peared "like a tennis-ball floating in a sea of pus." Wagner (*loc. cit.*) gives two cases of abscess, arising seven and nine years respectively after falls, without any external wound; and Souques reports one of abscess arising eleven years after a fracture of the skull.

If the injury is followed by meningitis, this will usually develop within three or four days; but should it result in abscess rather than in meningitis, it will not usually form earlier than at the end of the first week. The situation of an abscess after a blow or fall is almost invariably under the site of the injury, but, as is shown by Macewen's earliest case, Harrisson's, and others, the location of the abscess must be fixed by considering not only the site of the injury, but the focal symptoms as shown by cerebral localization—*e.g.*, in Macewen's case the abscess was in Broca's lobe, but the cicatrix was on the forehead.

Still another occasional cause is localized meningitis. Of this, perhaps the most instructive case yet recorded is that found in the very able paper of Mr. A. E. Barker, in which the pus, accumulating undoubtedly between the island of Reil and the operculum, produced upward pressure on the motor centres for the face and arm. Complete recovery followed the operation.

Metastatic abscess occurs not infrequently in the brain as a result of various conditions, even in distant organs, such as gangrene of the lung, fetid bronchitis, and bronchiectasis. Tuberculous abscesses also are sometimes seen, but in both these cases the abscesses are usually multiple, and hold out but little hope for any successful surgical treatment. Wernicke and Hahn and Fränkel have reported two cases of tuberculous abscess which were single.

Symptoms.—The symptoms of cerebral abscess may be arranged in three categories: 1, those due to the suppurative process itself; 2, symptoms arising from general pressure; 3, focal symptoms.

1. Among the symptoms arising from the suppurative process itself, usually the most important is fever, and it is especially noteworthy that in intracranial abscess the temperature is either *normal* or *subnormal* most of the time, even when the gravest general symptoms exist. The temperature, however, does sometimes rise, especially toward the end, and is often attended by delirium, but will generally subside quickly, only to rise again after an interval if the patient survive long enough. Von Bergmann and others state, however, that the local cranial temperature in abscess will rise. If, therefore, symptoms of serious intracranial pressure exist, if the general temperature is normal or subnormal, while the local temperature shows a rise and the pulse is slow, the first thought of the surgeon should be to seek for evidence of abscess of the brain. A chill not uncommonly occurs, but may be absent. Of course there will be loss of appetite, vomiting, general malaise, etc. Somerville has stated that when pus is present in the brain, the chlorides in the urine will be below the norm and the phosphates above; but I know of no confirmatory examinations of this important assertion.

2. Among the pressure symptoms, headache holds an important place. It is almost invariably present, and not uncommonly of an extreme and severe type, so that the patient will constantly moan; and if he be sufficiently intelligent, this will be the one thing of which he will complain. It is apt to become worse, and when the temperature occasionally rises it is often located distinctly at the focus of the lesion, but sometimes is general. It does not, therefore, always serve as a guide to the situation of the abscess. The pulse is almost always slow, and may even fall to thirty or forty in the minute. Respiration is often of the Cheyne-Stokes type. The mental condition is very soon impaired, and gradually, as the pressure increases, becomes worse and worse until the patient may become comatose. Not seldom the bowels and bladder will be evacuated involuntarily. Convulsions of an epileptic type often occur, but not usually when the abscess is situated in the temporo-sphenoidal lobe. Sometimes convulsions will be the very first acute symptom. Muscular twitchings may occur, and if so, their occurrence will often point to the cortical centre involved. Sensation is not usually much impaired.

The presence or absence of choked disc does not seem to be pathognomonic, as it is sometimes present and sometimes absent. When present, even if bilateral, it is almost always more marked on the side of the lesion, though this is sometimes reversed. Not uncommonly there will be ptosis, and sometimes paralysis of the entire third nerve, while the sixth may escape; though sometimes the reverse is the case. The pupil of the same side is generally dilated, and more or less immobile. Almost all the symptoms of pressure vary from time to time, and the patient's general condition fluctuates in a remarkable degree, sometimes simulating recovery, soon to relapse again into a worse state than before. Theoretically, there should probably be deafness of the opposite ear if the first or second temporal convolution is involved; but this symptom is very uncertain.

When the abscess is situated in the cerebellum, the diagnosis is apt to be very obscure. Occipital headache and rigidity of the neck muscles often exist. Inco-ordination of movement, and especially an unsteady, drunken gait, indicates pressure upon the middle lobe. Vomiting and vertigo are frequent and persistent. If these symptoms exist with tenderness on pressure and pain on percussion over the cerebellum, they may point definitely to the cerebellum. Optic neuritis is not frequent in cerebellar abscess. But here, above all other localities, the remark of von Bergmann eminently applies: "The technique of the evacuation of brain abscess no longer deters us from operating. All progress in treatment must depend chiefly upon diagnosis." It is, therefore, especially important that all cases of brain abscess should be observed and reported with the minutest and most exact detail, especially if there is any suspicion of the cerebellum being involved, in order that we may learn how to make a more exact diagnosis.

At present the condition of the reflexes is not known with sufficient accuracy to be of much value in diagnosis, though they are probably increased on the side of the lesion. Their study is therefore all the more important, not only in abscess, but in all other cranial lesions.

3. The symptoms by which the locality of an abscess may be inferred are chiefly those which are so admirably described in general by Dr. M. Allen Starr, in his article on *Brain Diseases: Diagnosis of Local Lesions*, in the present volume. I need, therefore, only briefly recall a few leading facts. The left temporo-sphenoidal lobe being adjacent to Broca's convolution, a very common result of abscess in this lobe would be motor aphasia. If the abscess is of such size as to press upon the inferior centres of the motor region, paralysis or paresis of the opposite side of the face would probably be first induced, followed by paralysis of the arm, and occasionally even by complete hemiplegia of the opposite side. If the ear disease has implicated the seventh nerve in its passage from the petrous bone, there will be, of course, palsy of the same side of the face. Sometimes there will be a distinct squint from paralysis of the sixth nerve. Especially are all localizing symptoms valuable in those cases, which are not altogether rare, in which there is a suppurative discharge from *both* ears.

Mr. Barker has suggested that at the operation the mastoid foramen, through which passes a small vein to the lateral sinus, should be laid bare and an examination for pus be made. Should pus be found exuding from this foramen, it would certainly be a most valuable sign; but thus far I do not know that its examination has proved to be of positive value. The foramen (Figs. 1026 and 1027, *i*) lies one and one-fourth inches behind, and about one-fourth inch below, the external meatus, at the base of the mastoid process.

Should the abscess exist in the frontal lobe, as is sometimes the case from nasal disease, but little information can be derived from localizing symptoms, this lobe being a "latent" region. In the occipital lobe the same is

true, unless the cuneus is involved, when hemianopsia on the same side of each retina would certainly follow. Should the angular or supramarginal gyrus be involved in the lesion, the state of the pupil may possibly give valuable information. In the *American Journal of the Medical Sciences* for October, 1888, pp. 349 and 355, Dr. Oliver has described a species of monocular Argyll-Robertson pupil, which seems to promise to be of value in lesions of this region.

The temperature of the two sides of the head should always be carefully taken, and in doing so it should be remembered that the left side is normally hotter than the right (Gray and Seguin, *Arch. of Med.*, December, 1879). Should abnormal variation of the local temperature be observed, it would be a valuable indication, but one that as yet is not sufficient to localize an abscess with absolute certainty.

Percussion and pressure on the head are also valuable, but alone are not to be relied on absolutely. Taken with other symptoms, they may assist materially in the localization of an abscess. Hulke records an instance of a tender spot above the ear in a case of abscess in the cerebellum; and another of a tender spot over the occiput with an abscess in the temporo-sphenoidal lobe. Pain on *percussion*, but *not spontaneously complained of*, in the opinion of Ferrier, is of greater value than mere tenderness on pressure. Pressure and percussion are of value, in many cases, in diagnosticating cerebellar abscess from cerebral. Should the abscess, as occasionally happens, be extra-dural, its locality would almost certainly be indicated by œdema of the overlying scalp. This, therefore, should always be looked for.

Differential Diagnosis.—First, *meningitis:* This is often a very difficult differential diagnosis. In meningitis there will usually be delirium, delusions, photophobia, contraction of the pupils, convulsive facial twitchings, high general temperature, and marked rigidity of the neck muscles, all developing rapidly after an injury or from disease of the ear, or in a strumous patient.

Secondly, *mastoid disease*, following purulent otitis media, sometimes gives rise to serious cerebral disturbance. Trephining the mastoid—which in nearly all cases of cerebral abscess, at least from ear disease, will precede the opening of the skull—will, in general, quickly differentiate this from intracranial abscess. As a rule, the mastoid region will be swollen, œdematous, and painful; in other words, will present the usual evidences of mastoid disease. For the diagnosis from extra-dural abscess arising from mastoid disease, see page 415.

Thirdly, *thrombosis of the lateral sinuses and pyæmia* would most likely involve the internal jugular vein, into which, most probably, the thrombus would extend. It would be hard, cord-like, and painful, and the veins of the face would almost certainly be turgid and swollen. Besides this, very probably, there would be general symptoms of pyæmia, such as involvement of the joints, lungs, liver, etc. The temperature also would never, as in abscess, be near or below the normal, but of the pyæmic or "pump-handle" type. There would almost certainly be rigors, profuse sweating, and great general prostration, without such marked dulling of the intellect as exists in abscess.

Fourthly, *tumor*. While in most cases the diagnosis between abscess and tumor can be pretty clearly made, yet, in not a few cases, the diagnosis is difficult and sometimes impossible. Usually the development of a tumor is very slow, and is attended with distinct focal symptoms from the time when its existence is first manifested. While the development of abscess may be deferred in its outbreak, yet once started, it usually runs a much more rapid course than a tumor. Moreover, abscess has usually some evident cause, as either injury, aural or nasal disease, etc. Tumor sometimes develops as a result of injury, but more commonly without. In tumor the optic neuritis is almost always double, and usually more intense than in the case of abscess. In abscess, also, choked disc is much rarer, and if present, it is not rarely unilateral instead of bilateral, and may be on the side opposite to the abscess rather than on the same side (Ferrier and Horsley's, Barker and Gowers' cases).

While tumor sometimes exists in the temporo-sphenoidal lobe or in the cerebellum, yet abscess is far more common in these situations. In other parts of the brain tumor is far more common than abscess. If syphilis exist as a cause, it is far more likely to give rise to tumor than to abscess. The temperature is not apt to rise in either case. Rapid and sharp fluctuations in the general condition of the patient would be more suggestive of abscess than of tumor; slow fluctuations are more common in tumor. Emaciation without sufficient cause sometimes attends abscess.

Surgical Treatment.—The almost uniform mortality that attends abscess of the brain, if not relieved, renders any means that holds out a reasonable prospect of relief a necessity. Very many such cases of abscess have been operated upon successfully by trephining, even so long ago as when Dupuytren and others boldly punctured the brain. So early as August, 1849, Detmold even punctured the ventricle itself and evacuated an abscess, and Dr. George R. Morehouse, of Philadelphia, informs me that he did the same during the Civil War. All this was done with boldness, it is true, but we must also add that in the majority of cases it was rather the result of happy chance than of scientific precision.

The operation has entered upon an entirely new career since the establishment of the doctrines of cerebral localization. Abscesses in the brain, in the last few years, have been frequently and accurately localized, and successfully operated upon, by a large number of surgeons.

When abscess from ear disease is suspected, the mastoid should in most cases first be trephined and carefully washed out. Should this operation not give relief, then we must proceed further and trephine the skull. But before this is done, the ear and the mastoid should be most carefully cleansed with a borated solution and filled with powdered boric acid, in order to prevent any possible infection of the brain. The head should be shaved, certainly over a *large* area, or better, entirely, and the scalp cleaned and disinfected in accordance with the method already described.

The question as to where the trephining shall be done is an important point. As already related, even in case of abscesses arising from injury, the scar is not always over the point at which the abscess exists. It must be located by cerebral localization quite as much as by the site of the external lesions. Moreover, tenderness on pressure is not always a reliable indication of the site at which the trephining should be done, though tenderness on percussion is a more reliable sign.

In order to attack an abscess in the temporo-sphenoidal lobe two points are advocated. Mr. Caird, who operated on Greenfield's case, applied the centre pin of the trephine one inch and a quarter behind the external angular process, and nearly one inch above the zygoma. This seems to me a very undesirable point, because it would generally strike the middle meningeal artery at, or just below, the antero-inferior angle of the parietal bone, where the artery not infrequently passes through a bony canal, and might give rise to hemorrhage which at least would be troublesome.

A point three-fourths of an inch in front of the meatus and an inch and a half above Reid's "base line" was the spot I selected in a case of trephining for supposed cerebral abscess, for reasons there given. It is better than Mr. Caird's, I think, as it avoids the artery and even its posterior branch, and gives access to the temporo-sphenoidal lobe at about its middle; but the danger of wounding the middle cerebral artery, if the brain is incised or punctured, is possibly even a more serious objection. In certain other cases in which the symptoms seem clearly to point to such a location, this point might, however, be selected with advantage.

In the majority of cases, however, I should agree with Mr. Barker that the best place for trephining is one inch and a quarter behind the external auditory meatus,

and the same distance above Reid's "base line" (Figs. 1026, *c*, and 1027). This is just above and behind the junction of the petrous with the remaining portions of the temporal bone. Even in children the distance above Reid's "base line" should be the same, I find, for at a lower point the upper border of the petrous bone would

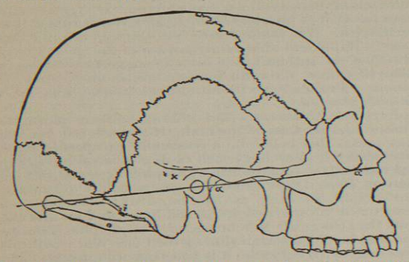

FIG. 1026.—From a Photograph of a Dissection of the Skull Before Exposing the Brain. *a, a*, Reid's "base line," running from the lower border of the orbit through the centre of the auditory meatus; *c*, the exact point at which the pin of the trephine was applied to open the cerebral abscess, just behind the squamosal suture; *x*, the point at which the mastoid antrum was opened; *i*, the foramen for the mastoid vein; *o*, on the point below the inferior curved line at which the cerebellum should be explored if abscess arises in it. (Barker.)

greatly and suddenly thicken the inferior edge of the button of bone and might give some trouble in its removal. A director thrust downward, forward, and inward in the direction of the opposite ala of the nose would pass through the axis of the temporo-sphenoidal lobe, and be almost certain to strike an abscess of any size. Should it fail to do so, punctures may be made in various other allied directions, in order to reach possible small abscesses. As pointed out later, this same trephine opening can also be utilized for tapping the lateral ventricles, if necessary.

In the report of the operation above alluded to, I have shown that repeated punctures may be made with a grooved director or hypodermic needle without any serious damage to the brain substance. I have there stated at some length my reasons for preferring the grooved director to either the knife or needle for *exploration* alone. A needle sucks up healthy brain tissue, even when the suction power does not exceed seven to ten minims, and the danger of wounding the vessel is not an imaginary one. With the director we feel much more safe, and will, therefore, be proportionally bolder and more thorough in our explorations. Such boldness and thoroughness, combined with safety, will often result in success, when timidity from possible danger would result in failure. In a recent case I punctured the frontal lobe four times with a director, and to the depth of two and one-half inches, without any evil symptoms as a result. Rivington, in 1881, was, I believe, the first to use the director boldly in this manner. He thrust it two inches into the brain. The remarkable paper of Spitzka shows how freely we may puncture the brain without evil result. In many cases no trace of the puncture could be found, and where it existed there was only usually a trace of blood. Even the filthiest mud was injected into animals' brains, with but little damage as a rule.

For *incision*, however, as distinguished from *exploration*, the *knife* is certainly to be preferred. As soon, therefore, as the abscess cavity is reached the knife should be used, and then a pair of hæmostatic forceps be introduced, closed, and drawn out expanded to a reasonable degree, in order to afford free vent for the pus. Should the wall of the abscess cavity be lined with granulation tissue, it should be removed by the sharp spoon or otherwise, just as in case of an abscess in other parts of the body, care being taken not to encroach on any important neighboring centre or vessel. The abscess cavity may now be very gently washed out with normal salt solution, and a rubber drainage tube then be inserted. This should be passed through a good-sized buttonhole opening in the flap, and secured to the scalp by a long silk thread tied in a bow knot. The bone should not be replaced. If the first trephine opening does not afford good drainage a second should always be made in the proper place. An ample dressing should then be applied. The drainage tube should be kept in place, but gradually shortened until the discharge has diminished to such an extent that it is safe to remove it. The silk thread may be untied, secured to the tube, and retied at will. Even with the greatest care it will happen every now and then that the wound, after apparent healing, will have to be reopened to give vent to a reaccumulation of pus, as in a number of cases already reported. Thus McCutcheon trephined his patient five times for as many different objects: (1) after the accident; (2) for compression; (3) for epilepsy; (4) for atrocious headaches; (5) for necrosed bone; each operation being followed by benefit, and the final one by recovery. Fenger and Lee operated three times, Rivington operated four times, and Schede operated five times. All of these cases recovered. In Westmoreland's case the blow was received in 1879, and repeated attacks of suppuration occurred in 1881, 1883, and 1886. In each case reopening the wound and redraining resulted in recovery.

Of course, if a fistula be discovered, even a small one, as in the case reported by Truckenbrodt, and operated on by Schede, the trephine opening would be made at the site of the fistula rather than at any of the points above described, and would lead to the abscess. Weir has suggested the injection of an aniline solution to discover the route and extent of the sinus.

If the abscess is in the cerebellum the proper place to trephine is well below the superior curved line, so as to avoid the lateral sinus, the centre pin being placed midway between the tip of the mastoid process and the inion. A three-quarter-inch trephine or the chisel or a gouge should be used. It must be remembered that the skull is quite thin and easily penetrated at this point. The opening can be enlarged later if necessary.

The flap in the dura should have its base upward. Of course, the occipital artery will have to be ligated. As

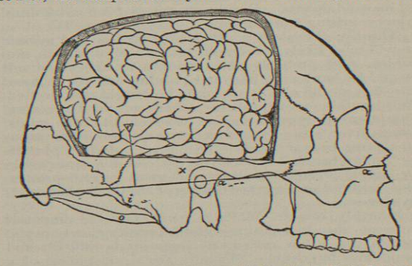

FIG. 1027.—Photographed from the Same Skull, with the Brain Exposed *in situ*. The lettering is the same as in Fig. 1026. The point at which the opening was made in the central cortex (*c*) is observed to lie on the posterior part of the second temporo-sphenoidal convolution. (Barker.)

pointed out by Weir, "with the use of a spatula to lift it up slightly, the cerebellum can, if necessary, be viewed with an electric light nearly to the foramen magnum." With a grooved director or other appropriate means, the cerebellum can now be punctured and the abscess evacuated in a favorable position for drainage. Even should the abscess be upon the opposite side of the cerebellum,

it would be easy, as I have shown, to reach it obliquely through such an opening. In making any puncture, however, care should be taken not to injure the superior vermiform process. A drainage tube should be used and the abscess treated as before described.

If an abscess exists in any other place than in the temporo-sphenoidal lobe or in the cerebellum, the trephining should be done immediately over the site, as determined by cerebral localization, and the cavity treated as above described.

Should no abscess be found at the first trephine opening, and there be a possibility of its existence at another point, there is no objection to a second trephine opening, and even a third, should the necessity arise. The danger from an additional trephining is so slight, and the danger from abscess, if it exist, so great, that we should seek for it at a second or even a third point, if not found at the first. It is, however, scarcely necessary to add that this additional trephining should not be done without good and sufficient reasons. In such cases, when the abscess is found to be encysted and encapsulated by a thick membrane, the membrane should, of course, be removed, as was done by Bergmann.

EXTRA-DURAL ABSCESSES.—Besides the abscesses in the substance of the brain, another variety exists that it is very important to recognize: that is, an abscess between the dura and the bones of the skull. These almost always arise from ear disease by involvement of the bone and subsequent pachymeningitis externa followed by suppuration. The pus may accumulate in an abscess, or may be diffused between the dura and the skull.

Symptoms and Diagnosis.—They cannot be distinguished from cerebral abscesses proper, or from leptomeningitis or thrombosis of the lateral sinus, by the eye symptoms or headache, but other means may enable us to do so. The temperature, in marked contrast to cerebral abscess, will rise to 102°–104° F. The pain in extra-dural abscess is usually fixed either above or behind the ear, and is increased by percussion or by pressure. The mastoid, of course, will be involved, but the tenderness on pressure or percussion will extend both farther back and higher up than the mastoid. Usually there will be œdema of the overlying scalp. If the mastoid has already been opened and no improvement has followed, and no marked symptoms of the other cerebral diseases mentioned above be present—such as the pronounced cerebral irritative lesions of leptomeningitis, the localizing or focal symptoms and low temperature of cerebral abscess, or those of thrombosis of the internal jugular, and other signs of pyæmia in plugging of the lateral sinus—we should suspect extra-dural abscess. Pressure symptoms are rarely seen in extra-dural abscess, especially if it arise from aural trouble. If evidence exist of caries of the bone, extra-dural abscess should be suspected, and especially if the pus well up through such a sinus and show any pulsation communicated from the brain. Not seldom a sequestrum or carious bone will be found.

Treatment.—The ordinary operation for trephining the mastoid will usually have been done for the earlier symptoms. If not, it should be done at once, and further operative interference be carried out, if so indicated. If the operation be limited to opening of the mastoid, and this does not speedily bring relief, the skull itself should be opened either by the trephine or by the rongeur forceps. The probe or escaping pus will indicate to us any fistula, and this must be followed up till the carious or necrosed bone is discovered and the dura laid bare. This last can usually easily be recognized by its texture, its relation to the bone, and its pulsation. Should the lateral sinus be exposed, care must be taken not to wound it. Should a thrombus exist, it must be treated as indicated under that heading later. That recovery may take place after thrombosis of the sinus and without interfering with it, is shown by a case of Hoffmann. The abscess cavity having been reached, it should be cleaned out, the granulations from its walls removed, and free drainage provided, all carious or necrosed bone having, of course, been first removed. Unless such efficient operative measures be taken, the case is almost sure to prove fatal. Hoffmann, whose paper (*loc. cit.*) is the best study of the subject I have found, gives a ghastly table of 102 fatal cases in which the diagnosis was established by a post-mortem examination, and its impressive lesson is but reinforced by the 10 additional cases diagnosticated during life. Four of these were observed by others, of which 3 recovered after operation; 6 are reported by himself, of which 5 recovered after operation, one dying six weeks later from bronchitis. No other commentary as to the absolute necessity for an operation can be needed. The causes of death were mostly meningitis, cerebral abscess, and pyæmia, with, and probably from, thrombosis of the lateral sinus.

PYÆMIA AND THROMBOSIS OF THE CEREBRAL SINUSES.—Under the title *Ear: Intracranial Complications*, etc., in Volume III. of the present work, Dr. Orne Green considers this matter very much more fully, especially from the point of view of the otologist. A few words, however, ought to be said about it from the view of the general surgeon. This is all the more true, because nearly all the cases until within the last few years have passed unrecognized and unoperated on, while the results of operation have been extraordinarily good.

In a table which I published in Ashhurst's "International Encyclopædia of Surgery," (supplementary volume), I collected 84 cases, of which 56 recovered—66.7 per cent. Since that time a large number of cases have been reported, but no later complete tabulation to my knowledge has been made. I have no doubt that a considerably larger percentage of recoveries would be shown in the later cases.

The cause of the thrombus may be infected fractures, erysipelas, decayed teeth, etc., but by far the larger proportion of the cases arise from chronic otitis media. The thrombus, being an infected one, gives rise to a pyæmia with all of its ordinary symptoms. The infected clot softens and suppurates. Very frequently it extends into the jugular vein, whence fragments of it will eventually reach the lungs unless the progress of the disease is stayed. While the thrombus takes place in the vast majority of cases in the sigmoid portion of the lateral sinus (the curved portion of the sinus occupying the groove in the mastoid portion of the temporal bone), yet there are a fair number of instances reported in which the superior longitudinal sinus, the cavernous and other cerebral sinuses have been involved. The symptoms will be detailed fully in Dr. Green's article.

The only treatment to be considered for a moment is the surgical, and this must be prompt and thorough in order to be effective. The mastoid operation, if not already done, should immediately be carried out. If the internal jugular is involved, this should be exposed in the neck and tied below the thrombus, in order to prevent infection of the lungs. Ordinarily this thrombus can be readily recognized by touch, but sometimes, as in one of my own cases, the vein is so completely destroyed by suppuration that it is difficult to recognize it. Next, the sigmoid sinus should be exposed and deliberately opened. It should be cleaned as far as the clot extends; if need be, even to the torcular Herophili. If serious hemorrhage occurs, it can readily be controlled by plugging with strips of iodoform gauze. The vein and the sinus should be washed out both from above and from below. The petrosal and the cavernous sinuses cannot be reached by surgical operation.

Up to the present time, the symptoms of thrombosis of the superior longitudinal sinus have not been sufficiently clear to enable the surgeon to make a positive diagnosis of the location of the disease. Whenever we can do this, a similar operation to that on the sigmoid sinus should be done.

INTRACRANIAL TUMORS.—The *causes* of intracranial growths are various, but in the majority of cases the cause can scarcely be ascertained. Injury occasionally plays an important rôle, but much more frequently they arise without any apparent local cause. The statistics

of Hale White, and Bernhart, quoted by Seguin and Weir, give a sufficient number of cases from which to draw a reasonably correct conclusion. They number 580, and are as follows:

	Number.	Per cent.
Nature of tumor not stated	133	22.9
Tuberculous tumors	137	23.0
Gliomata	76	13.0
Sarcomata (including cysto-sarcoma)	75	13.0
Hydatids, cysticerci, and echinococci	30	5.0
Cysts	27	4.6
Carcinomata	24	4.0
Gummata	21	3.6
Glio-sarcomata	14	2.2
Myxomata (including myxo-sarcomata)	12	2.0
Osteomata	6	1.0+
Neuromata	4	—1.0
Psammomata	4	—1.0
Papillomata	4	—1.0
Fibromata	3	
Cholesteatomata	3	
Lipomata	3	
Erectile or vascular tumors	2	
Dermoid cysts	2	
Enchondromata	1	
Lymphomata	1	
Cases	580	

This shows that tuberculosis is nearly twice as common as any other one known cause. Tuberculous tumors are most frequent in early life, three-fourths of them occurring before twenty, and one-half before ten, years of age (Gowers). The various forms of malignant tumors exceed in number even those which are of a tuberculous nature. They are most common from twenty to forty. Other varieties, excepting hydatids and cysts, furnish each but a small number. The small percentage of syphilitic gummata is rather surprising. Dr. Gowers states that of 637 intracranial tumors the distribution was as follows: Cerebral hemispheres (excluding the central ganglia), 297; cerebellum, 179; pons, 59; central ganglia, 48; medulla, 31; corpora quadrigemina, 13; crura cerebri, 10. Starr, in a valuable paper on 300 cases of intracranial tumors in children, found 96 in the cerebellum.

The *Symptoms* have been so carefully studied and so fully treated by Dr. Mary Putnam-Jacobi, in the present volume of this HANDBOOK (article on *Brain, Tumors of*), and by Dr. M. Allen Starr, in his article on *Brain: Diagnosis of Local Lesions* (see p. 282), that it would be but a repetition here for me to consider them. Three points, however, ought to be more fully noticed, viz., disturbance of language, eye symptoms, and local temperatures.

A most important paper in connection with disturbance of language is that by Dr. M. Allen Starr. Words in ordinary use have a complex mental substratum, made up of a number of mental pictures. These are, first, memory of the sound of a word as spoken; if this be lost we have "word deafness." Second, memory of the appearance of a word as printed or written, if this be lost we have "word blindness." Third, memory of the muscular movements made in writing a word; if this be lost the result is "agraphia," or inability to write. Fourth, memory of the muscular movements made in pronouncing a word; if this be lost, although the vocal apparatus is perfect, it is known as "motor aphasia." Fifth, the word-hearing and word-uttering processes may be perfect, and the patient can understand what is said to him, and can pronounce words well, but the connection between the word-hearing and the word-uttering processes is broken, and the patient misplaces words or uses one word for another—for instance, calling the "four of spades" the "five of telephone." This is known as "paraphasia," or the aphasia of conduction of Wernicke. The lesion in these cases usually involves the island of Reil, and severs the fibres beneath it, the great association tract joining the temporal and frontal lobes with one another. Sixth, the mind may not recognize the use, odor, color, taste, etc., of any object presented to it. This general symptom is termed "apraxia." It has, of necessity, as many varieties as there are avenues by which the mind may be reached; for instance, by sight, smell, taste, hearing (not only hearing for language, but also for music), either of which may be lost separately, thus producing "mind blindness," "mind deafness," etc. The patient, however, though unable to recognize any object when *seen*, may be able to do so when *felt*. These symptoms (according to Starr) are found only when the lesion is in the left hemisphere in a right-handed person, and in the right hemisphere in a left-handed person. Hence, in examining an aphasic thoroughly, Starr states that it is necessary to test, first, the power to recall the spoken or written name of an object, seen, heard, handled, tasted, or smelled. Second, the power to understand speech, and also music. Third, the power to understand printed or written words. Fourth, the power to speak voluntarily. Does he talk clearly? Does he mispronounce words or talk jargon? Fifth, the power to repeat words when dictated. Sixth, the power to read aloud. Does he understand what he reads? Seventh, the power to write voluntarily. Can he read what he has written? Eighth, the power to write at dictation. Ninth, the power to copy. Tenth, the power to recognize the use of objects seen, felt, heard, tasted, or smelled. One illustration, and only one, so far as I know, exists of the diagnosis of a lesion by the existence of "mind blindness," and this was followed by a brilliant and successful treatment. This is recorded by Macewen, and is briefly quoted on page 425 of this article.

When it is remembered that the second, the third, the fourth, and the sixth nerves, in their entirety, are solely intended for innervation and specializing function of the organ of vision, it will be readily understood how important this apparatus becomes as an index of intracranial disturbance.

The methods may be briefly given in a series of short captions, as follows:

1. Always, if possible, get *central vision* in each eye separately, not only for form but for color, as this practically gives the physiological power of the most highly evolutionized fibres of each retina. To do this, cards of known sizes of types or symbols, and graded areas of definite colors, such as green, red, rose, blue, and yellow, should be placed at certain distances in good light, and the results compared with the normal standards for such distances. Should the patient be unable to designate types, symbols, or colors, then keys, coins, etc., of the same size as certain test letters can be held at the related distances, or less if necessary, and attempts made for similar selection among duplicates held in the lap.

2. *Power and range of accommodation* should be tried separately and combinedly for the smallest type visible, with or without helping lenses, at the nearest, furthest, and best points possible. Retinoscopy may be useful in quite a number of cases. Tonic and clonic spasm must be sought for.

3. *Visual fields* must be most carefully studied in reference to comparative sizes and areas for white, yellow, blue, red, and green; blind spots and points of feeble color saturation must also be diligently sought for and noted.

4. More complete study of *central color perception* should now be made with graded intensities of Holmgren's wools, and the results should be recorded upon suitable blanks.

5. The *pupils* should be examined and re-examined separately and in associated action, until definite answers can be given as to their comparative sizes and shapes.

6. Careful attention must be paid to monocular and binocular *action of the irides* to light stimulus thrown from all parts of the visual field; to associated action with the ciliary muscles, as in accommodative efforts; and to the combined and associated action with the ciliary muscles and internal recti muscles, as in convergence, and these tests must be repeated over and over until unequivocal results are obtained. Spasmodic action of the irides must be carefully looked for.

7. *Extra-ocular muscle balance*, when the organs are in a state of rest, should be obtained as correctly as possible.

8. Combined and disassociated *action of the attached extra-ocular muscles* in convergence, conjugate deviation, extreme separate and combined excursions in all directions, must be gone over with special study of the varying degrees of change from the slightest loss of innervation up to total paralysis. Search for clonic and tonic spasms should also be carefully made.

9. Combined and associated *action of the muscular apparatus of the ocular appendages* should now follow, in reference both to paretic and to spasmodic changes.

10. *Sensibility of the entire ocular superficies*, both to touch and pain, should be studied.

11. In cases in which a difference of temperatures is suspected, *comparative surface thermometry* should be made, although it is really best not to omit it in any instance.

12. Accurate *ophthalmoscopic study* of the media and the fundus of each eye should be repeatedly made, until adequate data as to the comparative condition of the two organs are correctly obtained.

Having thus obtained this grouping of ocular conditions in association with the history and concomitant symptoms, determinations can often be made of sufficient accuracy to point out at least not only the probable character of the lesion, but even its possible situation. Negative signs may oftentimes prove themselves of great value in the diagnosis of the position of the supposed growth; and no case can be said to be complete and ready for surgical procedure until all the ocular changes have been properly and carefully studied.

For the purposes of help in differential diagnosis the few following general observations may be of use:

Optic neuritis is very usual in some stage of intracranial tumor, and indicates more rapid progress of the growth. It is of no definite value in the diagnosis of the position, the character, and the size of the mass.

If the so-called monocular type be met with in such cases, the neoplasm is most probably situated in the opposite hemisphere; and should the neuritis be double (*which is most probably always the case*), it is almost certain that the side of the lesser optic nerve swelling is the one in which to look for the growth. The occurrence of this symptom is less frequent in abscess, and may be more ordinarily found upon the same side as that of the lesion than in tumor. It seldom occurs, if at all, in cortical lesions with irritative symptoms.

Primary optic-nerve atrophy with or without retinal change, as shown by the ophthalmoscope, is generally found in connection with basilar disease or trunkal inflammation, from trauma, new growths, general dyscrasia, and the introduction of toxic agents into the system. In epilepsy it is seldom decidedly marked, being usually found in its incipient form, and seemingly dependent upon the number and severity of the seizures. It is not apt to occur in abscess, except in those rare cases of the encysted and slowly growing varieties.

Weakening of any single muscle or any group of muscles generally indicates either pressure from a coarse lesion, external to any portion of the related outgoing fibres, or true infiltration of pathogenic material into the neural meshes themselves. Unassociated with other symptoms it is of little value in questions of the position of the lesion, and must be used in conjunction with other data to be of any determining use. Being, however, more of a fixed quantity than muscle irritation, it is of greater importance in such instances than the latter, as it better shows the probable position of the lesion. Localized spasm in itself is probably more apt to be caused by lesions in the motor zones and in the centres devoted to the action of the involved group or groups of muscles. It thus often offers itself of special diagnostic value in the localization of the initial point of the epileptic spasm.

In acute and subacute meningitis, irritative symptoms of both motor and sensory varieties appear, whereas in the chronic form degenerative changes are more prone to occur.

Hemianopsia is of paramount importance, more so than aphasia and agraphia. Each variety, carefully considered in conjunction with ophthalmoscopic study, experiments with pupillary responses, and other motor and sensory disturbances, can hardly fail to serve as most important data for indicating the probable situation of the lesion.

It must be remembered, however, that each ocular symptom in itself is not etiologically self-answerable. Careful study must be made of all the conditions, so that, by the process of exclusion, adequate data can be obtained upon which to base answers as to the character, the type, and the situation of the supposed intracranial lesion.

Surface Temperature of the Head.—Mills and Lloyd, in Pepper's "System of Medicine," vol. v., p. 1036, have given the record of four cases of tumor of the cerebrum and one of the cerebellum. Seguin and Weir (*loc. cit.*) have recorded the temperatures in their case, and I have done the same in the case of tumor in my first paper already referred to. The general conclusion seems to be that the average temperature of the whole head is elevated somewhat above the normal, and that the elevation of temperature is usually greatest at the station nearest to the site of the growth. But a much larger number of observations must be made in order to reach a definite conclusion as to this symptom; therefore, every case of supposed tumor, and, in fact, every other lesion in the skull, should have the surface temperatures carefully noted both before and after the operation, if any be done. In the second case in my paper the temperature certainly seemed to be elevated by the irritation of the lesion present. The elevation immediately disappeared after the operation, coincidently with the cessation of the epileptic attacks. In the third case in which the fits were relieved, but not cured, the temperature did not fall. Our surface thermometers also are as yet much lacking in accuracy, as they are used in practice.

Diagnosis.—While in many cases the diagnosis is sufficiently clear, in others we are, of necessity, in the greatest doubt, until the operation, it may be, reveals the correctness or the incorrectness of our conclusions. Hence, as already quoted with approval from von Bergmann, the great necessity of a correct diagnosis on the part of the neurologist, so that the surgeon may be sure that his attempt to remove a supposed tumor will not cause chagrin to both by finding none. This has occurred in numerous instances.

In the careful and elaborate paper of Seguin and Weir, already referred to, it is pointed out that the diagnosis before operation must be worked out in five lines of inquiry. (1) The existence of tumor; (2) its exact location; (3) whether it is cortical or subcortical; (4) whether solitary or multiple; (5) its nature; to which I would add (6) if possible, its size.

1. *Diagnosis of the Existence of a Tumor.*—When the symptoms referred to by Dr. Jacobi, in her article, are present—such, *e.g.*, as headache, cerebral vomiting, gradually developing stupor, convulsions either general or localized, paralysis in varying degrees, choked disc, sometimes hemianopsia, slow pulse, probable localized rise of temperature with aphasia and apraxia, and in some cases with but little anæsthesia—it is almost certain that we have a tumor to deal with. The most difficult diagnosis is often between tumor and abscess, and for their differential diagnosis I must refer the reader to the article on *Brain: Abscess of*, on p. 218.

2. *Diagnosis of the Location of the Tumor.*—This must be done chiefly by the localizing symptoms. In certain parts of the brain a tumor may exist and give rise to no localizing symptoms, but only to general headache, choked disc, convulsions, etc. This is more particularly in the anterior portion of the frontal lobes, in the temporo-sphenoidal lobes, especially on the right side, and in parts of the parietal and occipital lobes. But gradually these "latent zones" are being narrowed progressively to smaller and smaller portions of the cerebrum. It is not too much to hope that eventually there may be *no* "latent zones." The reader must refer to that portion

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