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THE DIFFERENTIAL DIAGNOSIS OF BRAIN ABSCESS

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In an attempt to clearly set forth the difficulties encountered in the differential diagnosis of suppurative encephalitis or brain abscess, one must consider at the start just how this pathology arises and, having a clear understanding of its beginning, attempt to point out its symptomatology in general, and in particular those features which distinguish it from other intracranial lesions. It perhaps should be mentioned that the various etiological factors to be discussed are drawn from the opinions of various writers on the subject, some of which must be regarded as purely speculative and some of which will become fallacious as our knowledge of physio-pathological knowledge of the processes involved increases.

Before discussing the etiological factors producing brain abscess certain points of anatomy and physiology should be borne in mind. I can do no better than quote Alkinson (17) as follows: "In the first place, the vascular supply of the brain, comes from two sources, central and cortical, both of which are branches of the circle of Willis. The central vessels pass out at the base of the brain directly into its substance and then outwards thru the white matter towards, but not as far as, the cortex. The cortical vessels supply the grey matter of the cortex by means of a large number of small vessels, and also a layer of white matter immediately subjacent

to the cortex, by a smaller number of larger vessels, these latter in the white matter passing towards but not anastomosing with, the terminal branches of the central arteries -- not anastomosing with them, because the cerebral arteries are end arteries. Therefore between these two groups of vessels is a zone of white matter with a poor blood supply which we may call an avascular zone. In the cerebrum this zone is situated just below the grey matter of the cortex, but in the cerebellum, by reason of the greater convolution, it likewise becomes folded and is found therefore to lie down the center of each folium.

"The second point to remember is that whenever a cortical vessel passes from the surface down into a fissure, it takes along with it a prolongation of the subarachnoid space in which the cerebro-spinal fluid circulates, so that both arteries and veins as they lie together in a fissure are surrounded by a perivascular space or Virchow-Robin space.

"The third point is that the cerebro-spinal fluid normally flows outward to the surface in these perivascular spaces, but Weed has shown that any increase in pressure in the subarachnoid space will cause a cessation and then -- a reversal of flow."

It is also well to call attention to the fact that any organ of the body is unable to function properly when it is invaded by micro-organisms, the seat of suppuration, or is poisoned by toxins. With the highly specialized tissue of the brain this point is of extreme importance, since many other organs may disguise their disabled physiology for a long time by reason of their inherent resistance to invasion. Nerve tissue, in the process of development, has lost much of its power of resistance with the consequence that once invaded by micro-organisms, suppurative processes, or toxins, it readily succumbs to their influence. As a result of this lowered resistance

Of nerve tissue, nature has provided a definite protective mechanism for the brain -- more elaborate than for any other organ -- as an attempt to compensate and to protect this delicate machine from both outside and inside influence. Externally the dura is essential not only because the bony cranium is liable to injury but because the nasal cavity is the natural habitat of many diversified bacterial forms and also the ear, a frequent site of infection, both are contiguous with the cranial cavity itself. We must further assume, from the frequency of so called haematogenous infections, that the blood stream is a conveyer of infections, since one of its functions is to devour micro-organisms, and so the brain may be attack from within by either micro-organisms or toxins. Besides its function of nutrition to the brain from the circulating blood, the cerebro-spinal fluid affords protection to the brain normally from any mechanical, bacterial or toxic substance that may be circulating within the blood thereby offering protection to the nervous tissue from internal injury. It now follows that any dearrangement of the blood itself, its vessels in the brain, the pia and external layer of the arachnoid space, cerebro-spinal fluid, or infection remotely or proximally all have their place in the etiology of brain abscess, and all of these must be checked if we are to arrive at any conclusions as to the etiology in a suspected case of brain abscess.

In attacking the problem Burnet (5) says we are beset with two problems in any suspected case: First, whether there is an abscess, and second, where is it located. In differentiation the first is our main problem, but the second cannot be disregarded, since localized signs may give a very valuable clue as to the pathology with which we are dealing. The diagnosis is at best difficult and Cairns (12) says that no group of symptoms will be found infallible and no symptom is pathognomic, but it is essential to the life of the patient that a

diagnosis be made as soon as possible, and in this respect it offers a problem that is unique in the field of organic neurology.

First to be considered (19) is the history of the onset and course of the pathologic process. Previous illnesses, accidents, operations, exposures and habits, as well as occupation, habitual colds, headaches, and a host of other factors that might influence any symptom or sign or predispose the patient to intracranial disturbance must be carefully investigated and worked out thoroly. The history of a discharging ear, previous mastoidectomy or a chronic disease of the paranasal sinuses is often of primary significance in distinguishing abscess from other pathologic conditions and in determining the probable site of the lesion. "It should also be borne in mind that multiple haematogenous abscesses may occur from a septic process elsewhere in the body, such as abscess of the lung or suppurative cystitis, while at the same time suppurative mastoiditis or disease of a sinus may exist without direct relationship to the lesion of the brain."

Casamajor (6) and MacEwen (9) both divide the symptoms of brain abscess into three stages: First, the initiatory stage, second, the latent stage, and third the stage of manifestation or terminal stage. These two authors differ in some respects in their description of these stages but the following is a brief general description of them:

The initiatory stage may vary in duration or it may be lacking. When present it is marked by indications of cerebral involvement as severe pain in the head, vomiting, rigor and fever. However there is considerable difference of opinion as to the temperature, some writers saying that the temperature is subnormal and others saying that it is always somewhat raised. The vomiting is more common in cerebellar abscesses than in cerebral. Clouding of the consciousness

may be of any grade from slight confusion to severe stupor or delirium. Other signs of meningeal irritation may be present, and the stage may last from 12 to 20 hours or may extend over a week.

The second stage is the varying stage. It may last a few days, a few weeks, over a year, or it may be entirely lacking. The symptoms of the initial stage may more or less completely disappear, and the patient gives the appearance of having completely recovered from his meningeal irritation. The abscess is now forming as a clearly localized lesion. This stage is characterized by pain which is elicited only by percussion, slow cerebration, want of sustained attention, pyrexia, slow pulse, paralysis and optic neuritis. As the abscess grows in size, symptoms of the third stage manifest themselves slowly but sometimes with startling suddenness.

In the third stage is when the neurologist usually first sees the patient. There is now either leakage of pus into the membranes or ventricles. The symptomatology now becomes clear and divides itself into two groups: First, general symptoms due to disease from brain pressure from the abscess and the surrounding edema, and second, local signs due to destruction of and pressure on structures in the immediate neighborhood of the abscess.

General symptoms: Fever is frequently absent, indeed the temperature may be and often is subnormal. Headache is a constant symptom but the pain may be distant from the lesion with the consequence that tenderness over a definite area cannot be relied on as a localizing sign. Slowing the pulse in the presence of a moderate fever is a valuable diagnostic sign when present. Choked disc is present in only 53% of the cases and therefore it cannot be relied upon as a diagnostic sign with the same reliance as in brain tumor. Okada claims that optic neuritis without papiledema is much more common. In general we may say that the symptoms are due more to a cerebral intoxication than to brain pressure. The abscess may go on to complete encapsulation which may remain quiescent for a long period and may finally become absorbed in some cases without surgical interference. However,

convulsive phenomena, either general, hemi- or local occur with many large abscesses. In fact the case may look like epilepsy or eclampsia. Again the cloudy consciousness due to cerebral intoxication makes cooperation difficult.

Local symptoms: The localizing signs are meagre and at times are entirely absent. The mental state is well nigh unsurmountable. In temporo-sphenoidal lobe abscess, which is the most frequent of otic origin, has the least definite localizing signs. The right lobe is a "silent area" in right handed persons with the consequence that an abscess of considerable size may develop without showing any localizing signs. If it is deep enough it may produce homonymous or quartarian hemianopsia by impairing the optic radiation fibers. If possible the visual fields should always be charted to determine if this valuable sign is present. Cairns (12) places special emphasis on this sign and if present operates without delay. However the mental condition prevents one from discovering whether or not it is present. In the left temporo-sphenoidal lobe is located the sensory speech area of Wernick, and disturbance of speech is the rule if abscess is in this area. Difficulty in paraphasia, inability to remember words they wish to use and more or less disturbance in the understanding of speech are present. This adds to the mental clouding and further obstructs diagnosis. Casamajor says that pure hearing defects of a subjective or objective nature have been practically never observed.

Burnet (5) reports a case in which he demonstrated the difficulties encountered with this type of abscess. The patient was a male, age 59 who came complaining of "sore eyes". Examination revealed a purulent conjunctivitis with plepharitis of the right eye. There were exematous patches over the lower lid and upper lip. He said that he had had a chill some days before. There was no facial paralysis. He had a slight bronchitis and extreme emaciation,

The patient did not take food well. Three days later he complained of pains in his knees and thighs. He was perspiring a good deal, the temperature was found to be 99°, pulse 100, and there was a disagreeable odor about the bed due to involuntary urination and defecation. The urinalysis was normal, the patient was drowsy, and strychnine and aromatic spirits of ammonia were ordered. The next day he complained of pain in both ankles. The pulse was still rapid but the temperature was normal. That evening he complained of pains in his head. The following day the temperature was 99°, pulse 104, face swollen, a trace of albumen was found in the urine and Pulv. jalapae co. gr. xxx was ordered. This produced watery stools and he became quite sensible and except for a slight headache he seemed quite comfortable. The temperature and pulse were now normal. On the fourth day he became deaf, or at least did not respond to sounds about him or to questioning, he had twitchings in his right hand, the right leg was drawn up and flexed at the knee. He complained of pain on the left side of the head, and kept putting his hand over that region. That evening he was almost unconscious, temperature 101°, pulse 108, Cheyne Stokes respiration and at 2 A. M. he died -- eight days after his first visit. The autopsy revealed an abscess in the temporo-sphenoidal area. The convolutions over the vertex were greatly flattened, especially on the left side. The ear on the left was entirely negative. The basal sinuses were entirely negative.

Special emphasis should perhaps be placed on these two points. First, the rapid onset and termination of the disease which shows that a cerebral abscess may be present for some time without producing symptoms and second, the ambiguity of the symptoms which should be accounted for by other findings.

Burnet lays special emphasis on the extreme emaciation of the patient, and devotes a goodly part of his article to the explanation of

it, and says that it is not sufficiently pointed out in articles on the subject. He further says that extreme emaciation should suggest tuberculosis, cancer or cerebral abscess. Another point often stressed by Keegan (14) is that if dehydration improves a patient who is suffering from intracranial pathology, it is evident that operation will improve him. The dehydration in this case removed the oedema surrounding the abscess, and had the abscess been drained there might have been a fair chance of recovery.

Dercum (2) points out that frequently we are told that the patient, who had been previously well -- at least in whom nothing unusual has been observed -- began to suffer suddenly from headache and vomiting. Less frequently do we find that these symptoms, particularly the headache, have supervened gradually; most frequently we are confronted by symptoms suggestive of a pathologic condition that is less acute or has suddenly become active. He says that when he talks to a patient, he is impressed by the fact that he (the patient) is somewhat dull, heavy, and apathetic, often markedly so. He then concludes that in addition to saying that the patient has headache and vomiting, hebetude in some degree is also present. However, headache, vomiting and hebetude do not justify the diagnosis of intracranial disease since they may be encountered in a case of otitis media or chronic otitis without complications. Dizziness won't help since it may be due to fever, but optic neuritis after paracentesis would justify the inference of intracranial involvement.

Potts (4) regards optic neuritis as one of the cardinal symptoms of brain abscess. "However," he says, "nothing is clear until the abscess cavity is opened or an autopsy shows the lesion. There should be," he adds, "a high leucocyte count with a high polymorphonuclear percentage, and the cerebrospinal fluid should be free from pus before an exploration is attempted."

Potts (supra) quoting Sachs calls attention to a symptom that may develop at times, that is the early involvement of the facial nerve, not a paralysis, but a reaction of degeneration. He claims that the early development of a reaction of degeneration in the facial nerve indicates the probability of an abscess in one of the lateral lobes of the cerebellum rather than a sphenoidal lesion.

A slow pulse is often present but, invariably in brain tumor the slow pulse is present in spite of the fever.

Having established the intracranial involvement the next important step is differentiation. We must differentiate between the following conditions: First, external purulent pachymeningitis; second, thrombosis of the lateral and other sinuses; third, purulent meningitis, limited or diffuse; fourth, purulent meningo-encephalitis; fifth, non-suppurative localized encephalitis; sixth, serous meningitis; and seventh, tumor.

To illustrate the difficulties encountered in a case of purulent pachymeningitis, Bagleton reports the following case:

D. McS. Male: Adjacent frontal lobe abscess following frontal sinus disease, orbital phlegmon, or osteomyelitis, and associated with extra dural abscess.

Previous History.-- Pneumonia five years before; always had some "nose trouble," with slight discharge, since childhood; had lost sense of smell for past three years. About three weeks before admission to hospital suddenly had pain and swelling of right eye; swelling extended to other eye and subsided; two weeks later pain in head, with recurrence of swelling of right eye.

Examination.-- Slight exophthalmos of right eye, with beginning chemosis and diplopia; limitation of motion toward nasal side. Polypoid degeneration of mucous membrane of nose, polyps filling both nostrils; creamy pus in both nostrils, apparently from ethmoids.

X-Ray Findings.-- Frontal sinuses moderate size, multilocular, deficiency of illumination both sides, more marked on right; haziness right ethmoid.

Diagnosis.-- Orbital abscess from ethmoid suppuration.

Operation.-- Right sides orbital abscess evacuated; caries of orbital wall of anterior ethmoid cells; ethmoids and frontal sinus filled with pus; pus evacuated. Examination of pus from sinus revealed large Gram-negative bacilli. Patient did well for three weeks. Exophthalmos slowly receded. Discharged from hospital.

Subsequent History.-- Several days later profuse discharge from wound, with severe pain in head, starting from bridge of nose and extending over top to back of head. Temperature and pulse normal; forehead puffy and tender; no tenderness over wound, which was now almost entirely closed.

X-Ray Findings.-- Frontals, right post-operative, left, marked deficiency of illumination.

Second Operation.-- Left frontal sinus opened; found to contain pus; thoroly removed mucous membrane, followed by tight closure; right frontal sinus reopened; large area of osteomyelitis of frontal bone found, osteomyelitis extending into orbit, with necrosis of roof of orbit; small sequestra removed; dura beneath osteomyelitis covered by flattened granulations.

Following second operation patient did well for several days when he suddenly had an intense headache. Lumbar puncture; smear negative; culture negative; --no bacilli. Following day, acute delirium, deep coma and sudden death on the second day.

Supra dural abscess is often a complication of otitis, but it is to be noted that it doesn't present the focal symptoms present in abscess. There is usually a tendency to hold the head in a fixed position especially when the mastoid is involved, and the pain is usually referred over the top of the head as in this case of down the

back of the neck if the dura over the mastoid region is involved.

To illustrate a case of sinus thrombosis to show the difficulties in ruling it out in the diagnosis of brain abscess:

Sinus Thrombosis.-- R. B. Male. Chronic otitis media, left ear. Frequent attacks of pain and headache; chills. Admitted to hospital suffering from mastoiditis, left side. Mastoidectomy done. Sinus thrombosis discovered; jugular not ligated because of condition of patient; thought to be dying. Recurrence of symptoms.

Operation.-- Ten days after mastoid operation, ligation of jugular. On opening vein it was found to contain free pus for a distance of about three inches, running down below the clavicle. The pus was not in the fascia around the vein, but was in the vein itself.

Immediately after operation the man complained of dizziness. Ten days later chill; violent headache, repeated at regular intervals during the day. Patient gradually became violent from pain, which passed as suddenly as it came. Had two chills. Marked papilledema of both eyes. Labyrinth dead. Spontaneous deviation of both hands to the right. Fell to right. No spontaneous nystagmus. Slight area of anesthesia along third branch of trifacial. One attack of vomiting. Lumbar puncture revealed cloudy fluid under pressure; cell count 160; increased globulin.

Spontaneous deviation to right and falling to right, both away from lesion, pointed to involvement of cerebellum over posterior surface of petrous portion of temporal bone. This was also confirmed by cerebro-spinal fluid, which gave symptoms of protective meningitis.

Cerebellum exposed in front of sinus. Incision of dura thru sinus region; in front of this evacuated large amounts of cerebro-spinal fluid.

Diagnosis.-- Sinus thrombosis, serous meningitis. Uneventful recovery.

In cases of sinus thrombosis, even if there be the symptom complex illustrated in the above case, there is usually fullness and edema back of the ear in the mastoid and occipital regions. Tenderness over this area, especially over the mastoid foramen, is usually present. The jugular on that side is less full than its fellow, the difference is especially evident on efforts at inspiration. The thrombosis may extend into the internal jugular which is felt as a painful firm cord.

Our third differentiation concerns purulent meningitis, limited or diffuse. Weed (25) says that in all experimentally produced meningitis, only one brain abscess occurred -- this a superficial one -- showing that it is not the micro-organisms in the blood stream that cause a brain abscess -- there must be another factor added to this. This factor is undoubtedly thrombosis of a vessel, and the affinity of certain microorganisms for cerebral tissues.

To illustrate: Patient F. V. Male, entered hospital on October 3rd, with chief complaint of pain in left leg and groin, which caused inability to walk, sleeplessness and slight headache.

History.-- Present illness dates from a week before admission to the hospital, when he received a blow on the head -- in left parietal region. He was not unconscious and worked next day. The following day he felt better. Three days before admission he began to have severe pain in left thigh and groin. Past history negative.

Physical Examination.-- Patient did not look ill; head showed no evidence of injury; eyes, nose and ears, negative; Slight tenderness over left hip; knee jerks diminished; no paralysis or sensory changes. There were two eye-ground reports, one that the discs were indistinct, the other that they were negative; ~~X-Ray~~ for fracture of skull and enlargement of sella turcica both negative; for left hip injury, negative. Cell count, 18,000; polys, 76%; lymphocytes, 24%; temperature, 102°.

October 4--(Next day)--Lumbar puncture; spinal fluid clear, transparent, no nebula; globulin, negative; cell count, 3 per cmm. Another lumbar puncture was performed October 14, which showed marked bloody fluid, containing pus cells and numerous chains of streptococci.

October 15--Patient became delirious and remained so to the end.

October 24--Death.

Autopsy: Head.-- Brain covered by plastic, purulent meningitis, having a greenish-yellow look; also a slight encephalitis; sinus free and clear; no fracture to be seen.

Abdomen.-- Liver slightly enlarged; all organs in abdomen show acute cloudy swelling; inferior vena cava from level of fourth lumbar vertebra down, and extending into iliacs and femorals on both sides, was the seat of a purulent, septic thrombosis; at most central part of involvement was an organizing clot; there was an involvement of the tissues surrounding the vessels.

Chest.-- Acute, cloudy swelling of heart, and edema of lungs, with congestion of bases.

Probable cause of death.-- Suppurative meningitis (strep), with original focus a suppurative thrombophlebitis. Secondary or terminal lesions were acute, cloudy swelling of heart muscle, liver and spleen; pulmonary parenchymatous necrosis.

In nearly all cases of meningitis we can differentiate by the following points: An epidemic, retraction of the head altho this this is not always an early symptom, involvement of the cranial nerves on both sides. when the meningitis is circumscribed the diagnosis is particularly difficult. In the diffuse form the spinal fluid is rich in cells and bacteria. It is, however, rarely necessary to make this differentiation and few writers even discuss the possibilities of having to make the differentiation.

Cases of purulent meningio-encephalitis may give exactly

the same symptoms if the pia and cortex are involved. They are so often present together that exploration may settle the question. It is well to keep in mind that the "initial vague chill" indicates the beginning of an intradural suppurative process. This part of the history is obtained only by a systematic inquiry into the patient's history since it is often described rather as a "chilly feeling" rather than a chill definitely.

Dercum quoting Oppenheim (2) says that a non-suppurative localized encephalitis more often involves the frontal and central regions and corresponding symptoms appear, altho they are less definite. If it involves a temporal lobe it may simulate brain abscess in this region. However, the chill is usually evidence of suppuration and without it we may not say with certainty that an abscess is present.

Serous meningitis may result from otitis. In this instance however, the symptoms are those of a diffuse involvement while optic neuritis is usually an early and prominent symptom. The symptoms are rather mild both as regards temperature and physical signs. Cranial nerve involvement and other local signs may be present but they are not nearly so marked as in other forms of meningitis.

Brain abscess while it may run its course in a few days usually lasts for years. The patient may be slightly confused, a little depressed, but usually has lost weight and strength. The brain may become very tolerant to a large abscess. Hysteria has been the diagnosis when the patient is really suffering from a brain abscess. In ear disease which presents convulsions supervening, should be studied elaborately for possibility of abscess.

Percussion over the skull will often provoke a headache over an abscess. As a rule the headache is made worse by vomiting or muscular effort. The mental state is seldom entirely normal, it may be only slight or it may amount to stupor. Macewen says (18) with special emphasis that fever may be entirely wanting and that about a third of the cases have subnormal symptoms. "High fever occurs

only when the abscess has actually opened into the meninges or perhaps into the ventricles. Eagleton attaches the greatest diagnostic significance to the subnormal temperature and indeed most of the writers on the subject seem to agree with him.

Optic neuritis is not so frequent in brain abscess as in brain tumor. Oppenheim and Cassirer have estimated that papillary changes occur in only 53% of the cases. We must make a distinction between optic neuritis and choked disc; one results from toxicity of the abscess, the other from increased intracranial pressure. Lewandowsky quoting Okada found in 96 cases of cerebellar abscess, optic neuritis in 22 and choked disc in only 7. It is usually on one side in abscess. The spinal fluid being negative is also in favor of the lesion being an abscess.

Heiman collected 819 cases of brain abscess of which 645 were adaptable to statistical study. In these cases abscess was found 456 times in the cerebrum, 188 times in the cerebellum and once in the pons. It is 2 to 3 times more frequent in the male than in the female.

Neuman (10) gives figures from 12 foreign clinics on cerebral and cerebellar abscess. In the first group in 387 cases 237 died, a 61% mortality. Of 124 cerebellar abscesses, 109, or 88% died. In comparing these figures with those of Macewen who reported 80% recoveries, Neuman attributes the success to the difference in the material. Still one must not overlook the fact that perhaps Macewen was able to find more ease at early differentiation in his cases. Macewen operated upon selected material, excluding all abscesses combined with meningitis and sinus thrombosis, and he always operated personally. Again two other factors are important in Macewen's high percentage of recoveries. He often operated in two stages, waiting for adhesions to wall off the subarachnoid space, and he waited long enough for the adhesions.

Cairns (12) in speaking of the importance of making an exploration for abscess thru a clean wound, describes the following findings, following puncture which make the presence of abscess unlikely:

"1. Pus in the epidural space after a tiny incision in the dura excludes intercerebral abscess. It rather indicates purulent pachymeningitis.

"2. Abundant flow of cerebro-spinal fluid is against abscess since the cortex is usually flattened out over the cranium adjacent to the abscess or tumor.

"3. Examination of post mortem cases of temporo-sphenoidal lobe abscess shows that the temporal horn of the lateral ventricle is almost completely obliterated when there is an abscess in that lobe of the brain and if the ventricle is entered by the exploring needle, if more than one c.c. of fluid is obtained, it excludes abscess.

"4. Abscess is surrounded by a wide area of edema and if the tissue in the needle is not edematous (when it is examined when the needle is withdrawn) no abscess is likely."

We must not lose sight of the fact that trauma plays a role in the production of brain abscess and Coleman says that the mortality from abscess following gunshot wounds is particularly high. To illustrate the chronicity of some abscesses and how they follow trauma the following case is reported by Eagleton:

Chief Complaint.-- Headache, dizzy spells and defective vision of right eye.

History.-- Had skull fractured from explosion of stone three months previously. Speaks but little English.

Examination.-- Old wounds across forehead: Eyes: right cornea, dense scar across centre; Vision 10/70; left cornea, media and fundus normal; Vision 20/20. Ears: hearing,--right, whisper, 20 feet; left, whisper 10 feet. Bone conduction apparently shortened.

Rotation to right; past-pointing,--right arm, no past-pointing; left arm, past-pointing to left. Rotation to left; past-pointing,--right arm, past-pointing to right; left arm, no post-pointing. Rotation to right; nystagmus 24 seconds, falling normal. Rotation to left, nystagmus 20 seconds, falling normal. Examination unsatisfactory.

Three months later readmitted to the hospital.

Chief Complaint.-- Hiccough. States that "nothing bothers him." Headache; no dizziness. Has been unable to work well since accident.

Examination.-- Patient speaks but very little English, is very unintelligent, and at times appears drowsy. Hiccough at irregular intervals. Temperature and pulse normal. Reflexes normal; no paralysis or anesthesia; no aphasia. Eyes: Papilledema bilateral; edges of discs indistinct; veins tortuous. No hemorrhages.

X-Ray Examination.-- "Old fracture of frontal bone."

Following day hiccough disappeared. Following day vomited, seemed brighter. Suddenly chill followed by convulsions. Temperature suddenly elevated from normal to 105°. In deep coma. Lumbar puncture fluid turbid. Cell count 19,000. Streptococci. Death within a few hours.

Post-Mortem Examination.-- Leptomeningitis; abscess of brain of right frontal lobe, with very thin capsule surrounded by several areas of small secondary pus formation. Both frontal lobes degenerated; tip right frontal lobe forced into defect in posterior wall of right frontal sinus, result of old fracture. Mucous membrane of frontal sinus thickened.

Remarks.-- From post-mortem examination it would appear that the fracture extended thru the posterior wall of the frontal sinus, and was associated with injury to the frontal lobe and herniation of the brain into the frontal sinus. An infection of the mucous membrane of the sinus being now in direct contact with the brain, resulted in

the formation of the brain abscess and the development of a purulent leptomeningitis.

Benedict (19) speaking from the standpoint of the ophthalmologist says that the diagnosis of abscess of the brain is difficult even with ocular symptoms and signs, none of which is pathognomonic. He further says, "All the eye signs occur with other lesions of the brain, such as tumor of the brain, meningitis, and encephalitis. There are also to be considered extradural abscess, osteomyelitis of the skull and tumor of the dura with softening or haemorrhage; these are the conditions which may occur concomitant with disease of the sinuses and the mastoid and give rise to ocular signs similar to those which are the result of abscess of the brain; they complicate the diagnosis. Absence of any ocular signs makes the diagnosis of brain abscess less certain."

Neuman (10) in a study of 47 case histories of brain abscesses says that in cases of left sided brain abscesses, bacteria are found in the cerebro-spinal fluid twice as often as in cases of right-sided abscess. He further says, "We are inclined to diagnose brain abscess only when focal signs make themselves manifest. Aphasia is really a late symptom, we find. The capsule does not influence the extent of the abscess, for it may be broken thru and encephalitis may progress outside it. In spite of the uniformity of the pathologic findings the clinical picture does not seem to conform with them, but is influenced to a great extent by the surroundings of the abscess. All our patients with cerebellar abscesses complained about dizziness from the very beginning. Children seldom complain of dizziness, spontaneously. There is constant occipital headache in all these cerebellar cases. A cerebellar abscess affects the white matter very late, and at first tends to spread between the gray and white matter." This is along

the rather avascular area between the cortical and medulary circulation. It seems that the most valuable aid in a differential diagnosis is the exploratory puncture after sufficient signs have made themselves manifest to suspect the possibility of abscess.

It should also be remembered by way of prognosis that the question of a lasting cure is doubtful in many instances. The healing of an abscess cannot be looked upon as a permanent accomplishment, for brain abscesses have not sufficient tissue material to form a solid scar over a great defect in the brain substance, and consequently it is possible that one part of the resulting cavity heals as a solid mass, while, it is conceivable that another part may form a cyst which may sooner or later give rise to an abscess which must be considered as a recurrence.

The brain is richly endowed with connective tissue cells, in addition to its own supporting glia, and these cells are rapidly mobilized when any focus of infection occurs. That they are often successful in limiting the spread of infection is shown by Cairns (12) in the histological examination of the wall of the abscess, and by the not infrequent observation of cases in which an abscess is found to be completely surrounded by a dense fibrous capsule. He says, "In 12 of my 23 verified cases -- just over half -- the abscess had followed infection of the middle ear or nose. It cannot be emphasized too strongly that the temperature in a case of brain abscess that has not been operated upon, is usually subnormal!"

Often the offending organism is a gas former and several writers call attention to the fact that this small amount of gas will show on a skiagram, indicating the exact position of the abscess. Its frequency is shown by the fact that often on puncturing an abscess cavity there is a little puff of foul smelling gas before the pus comes thru the needle.

In consequence it can be seen, I think, that the diagnosis of brain abscess, regardless of location, is usually something of a problem. The patient should have the advantage of early use of every diagnostic procedure available. The frequency with which bizarre symptoms are presented is frequently cited in the literature and no writer attempts to give a set of clearly defined symptoms which is applicable to every case. Any suspected case must go thru the differential diagnosis above outlined before an abscess can be said to be probable. If, after this the probability points toward abscess, every patient, if not too moribund, should have the additional advantage of an exploration within the skull since this seems to be the only method of exactly diagnosing the presence of abscess. The advantage of a preliminary skiagram cannot be overlooked, and while it cannot be said to be final evidence in every case, its value is great often enough to make it routine in every suspected case.

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