Modern Surgery - Chapter 23. Diseases and Injuries of the Head

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XXIII. DISEASES AND INJURIES OF THE HEAD.

I. DISEASES OF THE HEAD.

In approaching a case of brain disorder, first endeavor to locate the seat of the trouble; next, ascertain the nature of the lesion; and, finally, determine the best plan of treatment, operative or otherwise. In all operations upon the brain the surgeon must be able to determine accurately the situations of certain fissures and convolutions, the finding of the situations of these convolutions and fissures comprising the science of craniocerebral topography.

The regional terms used in craniocerebral topography are derived from Broca (Fig. 311). The middle meningeal artery is found at the ptérior, one and one-quarter inches posterior to the external angular process, on a level with the roof of the orbit (Fig. 310). The fissures and convolutions of the brain are shown in Figs. 312-314. The fissure of Bichat is marked by a line on each side drawn from the inion to the external auditory process. A line from the glabella to the inion overlies the median fissure and the superior longitudinal sinus. The fissure of Rolando is very important, as

marking the motor region of the brain. It begins near the median line, half an inch posterior to the middle of the distance between the inion and glabella (Keen). This fissure runs downward and forward at an angle of 67.5°
for a distance of three and three-eighths inches. Chiene finds the fissure of Rolando by the following method: He takes a square piece of paper and folds it into a triangle (Fig 316, 1); the angle $BAC$ of this triangle is $45^\circ$; the edge $DA$ is folded back on the dotted line $AE$; the angle $DAE$ equals half of $45^\circ$, or $22.5^\circ$, and the angle $CAE$ equals the same (Fig. 316, 2); unfold the paper in the line $CA$; in the figure thus formed $BAC = 45^\circ$ and $EAC = 22.5^\circ$; $EAE = 67.5^\circ$, which is the angle desired. Place the point $A$ in the mid-line of the head, over the point of origin of the Rolandic fissure; the side $AB$ is laid along the middle line of the head, and the line $AE$ corresponds to the fissure of Rolando.* Fig. 315 shows Chiene's scheme for locating various points upon the brain. Horsley determines the situation of the Rolandic fissure by the use of his metal cyrtometer (Fig. 317). He places the point marked zero over the inionglabellar line and midway between the inion and the glabella. To find the fissure of Sylvius (Fig. 313, $S, s', s''$), draw a line from the external angular process to the occipital protuberance. The fissure of Sylvius begins on this line one and one-eighth inches behind the external angular process; the main branch of the fissure runs toward the parietal eminence; the ascending branch of the fissure corresponds to the squamososphenoidal suture, and continues upward in the same line half an inch above the suture. The precentral sulcus (Fig. 313, $F$) limits anteriorly the ascending frontal convolution; it runs parallel with and just behind the coronal suture, and a finger's breadth in front of the fissure of Rolando. The intraparietal fissure (Figs. 312, 313, $ip$) limits the motor region posteriorly. It begins opposite the junction of the lower and middle thirds of the fissure of Rolando, passes upward in a line

Fig. 314.—Inner surface of the right hemisphere of the brain (Ecker).

Fig. 315.—Chiene's lines for localizing brain-areas: M D C A, Rolandic or motor area; A, anterior branch of middle meningeal and bifurcation of fissure of Sylvius; A C, horizontal part of Sylvian fissure; the highest part of the lateral sinus touches P S at R; M A, precentral sulcus; I, beginning of superior frontal sulcus, M B C, contains the supramarginal convolution; B, angular gyrus.

Fig. 316.—Chiene's method of fixing position of Rolandic fissure ("American Text-book of Surgery").
parallel with the longitudinal fissure and midway between the Rolandoic fissure and the parietal eminence, passes by the parieto-occipital fissure, and downward and backward into the occipital lobe. The motor areas, which on the outer surface are adjacent to the fissure of Rolando, are shown in Figs. 312 and 313. The superior longitudinal sinus is overlaid by a line from the inion to the glabella. The lateral sinus is indicated by a line running from the occipital protuberance horizontally outward to a point one inch posteriorly to the external auditory meatus, and from this point by a second line dropped to the mastoid process. The supra-meatal triangle of Macewen is bounded by the posterior root of the zygoma, the posterior bony wall of the auditory meatus, and a line joining the two. The mastoid antrum is opened through Macewen's triangle to avoid injury to the lateral sinus. Barker's point the proper spot to apply the trephine in abscess of the temporosphenoidal lobe, is one and one-fourth inches above and one and one-fourth inches behind the middle of the external auditory meatus. Fig. 318 shows clearly the main points of craniocerebral topography, obtained by methods approved by many scientists.

Körnlein's method of localizing certain points is the most generally serviceable. (See Fig. 319.) A line, known as the base line, z M, is carried horizontally backward from the lower border of the orbit through the upper border of the external auditory meatus. Another horizontal line, K K', is drawn parallel with this, on a level with the supra-orbital ridge. A line z K is erected from the middle of the zygoma to the supra-orbital line. A vertical line is drawn from the articulation of the lower jaw, A, and is prolonged to R. A vertical line is drawn from the posterior border of the mastoid base (M K') and is taken to P,
the middle line of the skull. A line is drawn from $K$ to $p$, and between the points $r$ and $p'$ it overlies the fissure of Rolando. The angle of $p$ $k$ $k'$ is bisected by the line $k$ $s$, which corresponds to the fissure of Sylvius from its point of bifurcation to its posterior termination. $k$ marks the bifurcation of the fissure of Sylvius. To reach the anterior branch of the middle meningeal artery trephine at $k$; to reach the posterior branch, trephine at $k'$.

Diseases of the Scalp.—The scalp is composed of skin, subcutaneous fat, and the occipitofrontalis muscle and aponeurosis. The scalp is liable to inflammation from various causes, and also to other diseases—namely, tumors, cysts, warts, moles (local cutaneous hypertrophies), cirsoid aneurysm (page 306), nevi, and lupus. Abscesses of the scalp are common. If an abscess forms beneath the pericranium, the pus diffuses over the area of one bone, being limited by the attachment of the pericranium in the sutures.
If an abscess forms in the tissue between the occipitofrontalis and the pericranium, it is widely diffused. Treves calls this subaponeurotic connective tissue "the dangerous area." Abscess of the subcutaneous tissue is apt to be limited because of the great amount of fibrous tissue. Abscess is treated by instant incision at the most dependent part, and drainage.

**Diseases and Malformations of the Bones of the Skull.**—The bones of the skull are liable to caries, necrosis, osteitis, periostitis, atrophy, hypertrophy, tumors, etc. (see Diseases of Bones).

**Microcephalus.**—By microcephalus is meant unnatural smallness of the head due to imperfect development. Marked microcephalus is not a common condition, but it is an occasional cause or associate of idiocy. A child may be born with a skull completely ossified even at the fontanelles, or the ossification may become complete soon after birth, but in many cases of microcephalus ossification takes place late or not at all. In microcephalus the face is usually fairly well developed; the jaws are prominent; the forehead is flat; the cranium and brain are small; the convolutions of the brain are simpler than is natural; there is apt to be marked asymmetry of the two sides of the brain; internal hydrocephalus may exist; areas of sclerosis and atrophy are common; porencephaly is not unusual. Some patients have perfect motor power; others are slow and inco-ordinate. Epilepsy, chorea, and athetosis frequently complicate the case. Idiots of this type often present deformities such as cleft palate, strabismus, distorted ears, hypertrophied tongue, deformed genitals or extremities, ill-shaped and irregularly developed teeth. They exhibit irregular muscular movements, are frequently paralyzed in childhood (infantile paraplegia or hemiplegia), and suffer from subsequent contractures. They are active, destructive, excitable, and are liable to be violent and almost demoniacal. As Clouston says, they look impish and unearthly.

**Treatment.**—Skilled training in a school for the feeble-minded or in an institution for idiots is necessary in treating microcephalus. Idiots have but little power of attention, and sensory impressions give rise to but few concepts, and these are feeble and fleeting. In order to educate the idiot it is highly desirable that speech be acquired, and "the more strongly the attention can be aroused, the more perfect does speech become" (Kirchhoff). The principle of the education of idiots is to stimulate, co-ordinate, and guide sight, hearing, and feeling.

Lannelongue, of Paris, has suggested an operation in cases of idiocy with premature ossification (see Linear Craniotomy, page 634). In this procedure the author has no confidence. Idiocy is a general disorder and not a local brain disease. Soft parts mould bone, and bone does not mould soft parts. There is no evidence that the brain is being compressed; in fact, the simplicity of the convolutions suggests the contrary. In many typical cases of microcephalic idiocy there is no synostosis even years after birth. The operation has been much abused. It is sometimes fatal, and, although a fatality may gratify the family, a surgeon is not a legal executioner. The remarkable improvement which has been reported in some cases results probably from misconception; the new surroundings, the strange faces, the firm discipline, the effect of the anesthetic, and the shock of the operation attract the feeble attention and rouse the sluggish senses. Many
Spurious Meningocele

Spurious Meningocele (the Puffy Tumor of Pott).—It occasionally happens, after a fracture of a child’s skull, that cerebrospinal fluid gathers beneath the pericranium and bulges the pericranium and scalp. When a spurious meningocele forms, the bone must have been broken and the dura and arachnoid ruptured. This protrusion fluctuates, pulsates, and is influenced by respiration. In some cases there is communication with the ventricles of the brain. The parietal and frontal regions are the most usual seats of the trouble. The opening in the skull may close; it may remain stationary; it may actually enlarge by bone-absorption. In some cases the spurious meningocele undergoes spontaneous cure; in some cases rupture

* “American Text-book of Surgery.”
† Amer. Jour. of Med. Sciences, Sept., 1895.
occurs; in other cases death takes place as a result of the cerebral injury. (See Joseph Sailer on "Spurious Meningocele," "University Med. Magazine," Sept., 1900.)

Treatment.—Close the opening by a plastic operation.

Hydrocephalus.—In external hydrocephalus the fluid is between the membranes and the brain; in internal hydrocephalus the fluid is in the ventricles. Hydrocephalus may be acute or chronic, congenital or acquired.

Acute hydrocephalus, which results from meningitis (particularly tuberculous meningitis), is usually internal, but may be external. The symptoms are headache, elevated temperature, delirium, stupor, convulsions, paralysis, and choked disk.

Treatment of acute hydrocephalus by medical means is of no avail. Tapping of the ventricles may be tried.

Chronic hydrocephalus is usually congenital. The cranium enlarges enormously and the bones of the skull are widely separated. The broad forehead overhangs the eyes. The child is an idiot, and very often does not learn to walk or to talk. Convulsions and palsies are common, and blindness is frequent. Such children usually die young.

The treatment of chronic hydrocephalus is rarely of much avail. Pressure by strapping with adhesive plaster has been tried. Tappings through a fontanelle may be performed by means of a trocar (only 5\text{th} or 3\text{rd} of fluid being withdrawn at a time). If much fluid is allowed to flow out, the head must be strapped afterward. If the skull ossifies, the lateral ventricles may be tapped. It has been proposed to drain by tapping the theca of the spinal cord (Quincke). This last operation is called lumbar puncture (page 654). The operation which promises most was devised by Sutherland and Cheyne, and is known as intracranial drainage ("Brit. Med. Jour.," Oct. 15, 1898). Their theory is that in hydrocephalus fluid distends the ventricles because the channels of communication between the ventricles and the subarachnoid spaces are closed. The subarachnoid spaces communicate directly with veins, hence fluid cannot collect under pressure in these spaces. Intracerebral drainage establishes a communication between the subarachnoid space and one ventricle. It is not necessary to operate on both sides because the lateral ventricles communicate. A small opening is made in the skull. The dura is incised. A number of strands of catgut, which are tied together, are pushed through the brain so that one end of the catgut mass lies in a ventricle and the other end beneath the dura. The dura and scalp are then sutured.

2. Injuries of the Head.

Caput succedaneum is a collection of bloody serum under the scalp of a new-born child and results from the pressure of labor. The pressure was about but not at the point where the bloody serum gathered. No treatment is required.

Scalp-wounds.—Scalp-wounds bleed profusely because the scalp is very vascular, because many of the blood-vessels are in fibrous tissue and cannot contract and retract, and because even blunt force splits the scalp almost like an incision. Scalp-wounds are treated as are other wounds. Even a large piece of scalp with only a narrow pedicle may not slough; hence
try to save any piece that has an attachment. Always shave a wide area and disinfect the shaven area and the wound. Arrest hemorrhage, and exercise great care in cleansing the wound and the parts about it. Stitch the wound with silk or gut. Very few sutures are needed if the wound is longitudinal, but many are required if it is transverse. The permanent arrest of hemorrhage is rarely effected by ligatures, but rather by sutures judiciously placed. If drainage is required, use a few strands of silk or gut; but drainage is rarely used unless we know the wound is grossly infected. Wet antiseptic dressings are used for the first few days and moderate pressure is applied by wet gauze bandages. Avulsion of the scalp is discussed on page 203.

**Contusions of the Head.**—Scalp-swelling from hemorrhage is usually considerable. The patient may be stunned or dazed. The swelling of hematoma must not be mistaken for fracture with depression. In hematoma there is a central depression, hard pressure on the center finds bone on a level with the general contour of the bone, and the margin of a hematoma is circular, is not quite hard, and is elevated above the general contour. In depressed fracture the edge is on a level with or below the level of the general bony contour, and the margin is sharp and irregular. The treatment is by bandage-pressure. If suppuration arises, at once incise.

**Concussion and Laceration of the Brain.**—For many years it has been customary to regard concussion as a condition produced by molecular vibrations in the nervous substance of the brain. Duret's classical observations have profoundly modified surgical thought, and have led to the opinion that in concussion of the brain there is injury to the brain itself, a rupture of cerebral vessels brought about by the advance and recession of a wave of cerebrospinal fluid. This wave first flows in the direction of the force. Keen says that there may be slight brain-injuries which can properly be called "concussions," but it is better to consider concussion as synonymous with laceration of the brain. It seems, however, highly improbable that slight cases of concussion are accompanied by vascular rupture or organic mischief; the symptoms are too transitory, and reaction too rapid and complete to permit of any such view. These slight cases are identical with and at least cannot be distinguished from shock. The cause of concussion is violent force, either direct (as a blow upon the head) or indirect (as a fall upon the buttocks). This force shakes, oscillates, or jars the brain, giving rise to waves of cerebrospinal fluid, which sometimes rupture vascular twigs, large vessels, or even the membranes. In the slighter ruptures concussion only exists; in the severe ruptures compression soon arises.

**Symptoms.**—In a slight case of brain-concussion the patient may or may not fall; his face is pale; he feels weak, giddy, nauseated, and confused; he often vomits, but soon reacts, and the pulse is slow. In a severe case he lies with complete muscular relaxation, cold extremities, pale and cold skin, shallow and quiet respiration, frequent, small, soft, and irregular pulse (pulse may not be detectable), and fluttering heart. He seems unconscious, but can usually be roused to monosyllabic response by shouting, pinching, or holding a bright light near his face. Occasionally, however, there is complete unconsciousness. The urine and feces are often passed involuntarily. The pupils may be unaltered, may be dilated or contracted, may be equal or unequal, but in any case they will react to light. Paralysis rarely exists, but if there is paralysis it is temporary.
The temperature at first is subnormal. In a severe cortical laceration there will be twitchings or even general convulsions, or the patient will lie curled up with limbs flexed and eyelids shut, and will resist all attempts to open his eyes or mouth or to move his limbs (A. Pearce Gould). Erichsen called this condition "cerebral irritability." As the patient reacts he will most probably vomit. Within twenty-four hours he usually improves, but is feverish and complains of headache and lassitude, sometimes becomes delirious, and in rare cases develops mania. After concussion recovery may be complete, but, on the contrary, a person's whole nature may change: he may develop hysteria, insanity, or epilepsy, and in many cases there is complaint for a long time of headache, insomnia, low spirits, and lassitude. If the patient in concussion recedes from, instead of advancing toward, recovery, coma will set in or inflammation will develop. The prognosis is always uncertain. Any concussion producing unconsciousness is a serious injury, because considerable laceration has probably occurred.

TREATMENT.—In treating brain-concussion, bring about reaction by the administration of aromatic spirits of ammonia (no alcohol, as this agent excites the brain), by pouring a few drops of ammonia on a handkerchief and holding it near the nose, by surrounding the patient (who lies in bed with a pillow) with hot bottles, by hot irrigation of the head, by the application of mustard over the heart, and by the administration of enemata of hot coffee or hot saline fluid. Do not pour fluid into the patient's mouth until he becomes able to swallow. If he cannot swallow, rely on hot enemata and hypodermatic injections of strychnin. Place the patient in bed in a quiet room, and watch him. If reaction is inordinate, apply cold to the head, give arterial sedatives and diuretics, and purge. For some days or for some weeks, according to the case, insist on an easy life. Give a plain diet containing a minimum of meat, administer an occasional purgative, and secure sleep. Sleep can often be obtained by some simple expedient, such as the administration of warm milk, placing a hot-water bag to the abdomen or feet, or applying a mustard plaster for a short time to the back of the neck. In cases where obstinate wakefulness exists, it becomes necessary to give bromid, chloral, sulphonal, trional, or some other hypnotic. Morphin is avoided because it is thought to increase venous congestion of the brain, but the elder Gross often used it, especially in cerebral irritation. If signs of compression arise, it is best to trephine, as the compressing agent may be a clot (see page 605). If inflammation arises, some surgeons will not trephine; but it is wise and proper, especially if the damage seems to be localized, to incise the scalp and inspect the bone. If a fracture is discovered and the symptoms are serious, perform an exploratory trephining, open the dura, and secure drainage for inflammatory products.

In any severe contusion the surgeon should at once incise the scalp and inspect the bone. For many weeks after a grave concussion a patient must be kept away from business and be watched because of the possibility of an abscess of the brain arising, and because of the liability of such patients to develop hysteria, neurasthenia, or insanity.

COMPRESSION OF THE BRAIN.—The causes of brain-compression are hemorrhage (Fig. 323), depressed fracture (Fig. 320), tumor, inflammatory exudate, pus, and foreign bodies. Death tends to happen from respiratory failure, not from heart-failure (Horsley).
Compressio of the Brain

Symptoms.—In great or sudden brain-compression complete coma exists without voluntary movement. The skin is hot and perspiring; the respirations are slow and stertorous, and the cheeks flap during expiration; the pulse is slow and full, and may be irregular; the pupils are somewhat dilated, and do not respond readily to light. In a unilateral compression the pupil on the side of the compressing cause is apt to be much dilated if the compression is affecting the base of the brain. In cerebral compression there are usually retention of urine, and often incontinence of feces; paralysis exists, which may be very limited (monoplegia), may be of one side (hemiplegia), or may be general. In hemorrhage into the interior of the brain the unconsciousness is immediate or nearly so. In bleeding from the middle meningeal artery a period of consciousness intervenes between the injury and the coma, in which period blood collects and the coma comes on gradually. In compression from depressed fracture or from a foreign body the symptoms usually come on at once, but they may be deferred for some hours. Compression from inflammation or pus begins gradually after a considerable time has elapsed.

A diagnosis must be made between coma due to brain-injury and the comatose conditions of apoplexy, uremia, epilepsy, hysteria, diabetes, opium-poisoning, and alcoholic intoxication. In hospital practice cases of unconsciousness without a known history are frequent. In attempting to diagnosticate examine carefully for any evidence of traumatism, and inquire as to how and where the patient was found, if any fit occurred, and if a bottle or a pill-box was found near by or in the pockets. The surgeon should himself examine the pockets. Smell the breath to notice alcohol or opium, but always remember that a man may be stricken with apoplexy while he is drunk, and may fracture his skull by falling when under the influence of opium or of alcohol. Draw the urine with the catheter if any water is in the bladder; examine the urine for albumin and sugar, and take the specific gravity. In doubtful cases of coma use the ophthalmoscope. In post-epileptic coma the temperature is never below normal, there are no unilateral symptoms, the condition resembles sleep, and the patient can be aroused. Hysterical coma occurs in boys and women; there are no objective symptoms, and the patient, though swallowing what is put into his mouth, cannot be roused (Gowers). In uremia, besides the condition of the urine (and always remember that a person with albuminuria is apt to develop apoplexy), there is a persistent subnormal temperature, and convulsions are prone to occur. There is edema of the legs, and paralysis and stertor are absent. In apoplexy hemiplegia exists, and the initial temperature is for a short time subnormal. A single convulsion may have ushered in the case. Alcoholic unconsciousness is often diagnosticated when apoplexy really exists. A man will smell of alcohol who has had one drink, but one drink will not produce coma; hence the smell of alcohol is not conclusive. In any case of doubt some hours of watching will clear up the diagnosis. Regard a doubtful
case as serious until the truth is clear. In *opium-poisoning* the pupils are contracted to a pin-point, the respirations are usually slow, shallow, and quiet, and may be stertorous; but there is no paralysis. Always remember that hemorrhage into the pons will produce pin-point pupils, but it also causes paralysis (crossed paralysis if in the lower half of the pons) and high temperature with sweating. In opium-poisoning the temperature is subnormal. In *diabetic coma* the pupils will react to a very bright light, the temperature is subnormal, and the breath and the urine smell like chloroform.

**Treatment.**—The treatment of brain-compression depends on the cause. Hemorrhage (extradural or subdural) requires trephining and arrest of bleeding; coma from depressed fracture demands trephining and elevation; foreign bodies must be removed; abscesses must be evacuated; some tumors are to be removed. In cerebral compression, if death is threatened by respiratory failure, make artificial respiration, and at once trephine over the supposed region of compression (Victor Horsley). Horsley has shown that irrigation of the head with hot water is of great value in bringing about reaction from shock in cases of brain-injury.

**Intracranial hemorrhage** may be either *spontaneous* or *traumatic*. In the vast majority of instances spontaneous hemorrhage comes from the lenticulostriate artery (Charcot’s artery of cerebral hemorrhage), and produces apoplexy, a disease belonging to the physician except in some ingravescent cases, for which ligation of the common carotid on the same side as the rupture is indicated. In adults traumatism is almost always the cause of a meningeal hemorrhage. The blood may flow from a sinus, or from the middle meningeal artery or one of its branches. Traumatism during delivery is a not unusual cause of hemorrhage from the middle meningeal artery (Richardière). Violent paroxysms of coughing in whooping-cough occasionally produce extradural hemorrhage or subdural hemorrhage. Geo. S. Brown reports such a case. He diagnosticated the condition and operated successfully (“New York Med. Jour.,” April 25, 1903).

**Traumatic Meningeal Hemorrhage.**—Hemorrhage may take place (1) between the bone and the dura (extradural); (2) between the dura and the brain (subdural); and (3) in the brain-substance (cerebral).
Extradural Hemorrhage

1. **Extradural hemorrhage** arises usually from the middle meningeal artery or from one of its branches. A spicule of bone may penetrate a venous sinus and produce extradural hemorrhage, or a sinus may rupture. Rupture of the meningeal artery or one of its branches is usually, but not always, accompanied by fracture (Fig. 323); in fact, in some cases not even a bruise can be found (Fig. 322). The ruptured vessel may be upon the opposite side to that on which the force was applied, hence the evidence of scalp-injury is not a certain sign of the side of the skull involved. The accident may or may not cause temporary unconsciousness; but even if it does, from this unconsciousness the patient almost always reacts, and there is a *distinct period of consciousness* between the accident and the lasting coma, the coma being due to pressure from a continually increasing mass of extravasated blood (Fig. 321). If the main trunk or a large branch is ruptured, the period of consciousness is short; if a small branch is ruptured, the period of consciousness is prolonged for hours or perhaps for days. As the clot forms and enlarges the patient becomes heavy, dull, stupid, and sleepy; he sleeps so soundly he can scarcely be aroused, and snores loudly, and finally passes into stupor and then into coma. The other signs of this condition are paralysis of the side opposite the blood-clot (not necessarily of the side opposite point of application of the force, for the artery may rupture from contre-coup on the uninjured side); this paralysis is apt at first to be localized, but it gradually and progressively widens its domain. If the clot extends toward the base, the pupil on the same side as the clot ceases to react to light, becomes immobile, and dilates widely, and, if the clot be on the left side, aphasia is noted. As the clot enlarges adjacent centers become involved. The face becomes paralyzed, then the arm, and finally the leg. Not unusually epileptiform attacks occur, starting in discharges from the centers which are irritated by the advancing clot before their function is abolished by pressure. The pulse becomes full, strong, usually slow, but occasionally frequent; the breathing becomes stertorous; the temperature rises, that of the paralyzed side exceeding that of the sound side. In a compound fracture the pressure of escaping blood may force brain-matter out of the wound (Keen). In extradural hemorrhage from a sinus the symptoms cannot be differentiated from those produced by arterial rupture.

*Treatment.*—In treating extradural hemorrhage localize the clot, not by the seat of the wound or contusion, but entirely by the symptoms. Endeavor to bring about reaction; but if the state of shock deepens or does not improve, and if pressure-symptoms increase, operate at once. To reach the middle meningeal artery or its anterior branch, trephine one and one-fourth inches back of the external angular process, at the level of the upper border of the orbit (Fig. 310). If this incision does not expose the clot, trephine again at the level of the upper border of the orbit and just below the parietal eminence. The first incision gives access to the main trunk and to the anterior...
branch; the second incision exposes the posterior branch. If signs indicate that the clot is traveling to the base, the trephine should be used half an inch lower than the point first directed. Arrest bleeding by a suture ligature or by packing (page 322), and always open the dura and inspect the brain. By this procedure a subdural hemorrhage may be discovered which, without it, would have been missed. Drainage must be employed.

2. **Subdural hemorrhage** is usually due to depressed fracture and rupture of the middle cerebral artery or of a number of small vessels. The *symptoms* are identical with those of extradural bleeding, but are usually very rapid in onset and are accompanied by a more distinct drop in temperature, and graver depression.

The *treatment* is trephining at the first point named in the previous article, enlarging the opening upward and backward with a rongeur, opening the dura, turning out the clot, ligating the bleeding point or packing, elevating any depression of bone, draining, and stitching the dura with catgut. Hemorrhage from internal pachymeningitis requires the same treatment.

3. **Cerebral Hemorrhage.**—The *symptoms* of cerebral hemorrhage are identical with those of apoplexy. The *treatment* is the same as that for apoplexy, except in ingravescent cases, when the common carotid on the same side as the clot may be ligated.

**Rupture of a sinus** usually arises from compound fracture or during a brain-operation. The *treatment*, if the rupture happens from fracture, is trephining. Enlarge the opening by the rongeur, pack with one large piece of iodoform gauze, or catch the rent with hemostatic forceps, leaving them in place for three or four days, or apply a lateral ligature or a suture ligature. Elevate depressed bone. In rupture during an operation control hemorrhage by packing.

**Fractures of the skull** may be *simple*, *compound*, *depressed*, *non-depressed*, or *punctured*. They are divided into fractures of the *vault*, usually due to direct force, and fractures of the *base*, due to extension of fractures of the vault, to indirect violence (a fall upon the feet, the buttocks, or the vault), to forcing of the condyles of the lower jaw against or through the base, or to foreign bodies breaking through the orbit, vault of the pharynx, the ear, or the roof of the nostrils. Fracture by contre-coup, which occurs on the side opposite the application of the violence, is very rare. Fractures of the skull are uncommon in early youth, but they are much more frequent in the aged. Usually the entire thickness of the bone is fractured, but either the outer or the inner table (Fig. 326) may be broken alone. In complete fractures the inner table is broken more extensively than is the outer table, because the
Fractures of the Vault

inner table is the more brittle, because the force diffuses, and also, as Agnew taught, because the inner table is part of a smaller curve than is the outer table, and violence forces bone-elements together at the outer table, but tears them asunder at the inner table (Figs. 324, 325).

Fractures of the Vault.—A fracture of the vault of the skull may be simple and undepressed, or it may be depressed (Figs. 320 and 326), compound, or comminuted. A mere crack may exist in a bone, and if a rent exists in the soft parts, a bit of dirt or a hair may be caught in the crack. Fractures of the vault arise from direct force. A fissure may escape recognition, although in some cases percussion gives a "cracked-pot" sound. Any considerable depression can be detected. In a simple fracture occasionally the cerebrospinal fluid collects under the scalp and forms a tumor which pulsates and becomes tense on forcible expiration (puffy tumor of Pott). Compound fractures can be readily recognized, but do not mistake a suture, a Wormian bone, or a tear in the pericranium for a fracture. A fissured fracture is marked by a dark line of blood which spourcing will not remove. Fracture of the inner table alone can only be suspected. The prognosis of fractures of the vault depends upon the extent of brain-injury rather than upon the extent of bone-injury. Simple fractures unite by bone; compound fractures with loss of bone unite only by fibrous tissue. The dangers may be immediate (hemorrhage, brain-injury, and septic inflammation) or be distant (epilepsy, insanity, and persistent headache).

Treatment.—The mortality of fracture of the skull used to be much greater than at present. Before the days of antisepsis it was 51 per cent. (Harte). Trephining is performed much oftener than was once the custom, and is vastly safer. Out of 26 trephined cases, 3 died (Harte). In any case of fracture of the skull endeavor to bring about reaction before operating, unless the signs of pressure continually increase or the evidences of shock remain unimproved or become graver. A simple fracture without depression and without brain-symptoms is treated expectantly (by rest, quiet, low diet, purgation, moderate elevation of and cold to the head, and arterial sedatives). A simple fracture with moderate depression and without cerebral symptoms is treated expectantly, and so also is a simple fracture in which symptoms existed but are abating. Simple fracture with marked depression requires immediate trephining, even when brain-symptoms are absent. Some surgeons make an exception in young children, and wait a while before trephining, in the expec-
tation that the expansile brain will lift the depressed but elastic bone up to the level. Trephining in cases where no symptoms exist, although there is marked depression, often prevents disastrous consequences arising in the future, and is known as "preventive trephining" (Agnew, Keen, Horsley, Macewen, v. Bergmann, and others). In all compound fractures, shave and asepticize the entire scalp, enlarge the incision, and explore the bone. If a fissure exists it must be asepticized, and if a hair or other foreign body is found in it, in order to effect removal and secure asepsis the outer table of the skull must be cut away with a chisel, the fissure being thus converted into a broad groove. In a compound fracture with much depression, trephine, elevate, and irrigate. In any fracture, trephine if distinct symptoms exist. In punctured wounds of the brain (punctured fractures), always trephine, open the dura, and disinfect

Fig. 327.—Extensive fracture of the base of the skull ("American Text-book of Surgery").

(Keen). In any case of fracture of the vault where trephining has been performed, it is wise to open the dura and examine the brain.

**Fractures of the Base.**—A fracture of the base of the skull may exist in only one of the three fossae, in two of them, or it may involve all. Figure 327 shows an extensive fracture of the base of the skull. The middle fossa is oftenest involved. Fracture of the posterior fossa is the most fatal. These fractures may be due to direct violence, to indirect force, and to extension of a fracture of the vault. Extension from the vault is always by the shortest route. Fracture by direct violence may arise from the penetration of the nasal roof, the orbital roof, or the pharyngeal roof by a foreign body. The posterior fossa may suffer from a fracture by direct violence applied to the neck. Fractures by indirect force may arise from blows upon the frontal bone (the
Fractures of the Base

Fractures of the orbital portion of the frontal or the cribiform process of the ethmoid breaking, from falls upon the chin (the condyle of the jaw breaking the middle fossa), or from falls upon the buttocks, the knees, or the feet (fracture occurring in the posterior fossa). The base is very rarely broken by contre-coup (Treves).

Symptoms.—Fractures of the base of the skull are apt to be compound. A solution of continuity in the pharynx, roof of the nares, orbit, or ear permits access of air to the seat of fracture and allows blood and cerebrospinal fluid to flow externally. In fracture of the anterior fossa the fracture may be compound, because of laceration of the mucous membrane of the nares or of the conjunctiva. Blood may run from the nose, its source being the vessels of the mucous membrane or the dura, the fracture being compound. Epistaxis does not prove the fracture to be compound, but only suggests it; but if the epistaxis is prolonged, the probability is greatly increased; and if the flow of blood is succeeded by a flow of cerebrospinal fluid the diagnosis of compound fracture is positive. Cerebrospinal fluid only appears when the mucous membrane, the dura, and the arachnoid are each lacerated (Treves). In fractures of the middle fossa blood may flow from the ear through a tear in the tympanum, its source being the vessels of the tympanum, the meningeal vessels, or a sinus. Blood may flow through the Eustachian tube and come from the nose, may be spit up, or may be swallowed and vomited. In many cases a quantity of cerebrospinal fluid flows from the ear, the discharge being increased by expiratory effort and a position which favors gravity. The cerebrospinal fluid must not be confused with either blood-serum or liquor Cotunnii. The cerebrospinal fluid is always present in large amount; the liquor Cotunnii can only be present in minute amount. Blood-serum is highly albuminous; cerebrospinal fluid is a serous fluid of very low specific gravity, never shows more than a trace of albumin, and contains considerable chlorid of sodium and in some instances sugar, which, when present, reacts to Trommer's and to Moore's tests, but does not reflect polarized light nor ferment with yeast (Keetley, from Collins). Treves states * that cerebrospinal fluid cannot flow from the ear in fractures of the middle fossa (1) unless the line of fracture crosses the internal meatus, (2) unless the prolongation of the membranes into the meatus is torn, (3) unless a communication exists between the internal ear and tympanum, and (4) unless the drum-membrane is torn. Miles, of Edinburgh,† claims that bleeding from the ear followed by a flow of cerebrospinal fluid is not pathognomonic of fracture of the middle fossa of the base. He maintains that when the drum is ruptured we may have these signs, when bone is not broken, the chief source of the blood being the vessels of the pia and temporosphenoidal lobe, the blood and cerebrospinal fluid flowing inside the sheath of the auditory nerve, passing into the vestibule, through the lamina cribrosa, and from the vestibule into the middle ear, finding exits from this space by way of the Eustachian tube, and also through the rent in the drum-membrane. Profuse serous discharge may flow from the ear after an injury without fracture when the drum is ruptured, the fluid coming from the cells of the mastoid. It must be understood that fracture of the base may exist when

there is no flow of blood or of serous fluid. A fracture of the middle fossa is usually compound, made so, even when the drum is not ruptured, by the Eustachian tube, and there is often paralysis of the seventh or eighth nerve or of both of them. In fracture of the posterior fossa there is usually respiratory derangement and blood accumulates beneath the deep fascia and produces discoloration in the line of the posterior auricular artery (Battle's sign), the discoloration first appearing near the tip of the mastoid. The discoloration appears in the line of nerves and vessels which emerge from the deep fascia, the vessels passing through openings and the extravasated blood emerging from the same openings. Fractures of the posterior fossa are apt to be compound through the pharynx, and in such cases the patient spits or vomits blood. Compound fractures of the posterior fossa are more fatal than fractures in either of the other fossae. Fractures of the base are apt to be associated with paralysis of cranial nerves. Optic neuritis often arises after the first week. In fractures of the base the temperature is subnormal during the shock, rises to 106° to 107°, falls again to about normal, and remains normal or subnormal unless there be inflammation or sepsis. Lumbar puncture may obtain bloody fluid. Such a finding means subarachnoid bleeding and indicates fracture. Harte ("Annals of Surgery," Oct., 1901) has collected 46 positive cases of fracture of the base of the skull from the records of the Pennsylvania Hospital; 35.5 per cent. recovered.

Treatment.—In treating a compound fracture of the base of the skull, collect any serous discharge and analyze it, and disinfect any cavity involved. In fractures of the middle fossa with ruptured drum clean the ear mechanically, wash it out with hydrogen peroxid and with a stream of warm corrosive sublimate solution of a strength of 1:2000 (turn the head toward the affected side while washing, so that the mercurial solution will not run down the Eustachian tube), insufflate iodoform, pack with iodoform gauze, and apply an antiseptic dressing. Several times daily the ear is to be irrigated, and insufflated with iodoform. The nasopharynx must be frequently irrigated with normal salt solution or boric-acid solution, and insufflated with iodoform. The conjunctival sac is frequently irrigated with boric-acid solution. If after a head-injury blood accumulates back of the drum, this membrane should be incised to permit of drainage and disinfection. In fractures of both the middle and anterior fossae and in fractures of the posterior fossa communicating with the pharynx the nasopharynx must always be cleaned. The exact method depends on the choice of the surgeon. We may wash out these cavities frequently with hot water, next with peroxid of hydrogen, and finally with boric-acid solution, or can use normal salt solution. After washing insufflate the nasopharynx with iodoform, and pack the nose with iodoform gauze (Keen, Dennis); also cleanse the conjunctival sac frequently. In some cases drainage has been obtained from the anterior fossa by breaking through the cribriform plate and introducing a tube by way of the nostril (Allis), and from the middle fossa by trephining above and behind the external auditory meatus. In a compound fracture of the orbit disinfect and drain. It may be necessary to trephine the roof of the orbit to secure drainage. In fracture of the posterior fossa examine to see if the fracture is compound, into the pharynx, and if it is cleanse with great care the nasopharynx, and mouth, as previously directed. In a very extensive fracture of the base, besides use of the methods set forth above, the entire head
Wounds of the Brain

should be shaved and a plaster-of-Paris cap be applied. Cases of fracture of the base must be put into a quiet and darkened room and be kept upon a low diet, sleep being secured, and the bowels and bladder being attended to. If we are uncertain as to whether a fracture exists or not, keep the patient quiet and in a darkened room, and on a low diet. Attend to the bladder, keep the bowels loose, examine the nasopharynx with mirrors and the drum through a speculum.

Wounds of the brain are produced by violence and by foreign bodies (knives, bullets, etc.). Except when due to penetration of a fontanelle in a child or of a parietal foramen in adults, wounds of the brain are accompanied by fracture of the skull. These wounds are very dangerous: foreign bodies (bone, hair, clothing, etc.) are often lodged in the brain, hemorrhage is usually severe, and sepsis is almost inevitable without proper treatment. Such cases are very fatal, though some astonishing recoveries are on record. Figures 328 and 329 show gunshot-fractures of the skull.

The symptoms of brain-wounds may be slight and long-deferred or may be immediate and overwhelming; they depend upon the site and extent of the injury. Localizing symptoms may exist, and encephalitis with coma is apt to arise. Abscess not unusually follows.

In treating wounds of the brain always shave the entire scalp and examine the weapon, if possible, to see if a piece were broken off. Asepticize, enlarge the wound, trephine, arrest bleeding, elevate any depression, remove foreign bodies, irrigate the wound, suture the dura, drain, and dress.
Gunshot-wounds of the Head.—A *penetrating* wound is one in which the bullet enters the head, but does not emerge; a *perforating* wound is one in which the bullet passes through the head and emerges. The bullet of the modern rifle will rarely lodge, but a pistol-bullet will often lodge. The wound of entrance is small; the wound of exit is large. At the wound of entrance the inner table is more extensively fractured than the outer table; at the wound of exit, the outer table is more widely broken than the inner table. In these cases there is always great concussion, and concussion-symptoms exist even when the bullet has not entered the brain. In moderate concussion the action of the heart is retarded; in severe concussion it is accelerated.* A bullet may be lodged within the cranium when merely a fracture without a bullet-hole can be detected. In these cases the bullet produces a fracture and enters the cranium, and then the depressed bone flies back into place (v. Bergmann). In such cases, if complete perforation occurs, the one existing opening is the opening of exit. A bullet may lodge in the bone, between the dura and the bone, in the brain, between the dura and bone of the opposite side, or in the bone of the opposite side, in the nasal fossa, maxillary antrum, or orbit. Always examine the side of the head opposite to the wound of entrance to determine if there is any bulging or fracture. A bullet may pass across the brain and be deflected from the inner surface of the skull (Fluhrer). Ruth does not believe the bullet can rebound from the opposite wall.† The secondary symptoms of gunshot-wounds of the head are varied and uncertain, and may not be observed at all before death. Fowler wisely points out that a patient with a gunshot-wound of the head may have also received other injuries, and the other injuries may be in part, at least, responsible for cerebral symptoms.  

**Treatment.**—Bring about reaction (see Concussion). In severe cases apply heat to the head, and make artificial respiration. It will sometimes be necessary to operate while artificial respiration is being made. In treating gunshot-wounds of the head shave and asepticize the whole scalp, disinfect the entire track of the ball, and arrest hemorrhage at the wounds of entrance and exit, using the rongeur to expose the bleeding points if the bullet be large, employing the trephine if it be small. If the bullet has emerged and has been picked up, examine it to see if it is entire. The bullet, if retained, is to be sought for. Place the head in such a position that the track of the ball will be vertical, then introduce Fluhrer's aluminum probe and let it find its way by gravity. The probe may find the ball near the wound of entrance, in which case extract the ball with forceps; or the probe may find the ball near the opposite side of the head, in which case make a counter-opening through the bone at a point the probe would touch if it were pushed entirely across. Take a new and *clean* rubber catheter (No. 9, French), insert a stylet, and carry the catheter through the wound (Keen). Knowing the depth of the ball, search for it around the catheter-tube as an axis, and when found extract it. After extraction drain the wound by means of a tube. When a counter-opening exists, drain through and through. If the ball cannot be detected, drain by a tube carried to the depths of the wound. After dressing always place the head in a position favorable for drainage. Fluhrer tells us that when a counter-opening fails to disclose the bullet, use the new opening as a doorway through which to

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† See the instructive article by Fowler, in Annals of Surgery, Nov., 1895.
search for the ball. He believes the bullet is not unusually deflected. The angle of deflection is somewhat greater than the angle of incidence, and the bullet is apt to fall a little toward the base. Splinters of bone are often driven into the brain by a bullet, and these are removed whether the ball is found or not. Several varieties of probes have been commended. Fluhrer uses a large-sized aluminum probe. Senn uses an instrument shaped like the Nelaton probe, but of the same diameter as the bullet (Fig. 330). (Of course, the porcelain probe will not show a black mark from contact with a modern bullet.) Fowler uses a graduated pressure-probe; so long as the pressure is within the limits of the spring, as shown by the scale, the probe is in the bullet-track. Girdner's telephonic probe is a valuable aid to diagnosis. Recently bullets have been located by the Röntgen rays. There can be no doubt that many gunshot-wounds have been recovered from without operation, and it is beyond question that many deaths follow operation (about 33 1/3 per cent., according to Hahn). Von Bergmann is so impressed with these facts that he does not operate when cerebral symptoms are absent.

Fungus cerebri (hernia of the brain) rarely contains true brain-substance. It is in most instances a growth from the neuroglia. Hernia cerebri cannot occur if the dura is not opened; it is rare in any case unless the brain is damaged, and is most frequent after septic wounds. In any brain-operation if the dura is opened suture it; or, if there be a great gap in the dura, turn in a flap of pericranium, its bone-forming surface being upward, and stitch this membrane to the dura (Keen). The evidence of brain-hernia is a protruding mass which is soft, lobulated, of a dirty white color, pulsating, painless to the touch, often bleeding, and sometimes discharging cerebrospinal fluid. In treating a brain-hernia employ antiseptic dressings. Skin-grafting benefits some cases. Pressure is dangerous. Excision by the knife or cautery does no good. After healing, a depression marks the site of the hernia.

Traumatic inflammation of the brain and its membranes is divided into encephalitis or cerebritis, inflammation of the cerebrum; cerebellitis, inflammation of the cerebellum; meningitis, inflammation of the meninges; arachnitis, inflammation of the arachnoid; pachymeningitis, inflammation of the dura; and leptomeningitis, inflammation of the arachnoid and pia.

Pachymeningitis.—Inflammation of the external layer of the dura is called pachymeningitis externa. It may arise from tumor, caries, necrosis, middle-ear disease, sunstroke, or traumatism. Syphilis is not unusual cause. The other membranes may become involved. Suppuration may arise, having extended by contiguity from neighboring parts. The symptoms of pachymeningitis externa are uncertain. They resemble often those of leptomening-
Diseases and Injuries of the Head

Pachymeningitis (page 617). Pressure-symptoms may arise. Headache is always present. Paralysis may or may not exist. If pus forms, the ordinary constitutional symptoms of suppuration are evident (high temperature and sweats), not the symptoms of abscess in the brain. In a severe case the other membranes become involved.

The treatment consists in removing the cause (carious bone, pus, middle-ear disease). In pachymeningitis from traumatism it is sometimes advisable to trephine in order to drain inflammatory products; in a case with localizing symptoms always trephine; in an ordinary case, without pus and with no evidences of traumatism, use wet cups back of the mastoid processes, apply an ice-bag to the head, and purge by means of calomel. Administer iodid of potassium in most cases. If sunstroke is the cause, treat according to ordinary medical rules.

Pachymeningitis interna may extend from the pia, or may extend from the outer layer of the dura. The form known as hematomata of the dura mater, or pachymeningitis interna hemorragica, may arise during infectious diseases (typhoid fever and rheumatism), in persons of the hemorrhagic diathesis, in diseases causing atrophy of the brain, in chronic diseases of the heart and kidneys, and in syphilitics. Among the exciting causes are traumatism, inflammation in adjacent parts, and, especially, the abuse of alcohol. In this disease blood is extravasated on the inner surface of the dura. Many observers do not class hemorrhagic pachymeningitis as inflammation, but regard the hemorrhage as primary.

The symptoms of internal pachymeningitis are very chronic, are not characteristic, and may be absent. They consist usually of persistent headache and apoplectiform attacks, with contraction of the pupil, slow pulse, and vomiting. Choked disk is not infrequent, localizing symptoms may be made out, and coma is apt to arise.

The treatment is the same as that for external pachymeningitis.

Acute leptomeningitis is a purulent inflammation of the soft membranes of the brain. The pathological changes can be noted in the pia and in the brain-substance. The brain is edematous, the pia purulent, the convolutions are flattened, the ventricles are distended with fluid, and hemorrhages occur into the brain-substance. Pus may be localized upon the pia, but it is usually diffused over one hemisphere or over both. Various organisms may be found, especially streptococci, staphylococci, and diplococci. In some cases we find the bacillus pyocyanus or the bacillus pyocyanus feotidus, which is identical with the colon bacillus and with the bacillus meningitis purulenta (Park). Saprophytic organisms are occasionally present. This disease may be acute or chronic, and a severe case is spoken of as encephalitis. Secondary leptomeningitis is apt to affect the convexity; primary leptomeningitis is apt to affect the base.

The causes of leptomeningitis are epidemic cerebrospinal fever, tuberculosis, acute general diseases (pneumonia, typhoid, erysipelas, and rheumatism), bone-diseases, traumatisms, middle-ear disease, syphilis, and sunstroke. The tissues of the pia and the cerebrospinal fluid contain diplococci identical with pneumococci. Infection may take place by various avenues. It may pass from the nose by way of the Eustachian tube to the ear, or from the nose to the frontal sinus or ethmoid sinuses (Hirt), and from these situations
Tuberculous Meningitis

to the brain. It may pass from the middle ear or mastoid to the membranes of the brain. In fractures at the base the organisms enter by way of the pharynx and the Eustachian tube, or the ear. The symptoms of acute leptomeningitis are violent headache persisting during delirium, flushing of the face, rigidity of the neck, cerebral vomiting, a slow pulse, elevated temperature, photophobia, contraction of the pupils, intolerance of sound, hyperesthesia of the skin and muscles, and delirium passing into stupor and coma. A chill or a succession of chills may occur. Choked disk, strabismus, and nystagmus are not unusual. Convulsions or paralyses may occur. Death is the rule within one week. The treatment usually consists of purgation with calomel; bleeding behind the mastoid processes; cold to the head; warm baths with cold affusions to the head; iodid of potassium, bromid of potassium, or morphin for vomiting and headache. A patient in this condition should be trephined in order to relieve pressure and to give exit to inflammatory products. It gives some hope of recovery, and the usually adopted medical treatment is practically useless. Should the patient recover, he is guarded for a long time from physical exertion, mental excitement, worry, irritation, constipation, and insomnia.

Chronic Leptomeningitis (or Encephalitis).—The causes of chronic leptomeningitis are the same as those of the acute form. If traumatism is the cause, the inflammation arises at a later period than it would in acute encephalitis. The symptoms of concussion follow a head-injury. Days, or even weeks, after the accident, a series of symptoms occur—namely: localized pain at the seat of injury, often accentuated by tapping; listlessness; irritability; apathy regarding business affairs and home obligations, or profound depression and hypochondria with inability to attend to business. Choked disk may exist. In any case acute encephalitis may arise, with or without a chill. The treatment of this disease is symptomatic unless local symptoms exist. Always operate if localizing symptoms are found. Intense local pain justifies trephining.

Tuberculous Meningitis (Acute Hydrocephalus; Water on the Brain).—This inflammatory condition is due to the bacilli of tuberculosis. In a child affected with tuberculous meningitis there is often a record of a fall, the injury acting as an exciting cause by establishing an area of least resistance. Prodromal symptoms are common (restlessness, irritability, anorexia, change of character). The disease begins with a convulsion or with headache, fever, and vomiting (Osler), the child cries out from pain (the hydrencephalic cry), and the bowels are constipated. The pulse is rapid in the beginning, but later becomes slow and irregular. The pupils are contracted, there is muscular twitching, and the sleep is impaired. The temperature is about 103°. In the second period of the disease the vomiting ceases, constipation becomes more marked, the belly retracts, headache is not so violent, and the patient lies in a soporose condition interspersed with episodes of delirium. In this stage the pupils dilate and are often unequal, the head is retracted, convulsions occur or limited rigidity is noted, the respirations are sighing, and if a finger-nail is drawn along the skin, a red line develops (the tâche cerebrale, due to vaso-motor paresis). Squint and consequent double vision are usual. In the last stage coma becomes absolute and general convulsions or limited spasms are apt to occur. Optic neuritis exists, and the child passes to death.
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along a road identical with that of typhoid collapse. In some cases the ex-
amination of cerebrospinal fluid withdrawn by lumbar puncture throws light
upon the diagnosis. In children the base is usually involved, and the disease
is apt to last from two to four weeks; in adults the convexity of the brain is
usually involved, and death is apt to occur in a few days.

The treatment is like that for traumatic meningitis.

Abscess of the brain is a localized collection of pus. The organisms
found are noted upon page 616 (Acute Leptomeningitis). The causes are
suppurative otitis media (in half of all the cases), fracture of the skull, con-
cussion of the brain, and general septic diseases. A tuberculous mass may
caseate (tuberculous abscess). The abscess may be between the dura and skull
(extradural), adhesions forming and preventing a general leptomeningitis,
between the dura and brain (subdural), or in the brain-substance (cerebral or
cerebellar). Leptomeningitis may arise because no adhesions are created, be-
cause septic clots form in veins or sinuses, or because infected blood regurgitates
into the sinuses (Park). A traumatic abscess is generally beneath the area to
which the traumatism was applied, but it may be on the opposite side. The
infection may begin in the nose, the orbit, or the middle ear (page 616).

Roswell Park says infection may pass along blood-vessels, lymph-vessels,
nerve-sheaths, or the prolongations of the membranes which extend outside
of the skull. An acute inflammation of the middle ear rarely causes abscess,
because an acute inflammation in sound tissues causes the formation of granu-
lation tissue, which acts as a barrier to infection. Chronic inflammation of
the middle ear is the most frequent cause of abscess. Park tells us if the roof
of the tympanum is involved, it is perforated and abscess of the middle fossa
ensues; if the tympanum is perforated toward the mastoid antrum, the abscess
arises in the temporosphenoidal lobe; if the perforation is toward the sigmoid
groove, the abscess forms in the cerebellum.*

Symptoms of Abscess of the Cerebral Substance or of the Cerebel-

* Park, in Chicago Med. Record, Feb., 1895.

Symptoms of Abscess of the Cerebral Substance or of the Cerebel-

— The symptoms due to pus-formation are as follows: There may be an
initial rise of temperature, but (except in extradural abscess) the tempera-
ture quickly becomes normal or even subnormal. Subnormal temperature
is not nearly so common as is usually supposed. It has been present in
about one-half of the cases I have seen. Toward the end of the case the
temperature may rise and the fever become linked with delirium. Surface
elevation of temperature over the seat of the abscess is occasionally observed.
A chill may or may not occur. Anorexia and vomiting are present. Urinary
chlorids are diminished and the phosphates are increased (Somerville).

Symptoms due to pressure are: headache (which at first is general, then
local, and grows worse later in the case, and exists even in delirium; this fact
distinguishes it from the headache of fever, which ceases in delirium); pulse
is very slow; respiration tends to the Cheyne-Stokes type; drowsiness lapses
into stupor and stupor passes into coma; paralysis of the sphincters takes
place; convulsions are common; sensation is rarely impaired; and paralysis
of the basal nerves may occur (third and sixth especially). The pupil on the
same side as the abscess is dilated and fixed. Choked disk is not invariably
found; if it is unilateral, it is on the same side as the abscess; if it is bilateral,
it is more marked on the same side as the abscess. Localizing symptoms,
spasmodic and paralytic, depend upon the center which is irritated or destroyed. In cerebellar abscess there are vertigo, vomiting, occipital headache, rigidity of the post-cervical muscles, incoordination, but choked disk is often absent.

Meningitis arises soon after an accident; an abscess, more than a week, and often many weeks, after an accident. Meningitis presents high temperature and the general symptoms before outlined. Mastoid disease may occasion cerebral symptoms without abscess, or it may cause abscess. In sinus-thrombosis there is septic temperature, the veins of the face and neck are enlarged, and a clot can usually be felt in the jugular. A tumor grows slowly, usually presents almost from the start localizing symptoms, and double choked disk is frequently present. In tumor the temperature is apt to be normal.

Treatment.—If abscess is due to ear disease with implication of the mastoid cells, at once open and clean out the mastoid, and after this proceed to trephine the skull in order to reach the abscess. In any case, if symptoms of abscess exist, trephine the skull at once. If localizing symptoms are present, open over the suspected region. If localizing symptoms are not present and the cause is ear disease, trephine at Barker’s point (Fig. 318). If no pus is found between the bone and dura, open the membrane. When the dura is opened, if the abscess is subdural pus will be evacuated; if the abscess is in the brain-substance, the brain will bulge very much and will not be seen to pulsate. A grooved director is plunged into the brain, in the direction of the abscess, for two or two and a half inches (Keen). If pus is not found, withdraw the director and introduce it at another point. When pus is discovered, incise the brain with a knife, enlarge the opening by inserting a closed pair of forceps and withdrawing the instrument with the blades open. Scrape away the granulation tissue lining the abscess-cavity, irrigate with hot salt solution, and introduce a rubber drainage-tube; stitch the dura, but leave an ample opening for the tube; bring the tube out through a button-hole in the scalp, and after the first two days pull the tube out a little every day and cut off a piece. If the first trephining does not find pus, trephine again at another point. In cerebellar abscess make a flap with the base up, and trephine or gouge away the bone just below the line of the lateral sinus. Puncture the brain as for cerebral abscess.

Brain Disease from Suppurative Ear Disease.—Chronic disease of the middle ear is apt to destroy the bone between the tympanum and the middle fossa of the skull, and thus produce meningitis, thrombosis of the petrosal or lateral sinuses, abscess of the temporosphenoidal lobe or of the cerebellum, or extradural abscess. Chronic otitis media also induces inflammation or suppuration of the mastoid cells (empyema of the mastoid). Pus in the mastoid may discharge itself into the middle ear, and from this point into the external auditory canal, through a perforation in the drum-membrane (especially in acute cases). In some cases the pus becomes blocked up within the mastoid process. Pus in the mastoid may after a time break into the cavity of the cranium or into the lateral sinus, or may find its way externally and open into the sheaths of muscles arising from the mastoid. It not unusually opens into the sheath of the digastric muscle (Bezold’s abscess). These facts teach the surgeon that chronic ear disease
should never be neglected, but should, if possible, receive the closest attention of the specialist. If no perforation exists in the drum, the surgeon must make one. In ordinary cases cleanliness and antisepsis are sufficient, the ear being syringed every day with a warm 2 per cent. solution of common salt. If only a small drum-perforation exists, 10 drops of pure alcohol or of corrosive sublimate solution (1 : 5000) are dropped into the ear daily; but if a large drum-perforation exists, boric acid and iodoform (7 to 1) are insufflated. Never inject alum. A strong silver solution is not safe; if it is used, wash the ear out afterward with warm salt water. If granulations or polypi exist, they must be removed. Some cases require the removal of the drum-membrane and the ossicles of the ear. Many cases of mastoid necrosis are due to tuberculosis. If headache, vomiting, and mastoid tenderness exist, open the mastoid (see Operations), in order to prevent abscess of the brain. In acute otitis media it is very rarely necessary to open the mastoid. The middle ear is on a lower level than the antrum of the mastoid, and in most acute cases both the middle ear and mastoid cells drain safely through a drum-perforation. Because a man has chronic otitis media it is by no means always necessary to trephine the mastoid. In many cases removal of the ossicles and drum-membrane effects a cure. In chronic otitis media, even if the mastoid is trephined, the ossicles and membrane ought to be removed.

**Cerebral abscess from ear disease** is almost always in the temporo-sphenoidal lobe, but may arise in the cerebellum. The **symptoms** are a transient rise of temperature followed in many cases by a normal or subnormal temperature; vomiting; mastoid, frontal, and temporal pain. The mind is dull, and stupor arises which passes into coma; the bowels are constipated; choked disk may be present; and convulsions or spasms or paralyses may exist. Trephine and clean out the mastoid, and asepticize (see Operations upon the Skull and Brain). Also trephine at Barker's point, one and one-fourth inches behind, and the same distance above, the middle of the external auditory meatus, open the dura and seek for pus. If pus is not found, open the cerebellum.

**Extradural Abscess.**—The eye-symptoms and pain are the same in this as in cerebral or subdural abscess, but the temperature is different, rising to 103° or 104° F. There is often considerable tenderness above and behind the mastoid. In extradural abscess following disease of the middle ear, trephine and clean out the mastoid; follow up a bone-sinus to the abscess, rongeur away the bone, being careful to avoid injuring the lateral sinus; curet, irrigate, and drain.

**Infective Sinus-thrombosis.**—Any sinus may be attacked. The disease may result from scarlet fever, smallpox, diphtheria, influenza, typhoid, or any acute suppuration. In erysipelas of the scalp, septic clots may form in the veins which pass through the bone and reach the longitudinal sinus. Infective thrombosis of the superior longitudinal sinus is thus produced.

In carbuncle of the lip and orbital suppuration the cavernous sinus may become involved.

In caries of the basilar portion of the occipital bone the circular sinus or the cavernous sinus may suffer. In caries of the petrous portion of the
Infective Sinus-thrombosis

Infective Sinus-thrombosis of the lateral sinus may occur.

In any case the symptoms are those of pyemia. The lateral sinus is the one most frequently attacked. In infective thrombosis of the lateral sinus there is usually a history of an old discharge from the ear.

Infective thrombosis of the lateral sinus may result from a specific fever, but is usually due to chronic suppuration of the middle ear associated in most cases with carious bone and pus in the mastoid process. Thrombosis of the lateral sinus occasionally follows an operation upon a suppuring mastoid, or develops in an individual who suffers from middle-ear disease who has been struck upon the head, who has had the ear syringed with force, or who has had injected a corrosive or very irritant fluid. Tuberculous bone disease is an occasional cause.

Symptoms.—In most cases there is a history of chronic ear disease. In children the symptoms are more acute than in adults. In any case the symptoms may rapidly become violent. In some cases there are preliminary symptoms of extradural abscess, pus being lodged in the groove of the sinus. It has been pointed out that pus in the jugular foramen may make pressure upon the pneumogastric, spinal accessory, and glossopharyngeal nerves, producing aphony, hoarseness, dyspnea, dysphagia, and slow pulse (Geo. F. Cott*). Marked headache ushers in sinus-thrombosis. The pain is apt to be localized about the ear and mastoid process, but may become general. There is usually tenderness of the mastoid. There is high fever from the start, but when the clot begins to soften and break down, hard rigors develop and the temperature fluctuates violently. The temperature varies each day between subnormal and 106° to 107°. A chill may occur once or even twice a day, and it lasts from ten to twenty minutes. The pulse is soft and usually rapid. The patient is nauseated, labors under vertigo, is very restless, is dull and stupid, sometimes delirious, and the muscles of the neck are stiff. Tenderness and marked edema are detected over the mastoid. When the clot extends into the jugular vein there is pain on moving the head and on swallowing, the cervical glands are swollen, and a clot may be felt in the neck. Choked disk exists in about half of all cases. There is often a profuse discharge of pus from the ear, but in some cases the discharge is found to have abated or ceased. Exophthalmos and swelling of the eyelids point to involvement of the cavernous sinus in the process. In early cases there is thrombosis of the lateral sinus alone, or of the lateral sinus and jugular vein. The internal jugular vein may be felt as a cord in the neck. In advanced cases other sinuses become involved (superior petrosal, inferior petrosal, both cavernous, the lateral sinus of the opposite side, the ophthalmic veins, and the torcular Herophili). A patient with sinus-thrombosis is in great danger of developing pulmonary metastasis and septic meningitis (Jansen). Septic meningitis is accompanied by abscess about the sinus. Sinus-thrombosis is a very fatal disease and usually runs its course in from seven to ten days, but occasionally lasts for weeks. It is a form of pyemia and death arises from the causes which have been referred to in discussing that disease.

Infective thrombosis of the cavernous sinus causes the general symptoms of pyemia and also edema of the lids, and exophthalmos.

Infective Thrombosis of the Petrosal Sinus.—Produces pyemic symptoms, but no characteristic signs.

The prognosis largely depends upon early recognition. The surgeon should, whenever it is possible, open a mastoid before sinus-thrombosis arises, and should evacuate an abscess about the sinus before a clot forms in the venous channel, or at least before that clot becomes septic (Jansen).

Treatment.—In 1880 Zaufal proposed the operation now practised, and Horsley did it in 1886. (See article by Geo. F. Cott, in "American Medicine," April 19, 1902.) Infective thrombosis of the lateral sinus is treated as follows: Open and clean out the mastoid, and expose the sinus by the use of the chisel or rongeur (Fig. 336). Open the venous channel, and if a clot is found to exist cut away the wall of the sinus. Introduce a small spoon into the lumen and carry it toward the torcular Herophili, and scrape away the clot until blood flows. Arrest hemorrhage by plugging a piece of iodoform gauze into the wound and toward the torcular. Jansen opposes removing the entire clot toward the jugular, and does not tie the jugular, believing that to do so increases the danger of thrombosis of the inferior petrosal and cavernous sinuses. He simply removes the soft clot, but does not disturb the solid clot toward the heart. Most surgeons differ with him, and after opening the sinus, turning out the clot, and packing, proceed to ligate the jugular vein at the level of the cricoid cartilage. If, after this operation, the clot in the jugular becomes septic, incise the vein up to the base of the skull and pack. Surgeons are of the opinion that it is futile to do any operation if pulmonary metastasis has taken place. In a recent case of the author's in the Jefferson Medical College Hospital the patient recovered after operation in spite of the fact that endocarditis had developed.

Until recently it was thought that the lateral sinus was the only sinus which should be attacked surgically, but in a case Knapp, of New York, requested Hartley to remove from the cavernous sinus a clot which was causing blindness and was due to sarcoma. The operation was successfully executed by Hartley, the incision being the same as is employed to reach a Gasserian ganglion in the Hartley operation. This patient lived several months. Another case was operated upon by incision of the sinus by Dwight (E. W. Dwight and H. H. Germain, "Boston Med. and Surg. Jour.," May 1, 1902). Some surgeons advise removal of the eyeball and curetment of the sinus.

Intracranial Tumors.—An encephalic tumor may originate within the skull. It may have arisen from an external growth invading the cranial cavity, or may be metastatic. A tumor that arises within the cranium may take origin from the periosteum, from one of the membranes of the brain, from the vessels, from the neuroglia, or from the brain-substance.

No region of the body is so liable to tumors as the brain. During the course of a number of years, the autopsies of the Munich Pathological Institute are stated by Bollinger to have shown one tumor of the brain in every 85 autopsies. Hale White's experience is that such tumors are even more common than this, and he estimates them at one in every 59 autopsies.

In endeavoring to determine the causes of intracranial tumors, we must accredit heredity with considerable influence in tuberculosis, and possibly
Intracranial Tumors

with some force in sarcoma and carcinoma. These tumors are decidedly more common in males than in females, probably because of the greater male liability to injury, syphilis, and alcoholism.

The majority of cases of tumor of the brain occur between the ages of twenty-five and fifty. Children are particularly prone to suffer from glioma and from tuberculous growths. In aged persons a tumor of the brain very rarely develops.

Injury may be responsible for the development of sarcoma, of fibroma, and possibly of other forms; in fact, a syphiloma may arise in a syphilitic person at the seat of an injury.

We use the term intracranial or encephalic tumor not only to include true neoplasms, but also to designate growths of parasitic, syphilitic, or tuberculous origin. It is of importance to attempt to make a diagnosis as to the form of tumor that is present; and this may be possible, on account of the fact that in many cases the form affects the symptoms. A useful classification of these growths has been made by Knapp, and is as follows: (1) the infective granulomata, including tuberculous growths, gummata, and actinomycotic areas; (2) connective-tissue growths; (3) epithelial growths; (4) aneurysms. The most common of all these tumors is undoubtedly that due to tubercle. In fact, Gowers estimates that if we exclude syphiloma, tubercle is responsible for one-half of the cases; and glioma and sarcoma together, for one-third.

**Tuberculous Tumors.**—Tuberculous tumors are the most common form met with. They may be single, but are often multiple; and multiple growths may be very widespread. A tuberculous tumor usually arises in the membranes or in an arterial distribution, but may begin in a ventricle, or even in the brain-substance. The tubercle bacilli responsible for the condition are carried by the blood. A large tuberculous tumor is due to the coalescence of many foci. It undergoes caseation in the center, and is surrounded by a zone of softened or sclerotic brain-substance.

**Gummatous Tumors.**—We may find a single gumma, but, far more often, syphilitic growths are multiple. Such a growth may be round, or may be irregular in outline; in fact, the outline is frequently blurred and indistinct. Some of these growths are soft, and some, which contain a quantity of connective tissue, are hard. A syphiloma usually arises from the membranes, and, hence, is generally on the surface of the brain; and the membranes in the region of the growth usually show distinct inflammation.

**Actinomycosis.**—This is a very rare condition, in which the mass may remain solid like a tumor, but is far more apt to break down into an actinomycotic abscess.

**Sarcoma.**—Injury seems to play a considerable part in the production of intracranial sarcoma. Any variety of sarcoma may arise. As a rule, at least in the beginning, the growth is single; but it may be multiple, or may become so. The majority of sarcomata arise from the membranes or from the periosteum, but some cases take origin from beneath the cortex. Early in their progress these growths are encapsulated, but some of them, from the very start, are infiltrating; and even those that were at first encapsulated later infiltrate. Endothelioma is sometimes met with. What is called angioma of the brain is, in reality, angiosarcoma. A psammoma is usually sarcomatous.
Diseases and Injuries of the Head

Gliomata.—A glioma is a growth so ill defined and so slightly differentiated in appearance from the brain-substance that it may easily be overlooked in an exploratory operation. It arises much more frequently from the white than from the gray matter, and develops from the neuroglia of the cerebrum, of the cerebellum, of the pons, or of the medulla oblongata. A glioma may be soft or may be hard; and soft gliomata are probably, in reality, sarcomata. Hemorrhage is very apt to occur in these growths.

Fibromata.—Intracranial fibroma is a rare growth. It is of firm consistence, is encapsulated, and may grow to a large size. Such growths can be readily enucleated. Injury seems occasionally to be responsible for their formation.

Osteomata.—Osteophytic growths not uncommonly take origin from the inner surface of the skull, but the osteomata arising in the dura or in the brain-substance are rare. Such growths, however, occasionally occur.

Cholesteatomata.—These tumors are fibrous growths covered with endothelium and containing layers of cholesterin. They are particularly apt to arise in the pia mater, but may begin in either of the other membranes or in the brain-substance. A cholesteatoma is commonly called a pearl tumor.

Enchondromata and true neuromata are rare, and lipomata are excessively uncommon.

Adenomata.—An adenoma occasionally springs from the conarium, or pituitary body.

Carcinomata.—Primary intracerebral carcinoma is rare, but does occur. Secondary carcinoma is more common, and may follow cancer of any part of the body, although it is most apt to follow cancerous growths about the face and neck. A primary growth may begin in the meninges or in the lining of the ventricle. Intracerebral carcinomata may be single or multiple. They are soft and non-encapsulated growths.

Cysts.—Mills says that cysts arise about an old hemorrhage, are small retention-cysts of a vascular plexus, or are porencephalic. Dermoid cysts are extremely rare.

Symptoms.—The symptoms are diffuse and local, and are similar in many particulars to the symptoms of some other lesions. Among the symptoms of tumor are headache, slow speech, stupor or coma, slow pulse, pain on percussion of the cranium, vertigo, vomiting, epileptic convulsions, double choked disk, partial or complete blindness, extensive or limited paralyses, paralysis of the face, the eye-muscles, or the limbs, zones of anesthesia and aphasia, word-deafness, word-blindness, agraphia, inco-ordination, and mental disturbances. The situation of a tumor is determined from localizing symptoms, their mode of onset and manner of combination. In some cases the symptoms are not characteristic, and in some cases there are no localizing symptoms. The nature of the tumor, its depth, and whether it is single, and if other tumors exist, is, if possible, determined. Localizing symptoms may be due to irritation or destruction of functioning power. Irritation causes spasm and destruction induces paralysis. Convulsions which are local or which begin locally are known as Jacksonian epilepsy. A local convulsion points to an irritative lesion of, or immediately adjacent to, the center which presides over the muscular movements of the part convulsed. Local paralysis points to a destructive lesion of the center which presides
Tumors of the Pons

over the movements of the paralyzed part. In some cases a center is damaged and the muscular movements it controls are paralyzed, but the adjacent brain-areas are irritated and the muscles they represent are attacked with spasms. In some cases an apparently paralyzed part becomes convulsed, the center not being completely destroyed and sudden hyperemia serving to awaken spasm. Always note the order of invasion of different regions and observe if spasm is followed by muscular weakness or anesthesia.

1. Lesions in the Cortical Motor Area.—An irritative lesion of the lower third of this area causes spasm of the opposite side of the face, angle of mouth, or tongue; and this condition is often associated with tingling (Osler). The spasm may remain limited or may extend widely, and may even become general. Tumors of the third frontal convolution of the left side cause motor aphasia. An irritative lesion of the middle third of the cortical area causes spasm, which is limited to or begins in the fingers, thumb, wrist, or shoulder (Osler). An irritative lesion of the upper third of the cortical motor area causes spasm, which is limited to or begins in the toes, ankle, leg, or hip. If such lesions exist an aura is occasionally felt in the affected region before the spasm begins, and there is often numbness after the spasm. Destructive lesions of the motor area cause local paralysis, which may be preceded by local spasm of the same parts, and is often associated with local spasm of other parts.

2. Tumors of the prefrontal region give no localizing symptoms, but produce general symptoms. Mental disorders are apt to occur. As the tumor grows it may subsequently involve the motor region.

3. Tumors of the parieto-occipital lobe may occupy a silent region of this lobe. There may be blindness or paraphasia when the angular gyrus is affected.

4. Tumors of the occipital lobe produce homonymous hemianopsia.

5. Tumors of the temporosphenoidal lobe frequently produce no symptoms. Tumors in the left lobe may cause deafness.

6. Tumors of any size in or about the corpus striatum cause hemiplegia by pressure upon the internal capsule. Pressure upon the optic thalamus produces hemianopsia and hemianesthesia. Growths near the basal ganglia produce intense optic neuritis and early pressure because of distention of the ventricles. Osler tells us that tumors of the corpora quadrigemina are apt to involve the crura, and later the third nerve. Ocular symptoms are always present (loss of pupillary reflex and nystagmus). If the third nerve is involved, there are paralysis of the motor oculi area on the side of the lesion (external strabismus, dilated pupil, and drop-lid), and hemiplegia of the opposite side of the body from pressure upon the crus. This condition is a form of crossed paralysis.

7. Tumors of the Pons.—Pontine lesions produce symptoms by pressure upon the particular nerves which come from this region, with or without the evidences of pressure upon the motor path. Forms of crossed paralysis may exist. Lesions in the lower half of the pons may affect the fifth, sixth, and seventh nerves on the side of the lesion, and the limbs on the opposite side. The auditory nerve may be involved in the lesion. In crossed paralysis the face on the side of the limb paralyzed is usually not affected, but in extensive tumors it may be paralyzed. Conjugate deviation may occur away
from the *facial paralysis*. In tumors of the upper part of the pons the pupils may be first contracted from irritation of the third nuclei, and later dilated from destruction of these nuclei. Anesthesia as a result of pontine tumors is not nearly so common as is motor paralysis, and convulsions are rare.

8. Tumors of the Medulla.—An extensive lesion inevitably causes death. Cranial nerves only may be involved, but crossed paralysis may take place. Vomiting is common, retraction of the head is not unusual, respiratory and circulatory disturbances and dysphagia are frequently noted; sometimes there is numbness, and occasionally there are convulsions; usually there is inco-ordination, because of pressure upon the cerebellum.

9. Tumors of the Cerebellum.—*Tumors of the middle peduncle* cause sudden uncontrollable movements of the trunk, either toward the side of the tumor or away from it. Vertigo and nystagmus are common. Symptoms are frequently complicated by evidences of pontine disease proper.

*Tumors of the middle lobe of the cerebellum* cause a sense of lost equilibrium and obvious unsteadiness in attempting to walk, or even to stand (Gowers). The patient has a tendency to fall; there are giddiness and vomiting.

*Tumors of the cerebellar hemispheres* produce no localizing symptoms. The usual unsteadiness of gait is due to pressure upon the middle lobe (Nothnagel).*

Treatment.—If any doubt exists as to the nature of a brain tumor, give the patient a course of iodid of potassium, and as doubt is the rule, we almost invariably administer it. Give the drug at first in small amounts, but rapidly increase it until heroic doses are taken (100 or more grains a day). Mercury should also be given hypodermatically. If iodid of potassium and mercury relieve the symptoms, operation is unnecessary, although it may be demanded later in order to remove an irritant scar. If antisyphtilitic treatment fails, the question of operation must be considered. In many cases of undoubted tumor excision for cure is not attempted because of the absence of localizing symptoms or because of the inaccessible situation of the growth. Tumors at the base, tumors of the pons and medulla, of the corpus callosum, of the basal ganglia, and of the deeper parts of the centrum ovale, are irremovable (Byrom Bramwell). Most tumors of the cerebellum should not be attacked. In tumors which are very extensive complete removal is usually out of the question. There is no use in removing secondary malignant tumors. It often happens that the brain itself (as in syphilis) is so extensively diseased, or that other organs (as in tuberculosis) are so involved, as to render attempts at removal futile. Bramwell tells us † that he has studied eighty-two cases of intracranial tumor, and he considers that in only five of them could the tumor have been entirely removed. The conclusion is that though some tumors of the brain may be successfully removed, extirpation is only to be decided on after careful study of all the indications and contraindications offered by the case. The fibromata constitute the best cases for operation. In cases not operated upon it may be necessary to use the bromids for convulsions and morphin for

* For full consideration of localizing symptoms, see the works of Gowers, Mills, Dercum, and Osler, which have been freely used in writing the above section.
headache. The headache is often benefited by purgatives, courses of potassium iodid, the ice-bag to the head, and the application of a hot iron to the nape of the neck. Though thorough extirpation is feasible in but few cases, operation should often be performed for palliative purposes. Grainger Stewart, Annandale, Horsley, Macewen, and Keen have advocated palliative trephining in certain cases.

This procedure is of value in diminishing excessive intracranial pressure, and thus relieving headache and decreasing the tendency to sudden death from inhibition of the heart or respiratory failure (Hughlings Jackson and Byrom Bramwell).

Palliative trephining may relieve optic neuritis, and thus retard or prevent atrophy and blindness. Bramwell asserts this positively, and he still believes that excessive intracerebral pressure is an important element, though not the only element in neuritis.

Most cases of tumor should be trephined for exploration; in some cases extirpation may be performed; in most cases extirpation is impossible, and the surgeon must be content with the palliative influence of trephining. A tumor of the brain if not cured by antisyphilitic treatment, is of necessity fatal if unoperated upon, and trephining is not a very dangerous operation. After palliative trephining, make an attempt to obtain prolonged drainage of cerebrospinal fluid.

Operative Treatment of Epilepsy.—The shock of an accident or a general concussion may establish epilepsy, especially in those predisposed by heredity or other causes. Traumatic epilepsy, Le Dentu tells us,* may be due to: (1) bone-fragments from skull-fracture; (2) outgrowths of bone due to tumor; (3) cicatrices of meninges resulting from laceration of membranes by bone-fragments; (4) chronic meningitis which ends in sclerosis of membranes; (5) cysts resulting from intracranial hemorrhage at the point of fracture; (6) arteriovenous aneurysm. We refer here, in speaking of traumatic epilepsy, purely to the condition when it follows a head-injury, and this is the common meaning of the term. Remember that epilepsy, as shown by Sachs, may follow a long-forgotten injury. When epilepsy has followed traumatism and a scar exists upon the scalp, excise the scar, especially if it is tender or is the seat of an aura. If, on lifting the scalp, a depression of bone or a disease of the bone is manifest, trephine for exploration, even over a silent area. Trephining in epilepsy may disclose a cyst, a dural scar, a brain-scar, a depressed portion of bone, or eburnation of bone from osteitis (Keen). In exploratory operations for epilepsy always open the dura. When the injury is over a known motor center it is important to trephine. This operation is especially indicated when the convulsions begin in the muscles of this center, in which case it is proper to remove the center after trephining. Remove all sources of peripheral irritation (Briggs reported a case of epilepsy in which there were distinct skull-depression and necrosis of the tibia, but the cure of the necrosis of the tibia arrested the convulsions). If epilepsy arises notwithstanding primary trephining, open the flap, round the bony edges with a rongeur, and cut out the scar.†

* La Presse médicale, June 9, 1894.
† The author, in Hare's "System of Practical Therapeutics"
These operations sometimes seem to cure epilepsy, but so, occasionally, does any operation. White records* ninety trephinings in which, though no cause was found for the epilepsy, great relief followed, and two cases were apparently cured; he mentions benefit or apparent cure following tracheotomy, ligation of the carotid artery, incision of the scalp, etc. The same effect may be obtained by a great shock, high fever, the administration of an anesthetic, or an accident. The fact seems to be that any operation, by means of nervous shock, may interrupt the epileptic habit; but in ordinary operations the fits tend after a time to recur, and soon reach their old standard of frequency. In the special brain-operations with excision of obvious lesions or discharging centers the fits usually recur, but they will rarely reach the old standard of frequency, and will be more amenable to medical treatment. Bramwell says that when traumatism is followed by epilepsy and the epileptic discharge starts from a cortical center which is not beneath the scar, trephine first at the seat of injury, and if no lesion is met with trephine over the discharging center. In epilepsy the fits are to be studied by a competent observer and, if focal epilepsy or Jacksonian epilepsy exist, and treatment by drugs has failed, trephining is to be performed over the diseased center and the explosive focus is to be located by an electric current and removed. Keen, Horsley, Nancrede, Macewen, and others practise this, but hope for improvement rather than expect cure. This operation causes paralysis, but the paralysis is rarely permanent, except, perhaps, of the finer movements. In non-traumatic chronic epilepsy without localizing symptoms trephining is not justifiable unless persistent headache calls for it as a means of relief from intracranial pressure. Annandale has recently advised us to consider experimental operation in such cases when the drug-treatment has failed and when the patient’s condition seems hopeless. He says there is no chance of improvement without operation, and operation may possibly disclose a removable lesion.† After trephining for epilepsy five years should elapse without a convulsion before cure is reasonably assured; and if convulsions arise, they must at once be met by medical treatment. A man having once had a convulsion may at any time have others; hence he should always be watched. It is not unusual for a few convulsions to occur soon after an operation for epilepsy, and then to cease for a considerable time. These early fits result from habit. Among the operative procedures suggested for the treatment of epilepsy may be mentioned circumcision, clitoridectomy, ocular tenotomy, ligation of the vertebral arteries, removal of the cervical ganglia of the sympathetic (page 588) (Alexander, Jonnesco, Jaboulay), and the actual cautery to the head (Féré).

Operations on the Skull and Brain.—Trephining (for a fracture of the skull).—Shave the scalp, scrub it with ethereal soap and sterile water, wash it with sterile water and then with alcohol or ether, scrub with a brush wet with corrosive sublimate solution (1 : 1000), and wrap the scalp in wet corrosive sublimate gauze (1 : 2000). The instruments required are a scalpel, a dissector, hemostatic, dissecting, and mouse-toothed forceps, trephines of

† Edinburgh Med. Jour., April, 1894.
several sizes (Figs. 331, 332), a periosteum-elevator, Hey's saw, rongeur forceps, a bone-elevator, scissors straight and curved on the flat, a dural separator, a tenaculum, small curved and large curved Hagedorn needles, and a needle-holder; catgut, fine silk, silkworm-gut, and Horsley's wax. Provide a sand pillow. The patient should be anesthetized unless he is unconscious, and is placed upon his back with the shoulders a little raised. A sand pillow is placed under the neck, and his head is turned away from the side to be operated upon. The position of the surgeon is such that the patient's head is a little to his left. A large semilunar incision is made with the base down, which incision goes through the periosteum, and the flap is lifted. The bleeding vessels of the flap are caught with forceps. The fracture is sought for and found. The pin of the trephine is projected beyond the crown and is set upon sound bone, the crown overhanging the line or edge of the fracture. The surgeon tries to avoid the region of a sinus or large artery. A gutter is cut in the bone, the pin of the instrument is withdrawn, and the trephining is completed. In going through the diploë bleeding is copious. The inner table feels very dense. Stop from time to time, clean out the gutter in the bone with the dissector, and try the bone with an elevator to see if it is loose. When the fragment is loose enough, pry it out. If the surgeon desires to replace the button, hand it to an assistant, who places it at once in a bowl of warm normal salt solution, kept warm by standing in a basin of water at 105° F., or who puts it in warm carbolized towels. The edges of the opening should be rounded with a rongeur and the bone, if depressed, must be elevated. Sometimes it may be necessary to remove splinters and fragments of bone. After removing the fragments the edges of the opening should be smoothed by the use of the rongeur forceps. The dura should be examined to see if injury exists, and hemorrhage must be stopped. Bleeding from the dura is arrested by passing a ligature of silk or catgut threaded in a small curved needle under the vessel on each side of the wound, and tying the ligatures. Bleeding from the pia is arrested by direct ligation, by suture ligature or by gauze packing. Bleeding from the diploë is arrested by the use of Horsley's wax. The wound is cleansed, in some cases the button of bone is re-introduced, in other cases some chips are cut from the bone and scattered upon the dura, but in most cases no attempt is made to fill up the gap in the bone. The scalp is sutured with silkworm-gut and horse-hair or gauze drainage is employed for a day or two. Sterilized gauze dressings are put on, a rubber-dam is laid over them, and a gauze bandage wet with bichlorid of mercury is applied.

Instead of the trephine some surgeons use the chisel or gouge and hammer to remove a portion of the bone. Other operators, believing that this procedure may cause concussion, employ the surgical engine.
Osteoplastic Resection of the Skull.—Wolff suggested this operation, and in 1889 Wagner performed it. It is employed for the removal of tumors and the Gasserian ganglion, and for exploration. A horseshoe incision is made through the scalp and periosteum, a groove corresponding to this incision is cut in the bone by special gouges or chisels. The bone is chiseled through, but is left attached to the scalp. The bone is then broken outward, the fracture taking place at the base of the bone-flap. After the operation the bone which is still adherent to the peri-cranium is restored to its proper place. Some surgeons use the surgical engine instead of the chisel, and others make trephine-openings and cut from within outward by means of the Gigli wire saw (Obalinski). The osteoplastic method of opening the skull is employed when a large opening is necessary, as when the operation is first of all for diagnosis. Krause, Keen, and others employ this plan in operating to remove the Gasserian ganglion.

Besides restoring a flap of bone into position, or replacing a button of
bone, or strewing the Jura with hone-fragments, other methods of closing
the opening have been practised. For instance, heteroplasty with a decal-
cified bone-plate and heteroplasty with a celluloid plate or other foreign
material.*

Osteoplastic Resection of the Skull by the Use of Stellwagen Trephine.—
The concussion inflicted by the mallet I believe adds to shock, may increase
or cause hemorrhage, may extend a line of fracture or produce fracture,
and may rupture a purulent collection. For these reasons I prefer a dif-
cerent plan. The surgical engine gives satisfaction to some, but it is difficult
to render it sterile, and it runs at such a high rate of speed that regulation is
troublesome and the instrument is dangerous. The trephine shown in the cut
has proved satisfactory. It has since been modified by substituting screws
for spikes for the spiked plate to keep it from slipping. The area of bone to be removed is
carefully determined as suggested by Mills (see Figs. 333 and 334): the
plate is screwed into the skull, the scalp is cut with the knife-blade, the base
of the flap being made narrow; the saw is substituted for the knife in the
instrument. The bone is cut by short, quick cuts, making no attempt to
swing the saw through the entire length of the incision at each turn of the
wrist. When the inner plate is nearly cut through, the division is completed
by a small osteotome. The operation can be completed on an ordinarily
thick skull in from eight to eighteen minutes. (See article by author in
“Annals of Surgery,” July, 1903.)

Trephining the Frontal Sinus.—This operation may be employed for
inflammation of the lining membrane of the sinus or for empyema. Make
a vertical incision in the middle of the forehead, starting one and one-half
inches above the nasion and terminating at the root of the nose. The button
of bone is removed and the opening is enlarged if necessary. The mucous
membrane is incised, the opening into the nose is found and is dilated, and,
a drainage-tube is passed into the nose from the sinus, the upper end being
left in the sinus. In some severe cases Jacobson advises us to curet the
sinus, to disinfect it by the use of silver nitrate or chlorid of zinc, and to
insufflate an “aseptic powder.” In some cases resect the mucous membrane.
I prefer an osteoplastic resection to trephining the frontal sinus.

Trephining the Mastoid (operation for mastoid suppuration, page 632).

Technique of Brain-operations (after Horsley and Keen).—Instru-
ments as for fractured skull. In focal epilepsy a faradic battery is required.
Always shave the scalp, and always antisepticize it. In localizations, mark
out the fissure upon the scalp with an anilin pencil or with iodin. Have
the patient semi-recumbent. Mark three points upon the bone with the
center-pin of the trephine before incising the scalp (both ends of the Rolandic
fissure and the point at which the trephine will be applied). Make a semi-
lunar flap three inches in diameter, with the base below. Control bleeding
in the flap by forceps pressure. The one and a half inch trephine should
be employed, but if a smaller trephine is used, the opening must be enlarged
with a rongeur. Before enlarging the opening, separate the dura from the
bone by a dural separator. As a rule, open the dura and examine the brain.
The dura is lifted by mouse-toothed forceps and is opened with scissors along

* See Bretano, in Deutsche med. Woch., May 17, 1894.
a line a quarter of an inch from the bone-edge, a broad pedicle of dura being left uncut. Hemorrhage is arrested by pressure and hot water, or by passing a thread of silk or catgut around any bleeding vessel by means of a curved needle. In some cases packing must be retained or forceps must be kept on. In packing, endeavor to use but one piece of gauze, so as to avoid leaving in a forgotten piece. Upon opening the dura cerebrospinal fluid flows out, the stream being increased with each expiration. Absence of pulsation of the brain points to abscess or tumor, and a livid color indicates subcortical growth. An old laceration is brownish. If the brain bulges through the opening, it means increased pressure (tumor, abscess, effusion into the ventricles, etc.). After opening the dura employ no antiseptics, especially when the surgeon intends using electricity to locate a center. Irrigate only with warm salt solution. In operating for tumor the dura is opened and in some cases the brain is incised. The tumor is turned out by the finger, or, if this is impossible, by the dry dissector, the scissors, the dull knife, or the sharp spoon. If the entire tumor cannot be removed, take away as much as possible. The removal of a portion often retards the growth of the remainder, and the trephining, by lessening cerebral pressure, relieves the symptoms and prolongs life. After removing a tumor arrest distinct points of bleeding with the ligature alone or the ligature passed around the vessel by means of a needle. Pack the tumor-cavity with gauze and bring the end of the plug out of the wound. Stitch the dura with silk and suture the scalp with silkworm-gut. In electrifying the brain faradism is employed of a strength about sufficient to move the thenar muscles when applied to them. The current is applied to the motor area by the double electrode. A careful observer watches the muscular movements. If, for instance, the surgeon wishes to remove the thumb-center, he moves the electrode from point to point until he obtains thumb-movements. The region is sliced away bit by bit until the center which is responsible for the convulsive movements is removed. It will be found impossible to remove only the thumb-center. Adjacent centers are sure to be more or less damaged, and a certain amount of paralysis follows the operation. If we wish to lap the ventricles, Keen directs the trephine-opening to be one and one-fourth inches behind the external auditory meatus and the same distance above the base-line of Reid (Fig. 336, a). A grooved director or metal tube is passed into the brain in the direction of a point “two and one-half to three inches above the opposite meatus.” The normal ventricle will be entered at a depth of two to two and one-fourth inches, but the dilated ventricle will be entered sooner (Keen). The moment of entry is marked by lessened resistance and a flow of cerebrospinal fluid. Drainage can be maintained by introducing a rubber tube. This operation has been employed in hydrocephalus. After an aseptic cerebral operation, as a rule, do not drain unless hemorrhage has been considerable. In many cases replace the bone, but not when the bone is diseased, is infected, or is very compact, or if it is desired to alter pressure. The dura is sutured by a continuous silk suture; the scalp is sutured by interrupted silkworm-gut sutures.

Operation for Mastoid Suppuration.—The instruments required in this operation are a scalpel, a gouge, a chisel, a mallet, curets, a probe, a dissector, dissecting and hemostatic forceps, and needles. Provide a sand-
bag to place under the neck. An incision is made one-quarter of an inch posterior to the auricle and down to the bone, and in the direction of the long axis of the mastoid. The bone is bared and examined, especially at a point in the line of the incision which is on a level with the roof of the meatus (Fig. 336, c). The bone will usually be found softened. Gouge it away and thus open the mastoid antrum. The bone-opening is within the limits of Macewen's suprameatal triangle, a space bounded by the posterior root of the zygoma, the posterior bony wall of the meatus, and an imaginary line joining the two. If the mastoid is opened in this triangle, the antrum

is entered directly and there is no chance of wounding the lateral sinus. If, in the adult, pus is not found on opening the mastoid antrum, gouge downward and backward, but with great care, so as to avoid the lateral sinus. If there be any possibility of the existence of pus in the groove of the sinus, the sinus should be unhesitatingly exposed. After evacuating the pus from the mastoid gouge away bony septa, enlarge the opening between the mastoid and the middle ear with the gouge, turn the head toward the side operated upon, and irrigate the mastoid with corrosive sublimate solution (1 : 2000); dust with iodoform, pack with iodoform gauze for a few days, and then introduce a silver drainage-tube. Treat the causative ear disease. A. Marmaduke
Sheild and Prof. Macewen operate on inveterate cases of mastoid disease as follows: A thick flap is raised behind the auricle, the flap including the orifice of any sinus and being "left attached by its stalk." The auricle is "detached forward and the soft parts over the mastoid are turned backward by horizontal incision." The "lining membrane of the canal is separated from the bone." The mastoid is opened and dead bone and caseous matter are removed, overhanging edges are chiseled down, and the posterior bony wall of the external auditory meatus is gouged away. The skin-flap is pushed into the cavity and is held in place with pads of gauze. The margins of the flap may be sutured, but this is not necessary. Macewen calls this procedure "papering" the cavity with skin.*

If mastoid suppuration has established abscess in the temporo-sphenoidal lobe, trephine, one and a quarter inches behind and one and a quarter inches above the middle of the external meatus (Barker's point) and search for pus as directed on page 619. If abscess of the cerebellum exists, trephine below the line of the lateral sinus. "The position of the lateral sinus is indicated by a line running horizontally outward from the occipital protuberance to within about an inch of the external auditory meatus, and thence downward to the mastoid process" (Owen's "Manual of Anatomy"). If infective sinus-thrombosis exists, break into the lateral sinus (Fig. 336, d) from the mastoid opening and proceed as directed on page 622.

Linear Craniotomy.—Instruments as for any brain operation, plus, however, several kinds of rongeur forceps. Make a large flap. Trephine the skull a finger's breadth from the sagittal suture, and the same distance back of the coronal suture. Rongeur the bone away in a line parallel with the sagittal suture up to a point in front of the lambdoidal suture. Remove the pericranium which covered the bone excised. Insert the dural separator, or pass it along the margins. In some cases an additional portion of the bone is removed over the fissure of Rolando. Various suggestions have been made as to the direction and situation of bone-sections. Bleeding is arrested and the flap is closed without drainage.

Removal of Gasserian Ganglion.—(See page 591.)

Operation for Infective Sinus-thrombosis.—(See page 622.)