

of this article which treats of Topography of the Brain, and to Dr. Jacobi's and Dr. Starr's papers in the present volume, for the details of the methods of localization, whether in the motor or in the sensory zones. One point must be regarded in following the history of a case. If a tumor increase in size, centres adjacent to the first one involved will also be affected; hence a succession of additional spasms and of pareses will develop in different parts of the body, and they are very important to study. The first limited spasm or paresis Seguin has proposed to call the "signal symptom"—a happy name for an important symptom in diagnosis. Rapidly produced blindness, as pointed out by Zenner and others, is usually due to tumors (especially in the cerebellum) which obstruct the veins of Galen or the straight sinus, and so produce internal (ventricular) hydrocephalus and pressure on the optic tracts, followed by choked disc and hemorrhages.

3. *The Diagnosis of the Depth at which a Tumor Lies, i.e., whether Cortical or Subcortical.*—Seguin, in the article already quoted, concludes that a tumor of the cortex cannot be distinguished from a subcortical tumor by the character of the convulsions, or by the presence or absence of localized headache, or by the cranial temperature. But tenderness on percussion rather than on pressure may very possibly be of some service. In this as in the question of local temperatures, it must be urged that more exact and detailed clinical histories may hereafter give us the means of making such a diagnosis. How near one may come to removing a tumor and yet miss it, is well shown in a case of Sands, in which he recognized unusual resistance in two punctures by the needle, yet did not remove the growth, which was found at the autopsy just below the surface. Surgery had not then reached its present boldness and success.

4. *Is the Tumor Solitary or Multiple?*—If solitary it may be successfully attacked by operation, but if multiple such an attempt would be clearly inadvisable in most cases, unless the multiple tumors are grouped within a limited area. If the tumor is single, the localizing symptoms will probably point to one area alone, if the tumor be small; or if large, several areas may be involved, but these areas will be adjacent to the primary one. If, however, localizing symptoms give two or more centres, far apart, without any intervening centres being involved, then the multiplicity of the growth is probable.

5. *The Diagnosis of the Nature of the Tumor.*—In some cases this may be made with fair approach to accuracy. For example, if the patient has cancer, tuberculosis, or syphilis in other organs, and shows characteristic symptoms of intracranial tumor, it will most likely be of the same type as the disease in the other part of the body. Beyond these three classes of tumor I do not think it possible to make other than a guess at its nature.

Hale White and von Bergmann are both opposed to operation in case the nature of the tumor is probably syphilitic. I quite agree with Seguin, however, that, provided thorough antisiphilitic treatment has been ineffectual, including the American method of the administration of large and increasing doses of iodides, if possible up to half an ounce a day, the probable gummatous character of the tumor or a syphilitic disease of the bones or membranes is not a bar to operation. Once a gumma has become organized and permanently developed, and has resisted vigorous specific treatment for six weeks, it should be attacked precisely as any other tumor would be dealt with, surgically, unless contraindicated by special symptoms, such as multiplicity, etc.

6. *The Size of the Tumor.*—This in a few cases can be probably diagnosed. The diagnosis of a small tumor will be based upon its involving a restricted area of representation in the brain, as shown by the limited portion of the body involved; by the non-progressive involvement of neighboring centres; and by the absence of marked pressure symptoms. A large tumor will involve a large number of neighboring centres and would show marked pressure symptoms. Until the parts are exposed by operation, however, it is impossible to make any accurate diagnosis of the size of a tumor. It is prob-

able, however, that a few of them will be so large as to prohibit surgical interference, before the general symptoms will be so grave as to make such interference quite inadvisable.

Surgical Treatment of Intracranial Tumors.—I have already referred to the historical case of Bennett and Godlee, which was the first really to arouse the attention of the surgical world to the possible diagnosis and removal of a brain tumor, of which there were no external local symptoms. I have also referred to some later cases which have been operated upon. The number of intracranial tumors operated upon has now reached such proportions (*vide infra*) that we can assume it as conceded that in all suitable cases operation should be at least attempted.

As to operative technique I have already considered the various steps under that head. The only point necessary to be insisted upon here is, that in cases of tumor which are not encapsulated, it is important that not only the entire tumor shall be removed, but also the zone of apparently healthy but probably infiltrated brain tissue in its immediate vicinity, so that we may be sure, so far as it is possible, that we have removed the entire neoplasm. In doing so the surgeon must remember that he can excise with greater impunity a larger area in the antero-posterior direction than in the vertical, for reasons already given.

Prognosis.—If the tumor is malignant, its return is only a question of time in the majority of cases. In tuberculous and syphilitic tumors the prognosis is, of course, a much more favorable one; while in cases of benign growths, such as fibroma, recurrence is not to be expected.

The prognosis as to death or recovery from such operation cannot be made in any individual case, for up to the time of the operation we cannot be certain of the size and the relations of such tumor, nor of the surgical complications that may arise during its removal.

The percentage of recoveries in cases of operation on intracranial tumors has been, for a new operation, unexpectedly large. Of course, in any individual case, it will depend largely on the size, position, complications, etc.

When the first edition of the REFERENCE HANDBOOK was published, I could gather only 17 cases of tumor which had been operated on, of which 3 were in the cerebellum and all 3 died.

In 1898 von Bergmann published the most recent statistics, which cover 273 operations for intracranial tumors of all kinds, of which 169 (61.9 per cent.) recovered and 104 (38.1 per cent.) died. One hundred and fifty-seven were exploratory or palliative operations, of which 82 (53.5 per cent.) recovered and 75 (46.5 per cent.) died. The chief reason for the fatality in exploratory or palliative operations has been either too extensive exploration in search of the tumor or for its removal, or that many of the cases were inoperable from the size or location of the growth and only relief from intracranial pressure was sought. If no tumor is found after cautious search by the knife, grooved director, and the gentlest use of the little finger, or if, being found, it is not removable, the operation should be terminated at once, especially if there is much bulging, indicating a large tumor. In fact, in cases of great increase in the intracranial pressure, until I have determined the fact that the tumor can be removed, I am very cautious about making a large opening in the dura, since the pressure will force out a large amount of brain substance which cannot possibly be replaced without extensive laceration, which invites fungus cerebri. Of fourteen cases in which trephining was done for the relief of increased intracranial pressure, all recovered.

Another important cause for the high mortality of the whole series has been the delay in operating. Physicians, who almost always see these cases first, postpone consulting the surgeon for an unreasonably long time in the vain hope of improvement. It cannot be too strongly insisted upon that tumors of the brain should be treated precisely like tumors in other parts of the body, by removal at the earliest practicable moment. In fact, in

the brain the reasons for early operation are even more cogent than elsewhere: its soft tissues are more easily injured; it cannot escape from pressure as do the soft parts, since the bony case in which it lies prevents this; and the growth of the tumor within the skull is insidious and not easily perceived, as it is when accessible to touch and sight. Progressive growth can be inferred only from progressive symptoms. As soon, therefore, as drugs have had a fair trial an operation should immediately be done, if the tumor can be located with reasonable certainty and if there is a fair prospect of success by operation. The limit of the "fair trial" Horsley places, and I think rightly, at six weeks. After that, time is wasted and life imperilled by longer waiting, since time only allows of increase in the size of the tumor with wider infiltration of brain tissue and the wider destruction by pressure, and the operative difficulties and dangers rapidly increase with each week or month of delay.

In the case of irremovable tumors, the opening in the skull should not be closed by replacing the bone. This partial operation will often be an immense comfort, and I have had the same experience that Horsley has had—namely, that the patient found so much relief from one operation that he requested a second.

Operations upon cerebellar tumors—by reason of their proximity to the fourth ventricle, the tubercula quadrigemina, and the pons with their important and vital centres—are more hazardous than those performed in any other less vital regions of the brain. Out of 23 cases, 15 died.

EPILEPSY.—From a surgical point of view cases of epilepsy may be sharply divided into the traumatic and the non-traumatic varieties. The cases arising from traumatism can again be subdivided into (1) those in which the scar, old depression, etc., arising from injury, lies over well-recognized centres, motor or otherwise, and (2) those in which the evidences of injury lie over the so-called "latent zones" in the brain.

In those cases in which the lesion lies over well-known centres, and the epileptic fits affect only the muscles corresponding to the motor centres (monospasm or hemispasm), there can be no question at present as to the propriety of surgical interference, and the excision of the epileptogenic centre so involved. In cases in which the injury lies over a portion of the "latent zones," I believe that here also it is often proper to operate.

It is true, time has cooled our earliest enthusiasm, but epilepsy is such a terrible disease that I find most parents are of my own opinion, viz., that no risk, even of death, still less of the probability of failure, is to be weighed against the possibility of benefit or cure. The danger of death is not very great, the number of failures is large, the number of cases benefited is considerable, the number of cures is limited but encouraging. If we could operate early, before the "epileptic habit" is formed, the number of cures would be much greater.

In these traumatic cases it is always possible that the scalp may be the site of irritation, and should there at least be no evidence of depression of the skull, it would always be wise, therefore, to excise the scar first of all, especially if it be tender, or if pressure upon it produces pain or an epileptic fit, or if the epileptic aura starts from the scar. Even should none of these symptoms be present, and if the bone be not fractured, I should deem it right first to excise the scar and then to wait in order to see whether this would cut short the epileptic seizures. Thus Briggs reports five such cases and Mears one in which such a happy result followed mere excision of the scars. I also have had two cases in which the attacks have not returned for several years after merely excising the scar. In one case the immunity has reached nine years. Any other source of peripheral irritation must also be eliminated, as has long since been observed. Briggs relates a case in point in the same paper, in which a girl had both a depressed cranial fracture and necrosis of the tibia. He wisely operated on the tibia first to eliminate this as a source of irritation, and the fits had not recurred when the case was reported five

years later, thus disproving their origin from the fracture of the skull, which was *prima facie* the most probable cause. It must be remembered also that any operation is apt to cause a cessation of the fits for some time; hence, before deciding that the epilepsy has been cured by removal of the scar or other source of irritation, at least two or three years of immunity should elapse. Should excision of the scar not cure the patient, or should there be a depression of the skull, with fits corresponding in their distribution to the motor centre or centres over which the scar lies, the patient should be trephined. The operator may find a splintering of the inner table. Sometimes a cyst will have been developed under the site of the injury. Sometimes, as a result of laceration of the brain tissue at the time of the injury, a brain scar will be found. The dura also will have been ruptured in some cases, and a scar will be found in it; or mere eburation of the bones, as a result of osteitis from the traumatism, may be the only lesion. The skull having been trephined and the dura opened, the damaged brain tissue should be removed; and if there be a scar or thickening of the dura, the dura itself should be removed. In removing the damaged brain tissue, care must be taken to see that it is all removed, even to the extent of trenching upon apparently healthy brain tissue, and the directions heretofore given that freer excision may be made in the antero-posterior direction than in the vertical (for reasons already mentioned) must be remembered. The bone should not be replaced in a large piece, if by its shape, or for any other reason, it would cause pressure on the brain. It may sometimes be replaced to advantage after dividing it into small pieces by the chisel or rongeur forceps.

In those cases in which the lesion lies over the "latent zones," the same rule as that given above would apply to the excision of the cutaneous scar. Should this not effect a cure, then it would be proper to operate. What should be done would depend upon what was found to exist in the brain, and any damaged brain tissue or cyst should be excised as already advised. Occasionally, after accidents, primary trephining will have been done, yet epilepsy will develop at a longer or shorter time after healing. In such cases, no matter where the scar is situated, it is sometimes wise to raise the flap over the site of the primary trephining and round off the edges of the bone, and to excise any scar in the dura or in the brain which may have resulted from the primary traumatism, or from any operation done at that time. Occasionally some benefit will follow, but generally the result will only be a temporary cessation of the attacks.

Non-Traumatic Epilepsy.—First, of the Jacksonian type. So far as our limited experience goes, it seems probable that in cases of distinct Jacksonian epilepsy it is proper to operate, and to excise the centre corresponding to that portion of the body which is involved. The experience of Horsley and Macewen, as well as quite a number of other operators, at present would seem to show that such operations at least do no harm, and in not a few cases they have resulted in apparent recovery both from the epilepsy and from the operation. It is a matter of some importance also that if we operate at all, it shall be as early as possible, before the "epileptic habit" has been established. But both in this and in the non-Jacksonian type, it is of the utmost importance that the fits shall have been always observed by a competent, and, if possible, a trained observer. I have had brought to me for operation a large number of cases of alleged Jacksonian epilepsy, and others of ordinary epileptic type, in which the fits were said to be limited and uniform in the point of beginning. These statements have been in some cases the result of the patient's knowledge, but more commonly of that of members of the family only. It is very evident that persons not trained to exact observation, and especially those persons whose affections are involved, and whose first motive would be to aid the patient rather than to observe the fit, are, as a rule, incompetent observers. Frequently, after placing such persons under observation in hospital, I have found that

the fits had not been at all correctly described. Therefore it cannot be too strongly insisted upon that accurate observations shall be made the foundation of knowledge before we proceed to excise any brain centre. In making these observations, not only should the observer note all the phenomena in detail, and especially the muscles involved—particularly the muscle or muscles first involved (Seguin's "signal symptom")—and the "march" of the fit (that is, the progressive involvement of one muscle or set of muscles after another), but the dynamometer should be used as soon as possible after the fit be paretic. Such operations have been seriously objected to on the ground of subsequent paralysis. This seems to me not to be a valid objection. To exchange epilepsy for paralysis would, I think, be a choice at which few patients would hesitate. It must also be remembered that the excision of a centre for an ordinary group of muscles, though it be followed by paralysis which may even be complete, has resulted eventually in so great a restoration of power as to convert the paralysis into only moderate paresis, probably through the compensative action of the centre on the opposite side. Thus, in the third case related in my first paper already referred to, in which excision of the wrist centre was done, the patient was entirely paralyzed from May 30, 1888, till early in July. Motion began to return at this time, and when I last saw him, in the middle of September, 1888, he had so far regained control of his hand as to be able to play baseball. The fits, however, had persisted, though changed in type, there being now but few severe convulsions, and only a moderate number of attacks of *petit mal*. In another case in which I excised the thumb centre the hand and arm became paralyzed to the elbow. This rapidly disappeared, and in a few weeks the patient could again sew perfectly well and the dynamometer showed no difference in the muscular power of the two thumbs.

As to operative procedure in these cases, it is important, first of all, to obtain a view of the brain sufficiently large for the operator to be able to recognize the convolutions. Once the convolutions are exposed, no antiseptic solution should be allowed to touch them until the centre sought for shall have been well defined by the battery. Hot water, however, may be used to check the bleeding. As soon as the brain is uncovered the faradic current should be employed by means of my double electrode (Fig. 1023, page 409).

The remainder of the operative procedure is as described in the section on the technique.

Secondly, in cases of general or "essential" epilepsy experience has shown that it is better to refrain from operation as a rule.

INJURIES OF THE HEAD.—Contusion.—In any case of serious contusion, the patient should at once be put to bed on light diet, and the bowels and general hygiene carefully looked to. The patient should then be closely watched, and, if any serious symptoms arise indicating intracranial mischief, a semicircular flap of the scalp should be raised and the bone inspected. If a fracture of the bone be discovered and the symptoms are at all serious, showing that inflammation of the meninges or of the brain substance has set in, or is impending, exploratory trephining must be done at once, and the dura be opened. Even if no fracture exists, if the symptoms are those of encephalitis, trephining should be done. It is possible, in such a case, either that a piece of the inner table has been separated, with or without external fracture, or that the dura has been ruptured or the brain lacerated, and that inflammation with exudation has begun. Once inflammation with its attending proliferation has set in, it is essential that a means of escape for the exudate be provided for, or for the escape of pus if the inflammation shall have proceeded so far. In other words, we should treat contusions followed by serious symptoms of mischief in precisely the same manner that we would treat them in any other part of the body, always remembering that in the brain it is impossible for any exudate or hemorrhage to find its way to the sur-

face without surgical assistance, by reason of the bony case in which it is retained. Trephining of the skull, therefore, is equivalent only to incision through the soft parts down to the seat of injury in any other part of the body. In many cases of very severe contusion, it would be proper immediately to make a horseshoe flap in order to determine the question of fracture. The swelling of the scalp is often so thick and so dense that in some cases it is extremely difficult to ascertain whether a fracture exists or not without such an incision. It is all-important to know this fact, and especially if there be depression or not, so that the proper treatment shall be adopted. *Preventive trephining*, in many of these cases, is not only justifiable but demanded. A simple incision through the scalp is of itself unattended with danger in these days of antiseptic surgery. It may be objected that if a simple fracture exists, by such an incision we convert it into a compound one; but the position taken by Roberts in 1885 is certainly the correct one, that such an incision, with modern surgical methods, adds nothing to the danger, and is the only method by which we can make an absolutely certain diagnosis in any serious case, and so enable us to pursue a course of treatment which will diminish or avoid the danger.

Should there be motor paralysis without any decided loss of sensation, there is almost certainly a lesion of the cortex; but, as Ferrier has pointed out, if sensation is impaired to any extent, there is probably a lesion of the sensory tracts of the internal capsule, or of the centres to which they are distributed.

Even after recovery from a severe contusion of the head, the patient should be carefully watched for some months, as in not a few instances abscesses, cysts, or epilepsy has developed after a long time. One case in which I trephined, a month after an exploratory incision of the scalp alone had been made, was most instructive as to the intracranial effects of a very slight extracranial traumatism. In enlarging the trephine opening, I found that the dura suddenly became remarkably adherent to the bone. Inspection showed me that the area of adhesion was precisely under the flap of the first operation. This had been simply the raising of a flap of scalp, had been conducted with the utmost antiseptic care, and had healed without incident in a few days; yet the simple lifting of this flap had been felt instantly within the cranium, and exhibited itself by the strong adhesion between the dura and the bone. A severe contusion, therefore, it can easily be understood, even without fracture of the bone, might set up such inflammation as would ultimately lead to suppuration, to the formation of a cyst or a tumor, or to such organic changes as would be followed by epilepsy. Williams has reported an unusual case in which a blow on the forehead produced an abscess which discharged through the nose.

Compression of the Brain.—In 1885, in a paper read before the American Surgical Association, Roberts insisted that the complexus of symptoms passing under the title of "compression of the brain" was due not so much to compression as to brain laceration and inflammation. In cases of encephalic hemorrhage, we certainly have an example of compression. Apart from this cause, and probably from tumor and from effusion, in both of which, however, inflammation has a large share, I certainly would agree with the position taken by him. A blow which is followed by symptoms of compression, when it is sufficiently serious to produce violence to the membranes, or laceration of the brain tissues, is, as a rule, one which has been followed by inflammation; and it is this inflammation with its exudate and swelling that causes the mischief. We are apt to think of increased intracranial pressure as a result to be looked for only from tumor, abscess, or effusion into the ventricles. But it is certainly reasonable to believe that mere inflammation of the cranial contents will be attended by swelling as in other tissues, and that thereby the intracranial pressure will be increased.

An experiment by Felizet is full of instruction. He filled a skull with melted paraffin, and after this had

cooled, he let the skull fall from a moderate height to the floor. The calvarium was then removed. No fracture existed, but the surface of the paraffin was flattened at the point corresponding to the blow. The skull had been momentarily depressed, and had returned again to its former shape by its elastic resiliency. Undoubtedly the same occurs in the brain, and no such momentary changes of form from violence, even though followed by a restoration of the organ to its original place, can have been produced without more or less laceration of the brain tissue. What is to be feared is that inflammation will take place, and that the products of inflammation will produce symptoms of pressure. Hence, in such cases, I would trephine for the same reasons as are given under the last heading, if similar symptoms arise.

Scalp Wounds and Injuries of the Head.—In every case of scalp wound, the head should be shaved over a large area, and scrubbed with a nail brush and soap and water, followed by an application of ether, and then of a sublimate solution. The scalp should, of course, by this process be thoroughly cleansed from all dirt and foreign substances, and if need be the edges of the wound should be trimmed in order entirely to get rid of the dust and dirt. The wound may now, and not until now, be examined by a probe and the finger, both of which must be entirely aseptic. Should the injury be limited to the scalp and the periosteum, after providing for drainage, the wound should be closed and dressed antiseptically. But should the skull be fractured, it should be treated as described below. In wounds which produce a crushing or sloughing of the scalp, the late Dr. William Hunt called my attention to the fact that the depressed scar resulting from loss of scalp tissue only, not seldom may be mistaken for an old depressed fracture of the skull—an error he had known to be made by more than one good surgeon.

Simple Fracture of the Skull without Depression.—This is often exceedingly difficult to diagnose. One of my patients, a bright, intelligent fellow, experimented on his own head the morning after a fall of nine feet, by tapping on his head on the injured side. He elicited a "cracked-pot" sound which did not exist on the uninjured side. It is possible that this may be sometimes of great value in diagnosing simple fracture without depression. If the fracture be simple and without depression, and without cerebral symptoms, it should be treated expectantly, but the moment that there are any symptoms of encephalitis the trephine should be used for the reasons previously stated. Two most instructive cases of such trephining are reported by Heuser.

Simple Fracture with Depression.—In simple fracture with depression I should certainly advise immediate preventive trephining, even if there be no sign of encephalic mischief present, although I am quite aware that many conservative surgeons are opposed to such radical treatment. As already stated, the conversion of a simple fracture into a compound one is at present attended with no serious risk. It must be remembered that any violence sufficient to break a bone and to depress it will unquestionably have produced some laceration of the brain substance, and possibly of the dura. In addition to this, as the inner table is so much more easily fractured than the outer, occasionally a fragment may have been detached and driven into the brain. The immediate dangers arising from such a fragment of bone and laceration of the cerebral tissues and membranes are those of serious inflammation, and if the products of inflammation are confined within the skull, without possibility of escape by drainage, the danger is a serious one. Even should the patient recover, as is undoubtedly often the case, the numerous instances of epilepsy arising from irritation of a scar, from a cyst, or from secondary degeneration are so great, and the danger of trephining so small, that but little choice would seem to exist.

Compound Fractures of the Skull.—The rule in such cases should be always to explore by a large incision in the scalp. Should there be no depression, no strong probability of separation of the inner table, or of serious laceration of the brain, or of hemorrhage, the

wound should be most scrupulously disinfected, and, after careful antiseptic dressing, the expectant plan should be pursued. Should the fracture be a mere linear fissure, after careful disinfection, if the fissure be at all impregnated with hair, dirt, etc., the soiled edges should be carefully chiselled away so as to make sure that we have cleaned them of all infective material; for it is in the probable infection more than in the mere fissured fracture (apart from the violence of the accident) that the danger of encephalic mischief lies. In doing this only the outer table need be cut away. An antiseptic dressing should then be applied.

But if depression exists, and there are symptoms which lead us to believe that serious injury to the brain, or fracture of the inner table, or hemorrhage is present, preventive trephining should be done at once. It goes without saying that a large area of the scalp should be shaved and most rigidly disinfected in all these cases.

Mr. Mayo Robson has reported an excellent illustration of the value of comparatively early trephining in such cases. A man received a blow on the left side of the head directly over the arm centre, the scalp showing a small lacerated wound. The right arm was paralyzed, this condition being attributed by the surgeon who first saw him only to bruising. Later rhythmic epileptiform spasms began in this hand, followed by facial paresis, œdema of the left optic disc, and exaggerated reflexes on the right side. Exploration showed a depressed fracture, and trephining saved his life. The twitchings disappeared in six days after the operation. Even had he recovered without operation he would probably have suffered from a Jacksonian epilepsy.

In a case of extensive compound fracture of the occiput, so early as 1810, Hutchison boldly anticipated modern surgery with the happiest results. The patient had fallen thirty feet and fractured the occiput, the fracture extending into the foramen magnum, as proved at the operation. He was trephined at once, and to the embarrassment of the surgeon, the dura bulged beyond the outer surface of the bone, and by its elasticity showed that there was an extravasation of blood beneath it. The next day this was incised, the blood evacuated, and, after a tedious illness from a suppuration that would now happily be conspicuous by its absence, the patient recovered.

Punctured Wounds of the Brain, which are of course always compound fractures of the most dangerous character, the rule should be absolute to trephine at once, whether there be brain symptoms or not. The almost certain danger of septic inflammation, and the need both for immediate provision for drainage and for antiseptic cleansing of the wound, render immediate trephining imperative, just as incision, cleansing, and drainage of a similar wound in the soft tissues is the rule. No better illustration could be given than that of a case reported by Ball in which a man was struck on the left temple with a pen-knife. The wound was not considered serious enough to warrant his admission to the hospital where he first applied. Ten days later aphasia, word blindness, and word deafness set in, without paralysis. Five days later he was trephined. The knife blade had penetrated the dura and wounded the brain. A clot was removed and drainage provided for. The next day his aphasia recurred, but disappeared after the blocked drainage tube was made pervious and further clots removed. An excellent recovery followed.

Wagner states that in 81 cases of complicated various fractures of the skull freshly treated as above advocated, the death rate was only 1.23 per cent.; whereas in 12 such, treated secondarily, the mortality was 33.5 per cent. No better commentary could be made.

GUNSHOT WOUNDS.—The experience of the last fifteen years in cerebral surgery has revolutionized the treatment of gunshot wounds of the brain. The application of antiseptic methods to the treatment of brain injuries, the consequent boldness with which we operate on the brain and its membranes, the introduction of the gravity probe and the making of counter openings by the trephine, both to search for the bullet and for drainage,

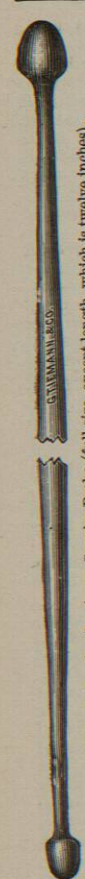


Fig. 1028.—Fluhrer's Aluminum Gravity Probe (full size, except length, which is twelve inches).

are the chief points in which recent practice differs from the old.

The cardinal principles to be applied to gunshot wounds may be stated as follows: First, the scalp should be shaved over a large area around the wound or wounds, or, better still, over the whole head.

Secondly, the entire wound should be disinfected, from the wound of entrance all the way to the wound of exit, or to the site of the ball, if the missile has not escaped.

Thirdly, if hemorrhage has taken place, either the wound of entrance or the wound of exit, or both, should be freely enlarged by the bone forceps or by the trephine, and the vessels secured by catgut ligatures, or, in rare cases, be controlled by pressure or by hæmomatic forceps.

Fourthly, the bullet or other missile should, if possible, be removed, if need be, by a second trephine opening.

Fifthly, absolute free drainage should be secured, again, if need be, by a counter trephine opening, even if the drainage tube should have to traverse the entire brain.

Sixthly, antiseptic or aseptic dressings should be applied, and the subsequent treatment of the case be conducted on general principles.

The admirable cases of Fenger and Lee, Fluhrer, Nancrede, Bryant, and many others since have proved conclusively the truth of the above maxims, and future wars will tell as different a story in cases of penetrating wounds of the head as they will in penetrating wounds of the abdomen.

Of the above points several have already been considered. The removal of the ball has always been one of the chief difficulties in cases of gunshot wounds. Fluhrer, in the brilliant article alluded to, however, showed a new method, which is of great importance. The wound having been suitably disinfected, together with, of course, the hands of the operator and the instruments, etc., the head of the patient is so placed that the probable direction of the ball will be vertical. The gravity probe of Fluhrer, made of aluminum, with large con-

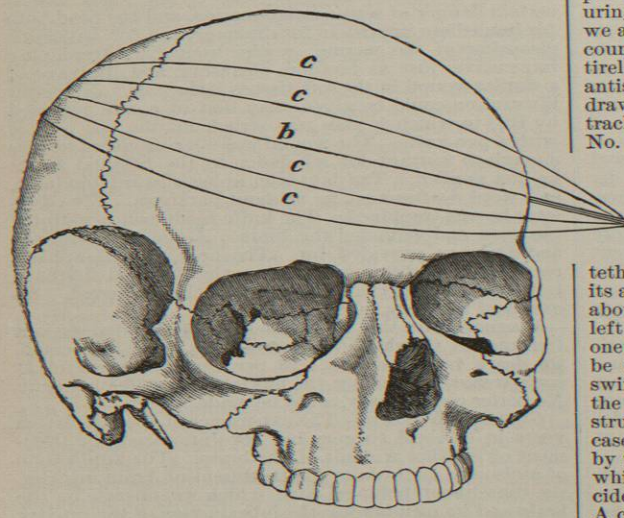


Fig. 1029.—a, The extra-cerebral portion of the probe; b, the line taken by the probe through the brain; c, c, c, lines placed in the direction of the probe with the aid of a string.

ical ends, is now introduced by its larger end. This probe is so light that it will not force its large end into the brain substance, and so produce a false passage, but by its own weight will follow the track of the ball, if this be made vertical. If the ball be within easy reach it may be extracted by the ordinary methods; if, how-

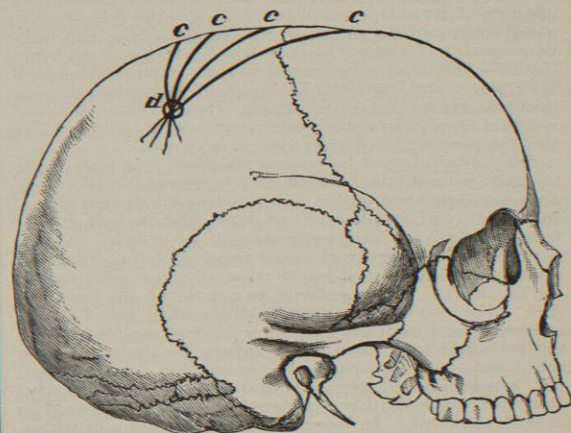


Fig. 1030.—c, c, c, c, Lines converging on the opposite side of the head; d, point at which to trephine.

ever, as shown by the probe, it has penetrated so far as to be more accessible from the opposite side of the skull, unless important centres lie in the way a counter opening should be made on the opposite side of the skull at the point at which the probe would emerge if pushed through. The proper point for the counter opening can be best located by the point of intersection of the lines determined in various planes by the method described by Bryant. Figs. 1029 and 1030 show the method plainly. Before the probe has been introduced in the search for the ball its length should be measured. If, then, it impinges against the ball, by measuring the protruding part of the probe the difference in the two measurements will give the depth at which the ball lies. Pushing the probe through to the counter opening, and again measuring the part protruding from the original opening, we ascertain the depth at which the ball lies from the counter opening. The probe is now to be carried entirely through the counter opening and two strands of antiseptic silk are attached to its extremity, and on withdrawal of the probe the strands of silk will lie in the track of the wound. To one of these is now attached a No. 9 (French) gum catheter, which should be new and carefully disinfected, especially in its interior, and within it should be a disinfected straight stylet in order to give it rigidity. The stylet being ensheathed by the catheter will not mislead by its metallic sound or feel in the search for the metal ball. A pair of forceps is now tethered to the catheter by a loop of silk round one of its arms, and the ball is searched for at its known depth, above, then below, then to the right, and lastly, to the left of the catheter guide. Between searching in any one direction and the following one the forceps should be entirely withdrawn and reintroduced so as not to swing around the catheter and thereby, perhaps, injure the brain substance unnecessarily. In case the ball has struck the opposite side of the cranium, as in Fluhrer's case, it will have rebounded in the direction determined by two influences: first, the natural angle of reflection, which will probably be about equal to the angle of incidence; and secondly, the influence exerted by gravity. A counter opening having been made, the wound in the meninges made by the ball in impinging on the opposite wall of the skull should be sought for, and from this, as

a new point of departure, a new search may be made in the same manner as above with the gravity probe. Another instrument may be used, also, in determining the site of the ball. It is the very ingenious invention of Dr. Girdner. The "telephonic probe," if it touch the ball, will indicate it by a grating sound, a sound which is not produced if it touch any other than a metallic substance.

By the second strand of silk a drainage tube may now be drawn entirely through the wound.

Until recently missiles that lodged in the brain were allowed to remain there unless easily accessible, under the impression that meddling with the brain with a view of removing anything that may have lodged was entirely unwarrantable. This, we now know, is an error. The missile should in all cases be removed if accessible. Dr. Wharton has presented the analyses of 316 cases in which foreign bodies were lodged in the brain. As a result of this investigation, in 106 cases in which removal was effected, 34 (32 per cent.) died. Of the much larger number, 210, in which the missile was not removed, 122 (58.1 per cent.) died, and of those who lived 10 died from the ultimate effects of the ball, and many of the others suffered from epilepsy and physical and mental deterioration.

Arnold, at the request of Bryant (*loc. cit.*), investigated very carefully 140 cases, and found that of the 85 cases in which the missiles escaped primarily, or were removed, 38 (44.7 per cent.) died. Of the 55 in which the missile was not removed, 32 (58.2 per cent.) died, giving nearly the same result as Wharton's tables.

If the bullet has not escaped, and cannot be found or removed directly, or by a counter opening, the wound should be carefully disinfected and thorough drainage should be secured by a rubber tube carried to the entire depth of the wound. If, however, a second opening has been made, the drainage tube should be carried entirely through the track of the wound.

Drainage should be kept free and thorough, and antiseptics secured by gentle syringing with sterile salt solution, but it should be done with great gentleness.

FRACTURE OF THE BASE OF THE SKULL.—Besides the ordinary dangers from fracture of the vault of the skull, we have at the base another danger of great importance, that does not at first glance seem to be present, viz., probable and insidious communication with the external air, and as a result of it, septic infection that is apt to be overlooked. This communication with the outer air may take place through the ear, the nose, the mouth, or the roof of the orbit.

Fracture of the occipital bone, involving the base of the skull, should be dealt with, of course, as in the case of fracture of the vault.

Heretofore fracture of the base has been excessively fatal, and it is a remarkable fact in cerebral surgery that Wagner, in the lecture already referred to (page 421), states that in twenty-three cases of fracture of the base that survived the first forty-eight hours (that is to say, those which did not die from the severe primary violence), every one of them recovered.*

If the communication with the air be through the ear, as shown by escape of the cerebro-spinal fluid, the first thing to do is most carefully to disinfect the ear, after having removed all of the wax, dirt, etc., within it. This disinfection should extend to all the hollows in the external ear and the surrounding scalp, which last should be shaved. The ear should next be well washed out with boric acid solution, and the ear and scalp should then be covered with sublimate gauze.

Should the fracture of the base involve the roof of the orbit and not communicate with the external air, of course it should be treated as a simple fracture without operative measures, unless the subsequent history should demand it. But should such a fracture be caused by an umbrella rib, a splinter of wood, a pair of scissors, or

* It is impossible, however, on the mere *ipse dixit* of Wagner, to accept the diagnosis of all these cases as undoubted fractures of the base, without detailed histories.

other such vulnerating body, then the whole region about the orbit should be carefully disinfected. After disinfection by bichloride solution (1 to 1,000) the normal salt solution should be used. An incision should then be made in the line of the eyebrow, in order to hide the subsequent scar, the lid drawn down, the track of the wound carefully disinfected, and a considerable opening made in the roof of the orbit by a gouge or chisel, rather than by a trephine. If the brain itself has been injured, the dura should be opened, and the track of the wound again disinfected. Thorough free drainage should be provided for, and the wound treated as usual.

Should the fracture involve the nose, the same principle would apply, viz., thorough disinfection and free drainage. Trephining here should be through the track of the exterior wound, if it involve the base of the nose or lower forehead. If the vulnerating body has passed through one nostril, of course the nostril should be first washed clean and then disinfected with boric acid and salt solution, and, after trephining, the same acid should be thoroughly insufflated into the nostril, both from below and by way of the trephine opening. The trephining would probably be done best just above the root of the nose, and would, unfortunately, involve the frontal sinus, which should always be avoided if possible. But the great danger from want of drainage must overcome every objection of a minor character. The frontal sinus, as well as the wound, should be disinfected, therefore, with great care, and the same drainage and dressing be applied as heretofore recommended. In order to prevent the passage of infective air through the nose, both from without and from the lungs, it would be well to plug up both anterior nares with a moderate tampon of sterilized cotton for the first three days at least. A tampon in the anterior nares would nearly prevent any current of air through the nose, even from behind. In children it is to be remembered that the frontal sinus is very small and ill developed.

INTRACRANIAL HEMORRHAGE, ESPECIALLY FROM THE MIDDLE MENINGEAL ARTERY.—Three papers published some years ago practically settled the question of the treatment of hemorrhage from the middle meningeal artery (Wiesmann, *Deutsche Zeitschr. f. Chir.*, Bd. xxi. and xxii., 1885; Jacobson, *Guy's Hospital Reports*, 1886, vol. xliii.; and Krönlein in the first journal, Bd. xxiii., Heft 3 and 4, 1886).

The violence that may rupture the middle meningeal is but slight in some cases; so slight, indeed, as even to leave no mark. A fracture may exist, but it may be so small as not to be recognizable by the touch, and barely by sight. In a number of cases there will be no fracture whatever. Stokes reports a case which is a model of diagnosis and treatment, in which, after only a bruise, trephining evacuated a clot an inch and a half thick, followed by immediate relief to the paralysis, and speedy recovery. Jacobson (*loc. cit.*) reports four cases out of seventy, of such hemorrhage, in which no fracture existed. A number of other cases have since been reported. In some, of course, the fracture will be both visible and palpable, not only over the vault but also at the base of the skull. Either the trunk or the branches may be ruptured. Of the seventy cases tabulated by Jacobson, in two certainly, and in four others probably, the trunk was injured; but the divisions beyond the trunk are the site of the lesion more commonly than is the main trunk itself.

The adhesions of the dura to the skull, it should be remembered, while in general very strong, are very slight in the area of the middle meningeal, as pointed out by Tillaux, and so favor hemorrhage.

The symptoms of the greatest value are: First, an interval of consciousness between the accident and the appearance of serious symptoms. This interval of consciousness is of the greatest importance, and probably is worth all of the other symptoms put together. It is due to the fact that it takes a certain amount of time for sufficient blood to escape to produce unconsciousness from pressure. It was present in two-thirds of Jacob-