeball may be met with.

Macewen fully describes thrombosis of the cavernous sinus, and states that it may be induced by infective inflammation in any of the nasal accessory sinuses; but he does not record any case in which the sphenoidal sinus was the primary source of infection.¹⁵

Henry Roth reports three cases of thrombosis of the cavernous sinus, one at the early age of 6, but without a *post-mortem* examination. In none of them is there a report of examination of the ears, or of an exploration of the sphenoidal sinus.¹⁶

E. W. Dwight and H. H. German have reported four cases of thrombosis of the cavernous sinus, and state that two were infected from the skin of the face or neck, one from the middle ear, and one from the frontal sinus. They give a very complete bibliography of 178 other cases reported in literature.¹⁷ But, unfortunately, the value of all these observations is greatly diminished by the absence in nearly all cases of a clinical or *post-mortem* examination of the nasal accessory sinuses.

Only too often is the source of infection attributed to some lesion on the nose or upper lip, a carious tooth, or a phlegmon of the face or neck, when it is quite open to consideration that the true source was a collection of pus in the sphenoidal sinus, with its much more direct anatomical connexions with the cavernous sinus.

Meningitis.—The onset of meningitis will be marked with the usual symptoms, though these will vary with the intensity and extent of the infection. I would, therefore, only draw attention to a few noteworthy points: While pain in the head is one of the most usual, yet this may be misleading, if it is referred to the ear, as it was in five instances (Cases 10, 14, 15, 17, 30). Rigidity and tenderness of the neck appear when the meningitis extends to the spinal cord.

A change in the character of the patient may be an early and possibly misleading symptom. He may be thought crazy, or become taciturn or irritable.

The presence of albuminuria must not be allowed to disconcert the diagnosis (Cases 4, 24, 25, 27, 31). It may be slight, and there may be hyaline casts, although at the

post-mortem examination the kidney shows only passive congestion. The amount of albuminuria may even be considerable, while only traces of congestion are found afterwards in the kidney under the microscope (Case 26). The evidence of the spread of sepsis was, in several cases, clinical only, and not pathological—rigors, delirium, high temperature, rapid tendency to sinking.

The eye symptoms in cases of meningitis due to sphenoidal suppuration vary in different cases. Exophthalmos, or immobility of the eye, rarely occur. While

the eyeball itself may not be tender, there may be pain on pressing it backwards. Diplopia and nystagmus are met with. Strabismus may be present or absent. Ptosis may occur.

The pupils may be equal and reacting, dilated, unequal, or more dilated on the affected side. The retinal veins may be gorged and the optic nerve cloudy or congested.

The progress of the case, when intracranial infection has started, is sometimes very rapid. In one instance the patient was unconscious in twelve hours and dead within four days (Case 12). In others it occurs at the end of five months, fifteen months (Case 35, intracerebral abscess), or 2½ years (Case 38, encysted abscess).

In cases of meningitis death may occur between four and thirty-five days (Case 15), although it has been delayed for five months (Case 1). In cases of thrombosis the duration of the disease varies from five to thirty-one days.

PATHOLOGICAL ANATOMY.

The *post-mortem* findings will vary (a) according to the duration and extent of the disease in the sphenoidal sinus, and (b) according to the route, the intensity, and the extent of the cerebral infection. Of these 42 cases now published together, the source of the infection has been demonstrated by necropsy to have been in the sphenoidal sinus in forty-one instances; in the forty-second case this connexion was proved during life. (Case 28.)

In most cases pus was found in the sphenoidal cavity. But this pus may have drained away just before or after

Fig. 3 (semi-diagrammatic).—Coronal section, through sphenoidal sinus, to illustrate immediate relationships with cavernous sinus and its contents, optic nerve, and base of brain.

death, or at the moment of making the autopsy (Case 17). In such instances confirmatory evidence of the sphenoidal sinusitis is found in the condition of its mucous lining or bony walls.

If the infection of the sinus is recent, and death occurs rapidly, the mucosa may be quite healthy. But, generally, the membrane shows degenerative changes, proving that the disease in the cavity is of some standing. The lining of the sphenoidal sinus may even be found detached and floating in pus (Cases 18, 24, 34, 42).

There was caries, necrosis, or osteo-myelitis of the bony walls of the sphenoidal sinus in a number of cases. Caries, with perforation of the roof or sides of the sphenoidal sinus, was found in 10 cases. But much more remarkable are the cases in which infection has spread from the sinus to the cerebral cavity without any visible lesion of the anterior or middle fossae (Cases 11, 12, 13, 17, 18, 19, 20, 21, 24, 34, 42).

The pituitary body may be surrounded with pus or may have become puriform. An abscess may be met with outside the dura, within the dura, between the layers of the dura, or in the brain.

Pus may be found at the apex of the orbit, or in the pterygo-maxillary fossa, and may occur in the middle ear (Cases 3, 11, 36). It is this coincident suppuration in the ear which has misled the diagnosis in some cases. Intracranial haemorrhage is a lesion rarely met with (Cases 24 and 41).

Haemorrhagic encephalitis—part of a general septicaemia—has occurred (Case 39). The cavernous sinus may present phlebitis, giving rise to pyaemia (Case 40), or its contents may be puriform without being thrombosed (Case 16).

The absence of gross lesions in the cranium may be associated with what Toubert describes as meningal septicaemia—a condition which may occur in acute (Case 37) or in protracted (Case 36) cases.

The longitudinal sinus escapes in most cases. It is only noted in one instance, where it was probably not infected from the sphenoidal sinus, but from an ulceration on the upper part of the vomer.

But the most common lesions met with in cerebral infections from the sphenoidal sinus are: Thrombosis of the cavernous sinus, and purulent basic meningitis.

The pus was noted to be offensive in six cases.

Pneumonia was also present in one case, in which the tonsils were soft and infiltrated (No. 3). Finally, there may be the evidence of general pyaemia, originating from the sphenoidal sinus via the cavernous sinus (Case 40).

BACTERIOLOGY.

In several observations the infecting organism has been demonstrated. Pure cultures of streptococci have been obtained from the sphenoidal sinus and from the thrombus in the cavernous sinus or the pus in the base of the brain. Staphylococci have been found in the sphenoidal cavity and in the blood—in both situations in pure culture. Micrococci have been seen in the fluid removed by lumbar puncture, grouped in pairs, and in diplococci or in chains in the pus of the sphenoidal sinus. The pneumococcus of

Friedlaender may occur in pure culture. The pneumococcus occurs in the pus both of the sphenoidal sinus and the meninges. In one case virulent *Diplococci pneumoniae* were found, not only in the sinus and the meninges, but also in the sphenoid bone itself, and in another a streptothrix was obtained from the meningeal pus.

PATHOGENESIS.

In considering the evolution of these intracranial complications, space will not permit of our studying the etiology of sphenoidal sinusitis itself, so I would only draw attention to the records of four cases which suggest that the pyogenic organism might originally have entered the system through the tonsil (Cases 3, 11, 18, 26).

In regard to the onset of endo-cranial complications we have to study why and how they occur.

Why? It would appear that the virulence of the microbe and the diminished resistance of the patient must be the chief factors. Neither the long duration, nor the degree of disease in the sphenoidal sinus, seems to

cause it. Retention of discharge, from obstruction of the ostium sphenoidale, is often invoked as a cause. But in both the cases I record there was a free outpouring of pus.

How? Perforation of the base of the skull, when it occurs, is sufficient to explain how the pus comes in direct contact with the meninges or venous sinuses. An abscess, extradural or intradural, may form the connecting link. More difficult is the explanation in those cases where this direct transference is not apparent.

As to the Route.—From the mucosa of the sphenoidal sinus to the subarachnoid space, there are three possible channels: (a) direct transference through the bone, (b) by the veins, or (c) by the lymphatics.

(a) *The route through the bone*, when it is destroyed by osteitis or necrosis, is evident. This channel of direct continuity is also demonstrated in the case of Ortmann (No. 18), where the bone was not perforated, but

typical *Diplococci pneumoniae* were found in the sphenoid bone itself—as well as in the pus of the meninges and of the sphenoidal sinus. Once the bone is invaded, the infection, of course, becomes much more serious, as diploë offers no resistance to its spread (vide Fig. 1).

(b) *By the Veins.*—The possibility of this route is rendered evident by recalling the veins of the diploë, and by a reference to Fig. 4, which shows the connexion between the veins of the sphenoidal mucosa and those of the cavernous and circular sinuses, and the ophthalmic vein.

The roof of the sphenoidal sinus may be only 1 to 2 mm. thick, and Zuckerkandl has found physiological defects in the bony wall, placing the mucosa of the sinus in direct contact with the dura. He had found similar dehiscences, placing the sheath of the cavernous sinus and the mucous lining of the sphenoidal cavity in contact. Here the wall is thin as notepaper, and Sieur and Jacob¹³ have found numerous vessels running through it from the sphenoidal to the cavernous sinus (vide Fig. 4). These defects in the

Fig. 4.—Diagram to show communication of veins of cavernous sinus with venous sinuses of the cranium; showing also interrelation of transverse and cavernous sinus with external veins. The asterisks (*) mark the anastomoses of the intracranial venous system with the veins of the surface. (Modified from Leube.)

typical *Diplococci pneumoniae* were found in the sphenoid bone itself—as well as in the pus of the meninges and of the sphenoidal sinus. Once the bone is invaded, the infection, of course, becomes much more serious, as diploë offers no resistance to its spread (vide Fig. 1).

roof of the tympanum have been much more studied than similar anomalies in the nose.

In some cases prolongations of the sphenoidal sinus may reach as far as the pterygoid process, and the pus may filter across the pterygo-maxillary fossa, reach the zygomatic fossa, and even point at the level of the first large molar tooth. Moreau, who points this out, makes the suggestion that in this way a swollen face, or a gum-boil, may be an early symptom of a sphenoidal sinusitis spreading beyond its boundaries.

(c) *By the Lymphatics.*—But the above venous channel, although it would explain the route in my case of thrombosis, would be less satisfactorily invoked in the case of meningitis. To explain the route of infection in such cases, the lymphatics have been considered as possible channels—based chiefly on the works of Key and Retzius,¹⁹ and the later investigations of Cunéo and André.²⁰ The lymphatics of this region communicate with those of the endocranium, and also with the peripharyngeal ganglia. Hence the possibility of a sphenoidal empyema being caused by an infectious angina. (Compare Cases 3, 11, 18, 26.)

In Zörkendörfer's case (No. 4) the pneumococci of Fraenkel-Weichselbaum were found in the meningeal pus, and in the pus of the sphenoidal sinuses. But they were not found in the blood, nor in the heaps of leucocytes within the blood vessels, nor in the substance of the brain. From this it is concluded that the penetration of the diplococci did not follow the blood stream, but passed by the lymph stream, or direct through the tissues, although the latter showed no change to the naked eye.

Sinus thrombosis attacks chiefly the cavernous sinus, spreading via the circular sinus to that of the opposite side, as well as forwards to the ophthalmic vein, and sideways to the petrosal sinuses.

Summary of Pathogenesis.—The following is an epitome of the above considerations:

1. Infection of the cranial cavity depends largely on the virulence of the infective organism, and the diminished resistance of the individual.
2. Neither the long duration, nor the extent of pathological changes in the sphenoidal sinus, appears to be a prime factor in this extension.
3. Infection of the cranial cavity takes place through the perforation of the bony walls, through the bone diploë, through the veins, or by the lymphatics.
4. Thrombosis of the cavernous sinus and basal meningitis are the commonest consequences, and occur with equal frequency.
5. Other complications are much less frequent (vide list on p. 771).

PROGNOSIS.

These cases illustrate the grave complications which may arise in a patient who complains of nothing, or, at most, nothing more than post-nasal catarrh. Even if it is diagnosed that this "catarrh" originates in the sphenoidal sinus, we are at present loth to recommend operative measures in the absence of much discomfort. Data are wanting to show the mortality of this form of empyema. Yet, in future, we cannot tell a patient with sphenoidal sinusitis that there is no harm in leaving it alone. Pus in this cavity apparently is fraught with more danger than in any of the other pneumatic spaces of the skull. Its anatomical relations are most delicate and intimate. It resembles the mastoid antrum in not having its ostium at a dependent point, but it is much more inaccessible, and the onset of secondary complications is far less definite. The maxillary sinus is rarely the originator of cerebral lesions, and there is no excuse for not treating this cavity as soon as pus is found in it. The frontal sinus possesses the great advantage of having its ostium at the most dependent point, and by freeing the access to this point we facilitate drainage, and lessen the risk to the cranial contents. It seems to me that suppuration in the sphenoidal sinus should never be left untreated. The opening in the anterior wall can be enlarged, and suitable measures will often result in completely curing the discharge. If not entirely arrested, the establishment of a free communication with the nose will relieve the patient of many symptoms, and will diminish the risks, otherwise inseparable, from fresh infection of the cavity.

In early cases of relapsing cyclitis, in choroiditis, and even in early glaucoma, Ziem claims that treatment of the

causative or contributory nasal suppuration will cure, or contribute to recovery.

Ophthalmic changes induced by sphenoidal disease may be cured if the infection has not spread by the cavernous sinus or ophthalmic vein. In a case of sudden, unilateral blindness, produced by exudation into the optic sheath, the eyesight has been restored by opening, and draining the sphenoidal sinus.²¹ In a remarkable case recorded by C. R. Holmes, there was total loss of sight in one eye from retrobulbar inflammation. Although no pus could be seen by anterior or posterior rhinoscopy, and although the patient when questioned denied any annoyance from nasal catarrh, yet the sphenoidal sinus, was opened; thick creamy pus was evacuated, and vision was restored.²² In both these cases there was some exophthalmos, and the eyeball was tender.

When the meninges are affected, it is suggested by Stanley Barnes (Case 16) that if a lumbar puncture withdraws a thick or yellow fluid, operation would be useless. But that, if the cerebro-spinal fluid is only slightly turbid, an operation would not be contraindicated. He thinks Kernig's symptom is uncertain, and that stiffness of the neck may be present in these cases without meningitis, as it was in my case.

Even early operation on the sphenoidal sinus, as in the case of Flatau (No. 7), fails to arrest a meningitis, and in my case of thrombosis the free and continued drainage of the original source of infection produced no visible benefit. In three other cases operation on the sphenoidal sinus gave no relief (Nos. 28, 34, 40). In Bronner's case (No. 20), the injection of antistreptococcic serum appeared, if anything, to make the patient worse; though it is fair to remember that the pathogenic organism had not been recognized.

Suppurative meningitis appears at present to be beyond surgical skill; but in cases of early threatening meningeal invasion I should in future be inclined to freely open and disinfect any suppurating sphenoidal cavity. The ease with which this could be done, and the facility with which after-treatment was carried out was noticeable in one of my cases.*

OPERATION ON CAVERNOUS SINUS.

With regard to the possibility of operation when only the cavernous sinus is involved, Dr. Dwight, in one case, attempted operation by approaching it through the temporal bone, by the route recommended by Krause in his operation for intracranial resection of the trigeminus. He succeeded in opening the sinus, but the patient died six and a half hours after the operation.

But if approached from its cerebral surface the cavernous sinus is opened through the wall where the most important structures are situated (Fig. 4). Grünert²³ therefore suggested that the best route was via the nose and the sphenoidal sinus, and this idea had independently occurred to Luc,²⁴ who has shown that it can be satisfactorily carried out on the cadaver with good prospect of success in the living subject. He approached the sphenoidal sinus by first traversing the maxillary sinus from the canine fossa. An important point of his researches is that although he always succeeded in making a large opening into the sphenoidal cavity, he was never able to break through its lateral wall into the cavernous sinus—if he had approached it by the maxillary cavity on the same side. It was, in fact, impossible to apply the chisel perpendicularly to the lateral wall of the sphenoidal cavity, and each attempt resulted in its entering the cranial cavity, either at the posterior extremity of the cribriform plate or beside the anterior clinoid process. However, on approaching the sphenoidal sinus by traversing the maxillary cavity of the *opposite* side, he succeeded in every instance in opening the side of the sella turcica and penetrating the cavernous sinus, without injuring the nerve trunks lodged in its outer wall, the sixth nerve, or the carotid.

If the ophthalmic vein is already thrombosed, or if the infection originated from the orbit, it will in addition be necessary to open the orbital cavity by the route suggested by Krönlein. The zygomatic border is temporarily resected, so as to allow of removal of the deeper part of the external orbital wall, and thus permit of access to the

* E. A. Crockett, in the *Boston Medical and Surgical Journal*, January 25th, 1906, publishes a case of meningitis successfully treated by drainage of the subdural space. The infection was from the ear.

summit of the orbit, where the ophthalmic vein and its principal afferent branches are reached.

If the patient's life is to be saved by operation it must be by undertaking measures before the septic phlebitis has extended beyond one cavernous sinus—an extension generally indicated by the development of ophthalmic symptoms on the opposite side. Perhaps the above suggestions may prove helpful to those who are called on to treat this grave complication.

TREATMENT.

I think that at present our knowledge justifies us in advising any patient with pus in a sphenoidal cavity to have the orifice of it enlarged, and the sinus drained and treated, both for the relief or cure of the suppuration, and as a preventive of intracranial complications. Fortunately, this can be done without external operation and with less serious risks than attend operation on the frontal sinus. The Roentgen rays promise to help us materially both in diagnosis and treatment.

The treatment of these accessory nasal cavities is a delicate matter, and this record suggests that the rhinologist is not necessarily responsible for the fatal intracranial complications which may rise. Secondary infections may be precipitated by surgical traumatism, but, also, they may be simply coincident.

CONCLUSION.

In conclusion, if the association of sphenoidal sinusitis with disease in the orbital and cranial cavities has not been hitherto more fully substantiated, this is partly due to the fact that neither physicians nor surgeons attach much importance to the condition of the nasal cavities, either at the bedside or on the *post-mortem* table.

Records not infrequently appear in our journals of cases in which physicians express surprise at meeting with a case of apparently primary meningitis. Or we read of a surgeon trephining a skull for symptoms of "cerebral compression," and at the necropsy he expresses his astonishment on discovering suppurative basal meningitis, which he is unable to track through the bone to the middle ear or elsewhere.

Another reason why this association is overlooked is that patients will frequently attend a rhinologist, or a throat clinic, when their nasal suppuration or their upper air passages causes them discomfort, but when complications supervene they are apt to go elsewhere and give no history of their nose or throat trouble.

I hope that, in view of my findings, pathologists will more regularly carry the *post-mortem* examination through to the neighbouring pneumatic spaces of the nose. No *post-mortem* examination is really complete without an investigation of the nose and its accessory sinuses. I venture also to urge that in cases of headache, neuralgia, and intracranial inflammation, and in the presence of thrombosis of the ophthalmic vein or cavernous sinus, these cavities should be examined as regularly as are the ear and the eye.

It is only by the collection of a large number of data, clinical and *post mortem*, that we will learn how often these sinuses are diseased, and which are the most frequently affected. I look forward to our thus securing much valuable information in regard to the association of nasal suppuration with diseases of the eye and the brain, as well as with more distant parts.

APPENDIX.

BIBLIOGRAPHY OF 42 CASES OF CEREBRAL AND OPHTHALMIC COMPLICATIONS OF SPHENOIDAL SINUSITIS.

CLASSIFICATION OF CASES.

(Each Group in Chronological Order.)

MENINGITIS.

1. Horner: Periostitis orbitae und Perineuritis nervi optici, *Klinische Monatsblätter für Ohrenheilkunde*, vol. i, 1863, S. 71.
2. Demarquay: Quoted in Morell Mackenzie's *Diseases of the Throat and Nose*, vol. ii, p. 370, London, 1884; Berger and Tyrman, p. 19; also in Grünwald's *Nasal Suppuration*, p. 140.
3. Weichselbaum (man, aged 21): Quoted by Netter in *Archives Générales de Médecine*, 1887, vol. i, p. 454.
4. Zörkendörfer: *Prager med. Wochenschrift*, vol. xviii, May 3rd, 1893, No. 18, p. 209.
5. Pekostawski: Ref. in *Centralblatt für Laryngologie*, vol. x, December, 1893, p. 288.
6. Dmochowski: *Archiv für Laryngologie*, Band III, 1895, pp. 255 and 301.

7. Flatau: *Berliner klin. Wochenschrift*, vol. xxxii, No. 41, October 14th, 1895, p. 901.
8. Caubet and Druault: *Annales des Maladies de l'Oreille*, vol. xxv, ii, 1899, No. 8, p. 211.
9. Grünwald (short case): *Nasal Suppuration*, English edition, London, 1900, p. 137.
10. Samuel Lodge, jun.: *The Laryngoscope*, March, 1900, vol. viii, No. 3, p. 139.
11. Toubert (man, aged 22): *Archives Générales de Médecine*, vol. 186, 1900, p. 385.
12. Toubert (adult): *Archives Générales de Médecine*, vol. 186, 1900, p. 385.
13. Toubert (female, aged 60): *Archives Générales de Médecine*, vol. 186, 1900, p. 385.
14. Oscar Dodd: *The Laryngoscope*, x, 1901, No. 5, p. 334.
15. Beever and Buzzard: Case of Basal Meningitis due to Streptothrix Infection, *Transactions, Pathological Society of London*, vol. liv, 1903, p. 321.
16. Barnes (with pus in venous sinuses base of brain, and tracking down to cauda equina): Septic Meningitis Secondary to Disease of the Nose (from the clinic of Dr. Foxwell), *Birmingham Medical Review*, September, 1905, p. 533.
17. StClair Thomson: *BRITISH MEDICAL JOURNAL*, September 29th, 1906.

THROMBOSIS.

18. Ortmann (slight basic meningitis and subdural abscess): *Virchow's Archiv für pathol. Anat. u. Phys.*, Band 120, 1890, p. 117.
19. Finlay (with plastic exudation at base of brain): *Archives of Otolaryngology*, vol. xxii, No. 6, 1903, p. 419.
20. Bronner: *BRITISH MEDICAL JOURNAL*, November 12th, 1904.
21. StClair Thomson: *BRITISH MEDICAL JOURNAL*, September 29th, 1906.

THROMBOSIS AND MENINGITIS.

22. Scholz: *Berliner klin. Woch.*, October 21st, 1872, No. 43, p. 516.
23. Duplay: *Archives Générales de Médecine*, 1874, vol. ii, p. 348.
24. Russell: *Medical Times and Gazette*, 1878, vol. i, June 8th, p. 614.
25. Raymond: *Bulletins de la Société Anatomique de Paris*, LX^e Année, Avril, 1885, p. 226; also described by De Lapersonne, *Archives d'Ophthalmologie*, vol. v, 1885, p. 445.
26. Panas: *La Semaine Médicale*, No. 31, 29 Juillet, 1885, p. 255; the same case is described by De Lapersonne, *Archives d'Ophthalmologie*, vol. v, 1885, p. 436.
27. Thiroloix and du Pasquier: *Bulletins de la Société Anatomique de Paris*, LXVII^e Année, 1892, p. 673.
28. Clauqué: *Revue hebdomadaire de Laryngologie*, xv, No. 17, 1895, p. 805.
29. Jassinger: From ref. in *Revue hebdomadaire de Laryngologie*, vol. xxii, i, 1902, p. 298.
30. Harold Wilson: *Archives of Otolaryngology*, vol. xxxi, 1902, No. 6, p. 443.
31. Jessop: Infective Thrombosis following Tonsillitis, involving Circular and Cavernous Sinuses; Necrosis of Body of Sphenoid Bone; Gangrene of Superficial Part of Frontal Lobe at Base; Meningitis: Death. *Transactions of the Ophthalmological Society of the United Kingdom*, vol. xxiii, 1903, p. 184.
32. Beek (man, aged 23): *Rousski Vrach*, 1903, No. 15, p. 574, from ref. in *Revue hebdomadaire de Laryngologie*, 1903, No. 35, p. 265.
33. Beek (female, aged 44): *Rousski Vrach*, No. 15 1903, p. 574, from ref. in *Revue hebdomadaire de Laryngologie*, 1903, No. 35, p. 265.
34. Moreau (from the clinic of Professor Jaboulay): Manifestations Oculo-orbitaires des Sinusites Sphénoïdales. *Thèse de Lyon*, 1905, p. 81.

INTRACEREBRAL ABSCESS.

35. Lévêque-Lasource: *Journal Général de Médecine*, 1810, p. 368.
- MENINGEAL SEPTICAEMIA (with slight or no anatomical changes).
36. Rouge: *Bulletin de la Société Médicale de la Suisse Romande*, V^{me} Année, Décembre, 1871, p. 379.
 37. Weichselbaum (young soldier): *Medizinische Jahrbücher*, Wien, 1881, p. 227.

ENCYSTED ABSCESS (between layers of dura mater).

38. Sandford: *Transactions of the Ophthalmological Society*, vol. xiv, London, 1894, p. 119.

HAEMORRHAGIC ENCEPHALITIS (part of a general septicaemia).

39. Schwabach: *Berliner klin. Wochenschrift*, No. 41, October 14th, 1895, S. 901.

40. Whitehead: A Fatal Case of Necrosis of the Sphenoidal and Posterior Ethmoidal Cells; Phlebitis of the Cavernous Sinus; Pyaemia. *The Journal of Laryngology*, vol. xix, April, 1904, p. 179.

INTRACRANIAL HAEMORRHAGE.

41. C. R. Holmes: *Archives of Ophthalmology*, vol. xxv, 1896, p. 460.

SUPPURATIVE ENCEPHALITIS.

42. Grünwald (boy of 14): *Nasal Suppuration*, English edition, London: 1900, p. 147.

REFERENCES.

- ¹ *Diseases of the Nervous System*, vol. ii, 1893.
- ² *Berliner klinische Wochenschrift*, No. 51, December 21st, 1896, p. 1139; and *Zeitschrift für Ohrenheilkunde*, Bd. 27, 1895, p. 32.
- ³ *Archiv für Laryngologie*, Bd. xi, 1900.
- ⁴ *BRITISH MEDICAL JOURNAL*, 1890, vol. i, pp. 643, 771, and 827.
- ⁵ Quoted by F. Martin, *De la Fréquence de l'Empyème*, Bordeaux, 1900.
- ⁶ *The Laryngoscope*, 1899, vol. vi, No. 2, p. 81.
- ⁷ *Journal of Laryngology*, vol. xvii, No. 11, November, 1902.
- ⁸ *Die Krankheiten der Keilbeinhöhle*, etc., Wiesbaden, 1886.
- ⁹ *Die Krankheiten des Gehirns und seiner Adnexa im Gefolge von Nasenerkrankungen*, G. Fischer, Jena, 1896.
- ¹⁰ *Archives Générales de Médecine*, vol. clxxxvi, 1900, p. 385.
- ¹¹ Lewy, *Thèse de Wurzburg*, 1892, quoted by Moreau (Case 34).
- ¹² K. Störk, *Die Erkrankungen der Nase, des Rachens, etc.*, Wien, 1895, p. 239; J. Broeckart, *Annales des Maladies de l'Oreille* vol. xx, 1904, No. 12, p. 1228.
- ¹³ Oscar Eversbusch, *Graefe-Saemisch Handbuch der gesamten Augenheilkunde*, Zweite Auflage, Kapitel xvi, Leipzig, 1904, p. 394.
- ¹⁴ *Bulletins de la Soc. Franc. d'Otologie et de Laryngologie*, Tome xvii, 1re partie, 1901.
- ¹⁵ *Pyogenic Diseases of the Brain and Spinal Cord*, Glasgow, 1893, pp. 245-260.
- ¹⁶ *New York Medical Journal*, February 27th, 1904, p. 394.
- ¹⁷ *Boston Medical Journal*, May 1st, 1902.
- ¹⁸ *Les Fosses Nasales et leurs Sinus*, Paris, 1901.
- ¹⁹ *Stud. über d. Anat. d. Nervensyst.*, etc., Stockholm, 1875.
- ²⁰ *Contributions à l'étude des Lymphatiques du Nez et des Fosses Nasales*, Paris, Steinheil, 1905; *Annales des Maladies de l'Oreille*, Tome xxxi, No. 5, May, 1905.
- ²¹ T. W. Halsted, *Archives of Otolaryngology*, vol. xxx, 1901, p. 222.
- ²² *Archives of Ophthalmology*, vol. xxv, 1896, p. 460.
- ²³ *Die operative Ausräumung des Bulbus Venae Jugularis in Fällen otogener Pyämie*, Leipzig, Vogel, 1904.
- ²⁴ *Annales des Maladies de l'Oreille*, vol. xxi, June, 1905, No. 6, p. 521.