

Three successful cases of cerebral surgery : including (1) the removal of a large intracranial fibroma (2) exsection of damaged brain tissue, and (3) exsection of the cerebral centre for the left hand : with remarks on the general technique of such operations / by W.W. Keen.

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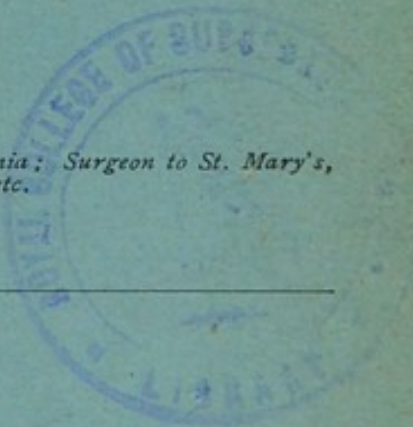
THREE SUCCESSFUL CASES OF
CEREBRAL SURGERY.

INCLUDING (1) THE REMOVAL OF A LARGE INTRACRANIAL FIBROMA
(2) EXSECTION OF DAMAGED BRAIN TISSUE; AND (3) EXSECTION
OF THE CEREBRAL CENTRE FOR THE LEFT HAND; WITH
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SUCH OPERATIONS.

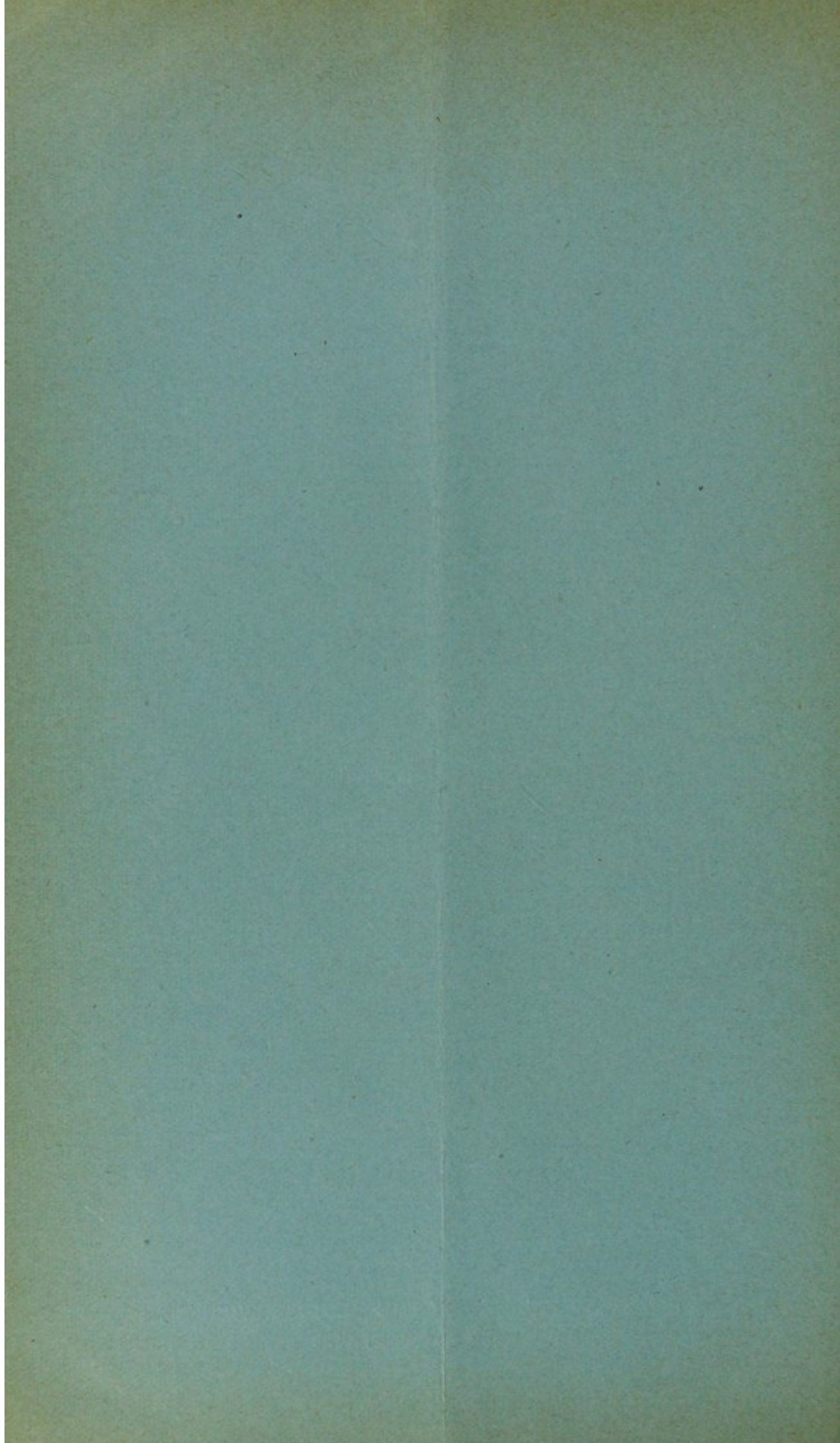
BY

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St. Agnes's, and the Woman's Hospitals, etc.*



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WITH REMARKS ON THE GENERAL TECHNIQUE OF SUCH OPERATIONS.¹

BY W. W. KEEN, M.D.,

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ST. AGNES'S, AND THE WOMAN'S HOSPITALS, ETC.

CASE I. *Large tumor in the cerebrum probably arising from an injury at three years of age; epilepsy and hemiplegia at twenty-three; tumor removed at twenty-seven; hernia cerebri; recovery; probable cure of epilepsy.*—Sent to me in May, 1887, by Dr. M. L. Davis, of Lancaster, Pa., with the following history.

"T. D., aged twenty-six, carriage-maker, married at twenty-three, has one child in good health; father died at twenty-seven from an injury to the spine; mother and maternal grandmother (aged eighty-three) living and in good health; the other three grandparents died at fifty-seven, seventy and sixty, the last of consumption.

"At the age of three he fell out of a window, a distance of several feet, striking his head upon some bricks. His mother says there was no cut, but his forehead was indented. He lay motionless for a long time as if he were dead, and remained comatose for an hour. His head became swollen and blue. Dr. John L. Atlee saw him the next morning and, as the child was moderately bright, thought he was merely stunned, as there was no evidence of injury except the swelling. The recovery from the injury was slow but apparently complete. The indentation was on the front part of the head, but the mother does not remember clearly on which side. The patient says his mother told him it was on the left side.

"At five years of age a discharge from the right ear followed an attack of measles. This discharge has continued at intervals ever since, and

¹ Read before the American Surgical Association, September 18, 1888.

has impaired his hearing. It is at times offensive, although accompanied by but slight pain. In August, 1886, the left ear became partially deaf. During his boyhood he was considered dull, was very forgetful and impulsive though not quarrelsome; he complained considerably of headache; no history of syphilis can be obtained and there is no visible manifestation of it after the most careful examination. His general health was good, excepting the frontal headaches, which were moderately severe. In the autumn of 1884, he became ill with neuralgic pains and was "all broken up." These symptoms gradually increased until February, 1885, when he was seized with violent epileptic attacks followed by intense pain in the head which lasted several days. These fits occurred once or twice a week, and the attacks of pain in the head increased in violence and duration. By the end of April the right arm became paralyzed, and the right leg, and the right side of the face, in the order named, the paralysis making gradual progress.

"My first visit was made on June 8, 1885. While hitching my horse, I heard him screaming with neuralgic pain. The pain was located on the left side of the head, and started about the supraorbital ridge, darting back to the occiput, but was more intense at the middle of the left side of the head. Inspection disclosed a small scar at this point. Pressure increased the pain. The entire right side of the face was paralyzed; both motion and sensation being affected, though motion had suffered more than sensation. The right pupil was largely dilated and did not respond to light; the left one was normal and responsive. The sight of the left eye was good, but whether perfect or not I could not determine. The vision of the right eye was imperfect; aphasia was a prominent symptom. He made marked efforts to converse, but could not; the pulse was 60 and irregular; respiration 16; tongue heavily coated; obstinate constipation; anorexia; insomnia; no fever.

"*Diagnosis.*—Pressure upon the anterior lobe of the left hemisphere involving the third convolution, extending backward, from exostosis, tumor or possibly only thickening of the dura mater; syphilis excluded.

"*Treatment.*—Iodide of potassium and arsenic with laxatives.

"The pain began to diminish and at the end of three weeks he was nearly free. Arsenic was suspended by July 1, 1885. Paralysis began to improve in the leg and in the arm. Aphasia was the last to improve, so that when he had regained the use of the leg and arm and could come to my office (a mile distant), he would bring pencil and paper and write any questions he desired to ask. The questions were, however, much mixed. About this time his eyesight began to fail until August, 1885, when he became totally blind, first in the right eye and later in the left. At the end of two months his left eye gradually improved so that he could again walk in the streets. The right eye remained blind for several months, when suddenly the sight returned in it, remained for a few hours and left as quickly as it came. This phenomenon has since occurred frequently, not only in the right eye but also in the left. He was annoyed, also, very much by flashes of light and mist before the eyes, accompanied by vertigo and constipation.

"The epileptic fits continued with diminished violence and frequency until November, 1886, since which time he has been exempt. His urine has been frequently examined, but there was found neither albumin, casts nor sugar. In the fall of 1886 he was at Jefferson Hospital, but returned after three weeks. His mental condition has been considerably

affected; his judgment is not good; memory fair; general mental powers slow; at times peevish and fretful."

May 30, 1887. Present condition. Headaches moderately severe, generally lasting from half an hour to several hours, and occurring from two or three in a week to one in several weeks. His speech is hesitating and slow and he has a feeling as of being dazed. He is very anxious to have an operation done if it holds out the slightest possible chance of relief. When he has spasms "hot air seems to rise from the stomach to the nose;" the eyes become dim and twitch toward the right followed quickly by the head, which is turned in the same direction. During this time he is mostly conscious and feels as if smothered; unconsciousness soon follows. As soon as the "hot air" is felt the right hand closes tightly, the forefinger first, then the thumb. He cannot tell whether the wrist, shoulder, and elbow are flexed in succession. The face also is affected (whether one side or both he does not know) and turns to the left, so that it seems "as if he were going to be turned entirely round to the left." These attacks last from five to ten minutes. Sometimes he has minor attacks with the same symptoms moderated without loss of consciousness. He has a good movement of the bowels every day; appetite ravenous; for four or five weeks has had night sweats almost every night, especially on the legs; has lost flesh since March 1st; his usual weight is 135 pounds, present weight 122 pounds. The gait would not now show any paralysis; his hand-squeeze is about equal; the leg-thrust of equal force, as judged by resistance to my hand; the face is not paralyzed; the right ear shows a slight discharge, but is the better hearing ear of the two; his deafness for conversation, however, is only moderate; the right pupil is slightly larger than the left. The right eye deviates slightly upward and outward. An examination of the head shows a small scar a quarter of an inch long, three and three-quarters inches above the middle of the zygoma and one and five-eighths of an inch in front of the bi-auricular line. The skull feels slightly irregular as if the bone had been injured; no marked depression; not now tender or painful, nor is there any sensation located at this point preceding the fits. The urine is rather highly colored and slightly clouded, the specific gravity 1023, no albumin, no sugar, a few crystals of uric acid; normal mucus.

June 7, 1887. While in the hospital he had six fits to-day. Dr. Moylan saw the fourth from the beginning. The eyes were staring, with the whites turned up, the eyelids moved rapidly up and down; the right pupil was larger than the left; the head was turned far to the right and the mouth drawn in the same direction; the four limbs were flexed throughout. He was lying on the left side, with the feet turned to the left, and rigid. This condition soon passed into marked convulsive efforts. The attack lasted two minutes. The face was normal in color at first but soon became very blue. There was no frothing at the mouth. A few days later Dr. Charles A. Oliver saw him in the convulsive stage of an attack which was described as follows, together with a careful ophthalmic examination:

"At the request of Dr. Keen I examined T. D., and obtained the following results:¹ The pupil of the right eye was four by five mm. in size upon exposure to broad, diffuse daylight, whilst the pupil of the left

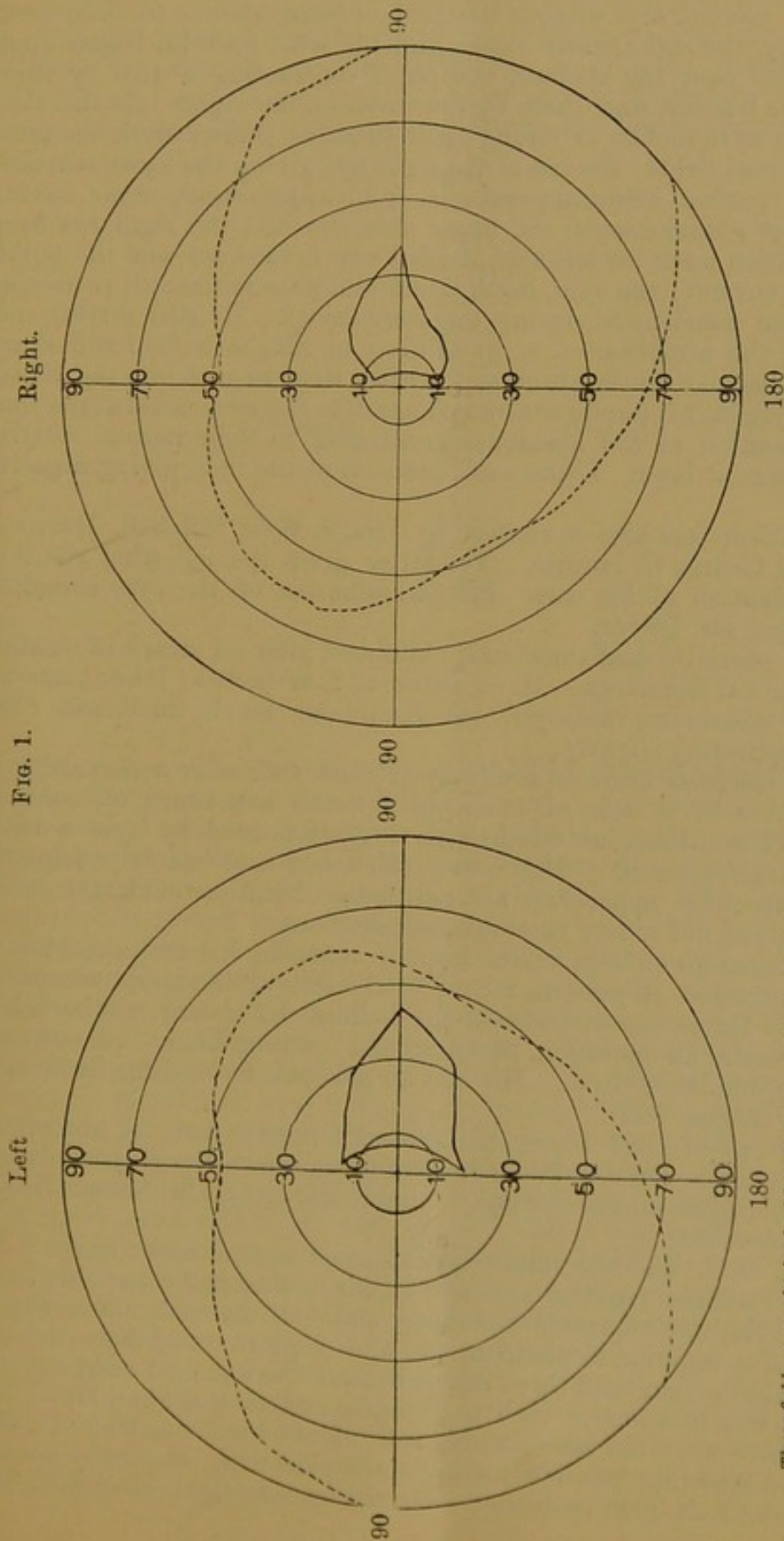
¹ This merely constitutes a *résumé* of sufficient fulness to render the case complete, reserving the discussion *in extenso* (in connection with other cases observed with Dr. Keen) for a separate communication.

eye was three by four mm. in size upon the same exposure. Both irides responded separately to light stimulus and accommodation, the right pupil becoming larger in all directions after a second's continuance of stimulation to what it had been brought by the first impulse of light. The right iris was slightly the more sluggish, each responding only when the stimulus was placed in small areas to the right of the eyes. The test for accommodation, which was made by approximating the finger and having the patient steadily gaze at it, taking care to keep it at the point of greatest visual acuity in the visual fields, showed that the irides were exceedingly sluggish. Both corneæ were seemingly equally sensitive, and a difference of six-tenths of a degree F. in the temperatures of the two lower culs-de-sac could be differentiated. (Right = 97.7° F., and Left = 97.1° F.) In a state of rest, fixation was accomplished with the left eye, the right being turned up and out. Careful examination showed that this condition was caused by a paresis of the right internus coexistent with paresis of the left inferior and superior recti; all of the other attached external and internal muscles being intact. In addition, there was a paresis of the inferior fibres of the orbicularis on both sides, more marked on the left; the left lower eyelid being partially raised by the corresponding face muscles. Vision with the right eye was reduced to the counting of fingers at six inches, about four degrees to the outside, whilst vision with the left eye, which was also excentric, was reduced to the counting of fingers at thirteen inches, about six degrees to the inside. Fields of vision gave the following results: left-sided homonymous hemianopsia superadded to large central scotomata; leaving two irregularly contracted right-sided fields in which nothing but form could be discerned.

"The ophthalmoscope showed in each eye a few faint vitreous opacities—almost complete post-neuritic atrophy with greatly diminished retinal circulation (the arteries being reduced to mere threads), much more marked on the left side; both choroids woolly and granular; whilst in the right retina there was a small isolated brilliant cholesterin crystal. Both disks gave decided characteristic appearances of previous choking.

"Five days later the patient was seen in the convulsive stage of an epileptoid attack. He had been complaining of frontal headache, accompanied by 'bad taste,' followed by vomiting. When first seen there were a series of irregular clonic contractions, which were marked in both lower and upper extremities of the right side and trunk, the head being turned toward the right. The mouth was drawn away from the left side. The right eye was fixed toward the upper temporal side, whilst the left deviated almost directly inward. During this deviation a slight horizontal nystagmus developed itself, which, as the general clonicism grew less and less, rapidly diminished, the excursions becoming greater in length and less frequent in action, with a steadily increasing tendency to fall into the ordinary state of rest, until in four minutes from the time when first seen, the oscillations had ceased altogether. During the nystagmic action the axis of the right eye was directed up and out, and the globe gave a slight twist downward upon its return internal movement. At the time of the convulsive seizure the right pupil was dilated to six by seven mm. in size, whilst the left pupil was enlarged to but four by five mm.; each pupillary area preserved its original long axis. The lower lids drooped during the clonic state, whilst the upper lids became con-

tracted, giving the eyes a staring appearance. Throughout this time the skin of the lids and the conjunctival mucous membranes seemed to



These fields were obtained with a McHardy perimeter in the ordinary way, except that the patient was made steadfastly to fix his eye upon the central point by means of a continuous noise (tapping with a pencil-tip upon the central white button, the act being rendered more sure by an assistant who continually watched that the eyeball was not moved. The surgeon's finger was carried in different directions along the perimeter arc, and when first recognized, the registry was taken.

be sensitive to touch and pain. It was now noticed that the patient profusely sweated upon both sides, and that there was equal thumping pulsation of the external carotids. At the moment of cessation of the nystagmic motion, and without the patient being spoken to, or aroused in any way, the right fissure closed and the left upper lid began gradually to fall over the eyeball, the pupil contracting to two by three mm. on the left side and three by four mm. on the right. At this time both irides were mobile to strong light stimulus thrown from the areas of the retained fields; the iris of the right eye giving the lesser reaction. Upon the patient being aroused (he, from appearances, never having entirely lost consciousness) the upper lids elevated, the right eye fixed to my position upon his left side, the left eye turned out and the pupils dilated to normal; the eyes, head, trunk and extremities still remaining in the same positions as during the convulsions. By still further concentrating the attention—*i. e.*, by talking to him in a loud and sharp tone of voice and causing him, at the same time, to gaze into the broad, diffuse daylight, his pupils contracted again to the sizes noted at the time of the cessation of the nystagmus, returning to their normal relative areas a moment later. Urine was examined at the time, giving negative results."

The patient was also examined by Drs. S. Weir Mitchell, Morris J. Lewis and George C. Harlan. The latter gives the following result of the examination of his ears. His examination of the eyes coincided with that of Dr. Oliver.

"A. D., partially deaf since early childhood after an attack of measles, still occasional discharge. H. = watch at four inches; lower posterior quadrant membrane destroyed, the remainder much thickened. The drum suppurating slightly.

"A. S., deafness came on suddenly (?) one year after a convulsion in 'consequence of a dose of medicine'; watch not heard on contact; tuning-fork not heard at all through air, but normal by bone conduction through mastoid. Membrane thickened and much contracted. Eustachian tubes apparently not patulous. Deafness evidently due to local changes, not to any cerebral complications."

For reasons given later under head of remarks, it was decided not to do any operation at present, but if, in the fall, after careful treatment under Dr. Davis, especially with the iodides, he should not be better and still desire an operation, that I should open his head. He returned home the middle of June. He had an epileptic fit on June 24th, July 26th and August 13th.

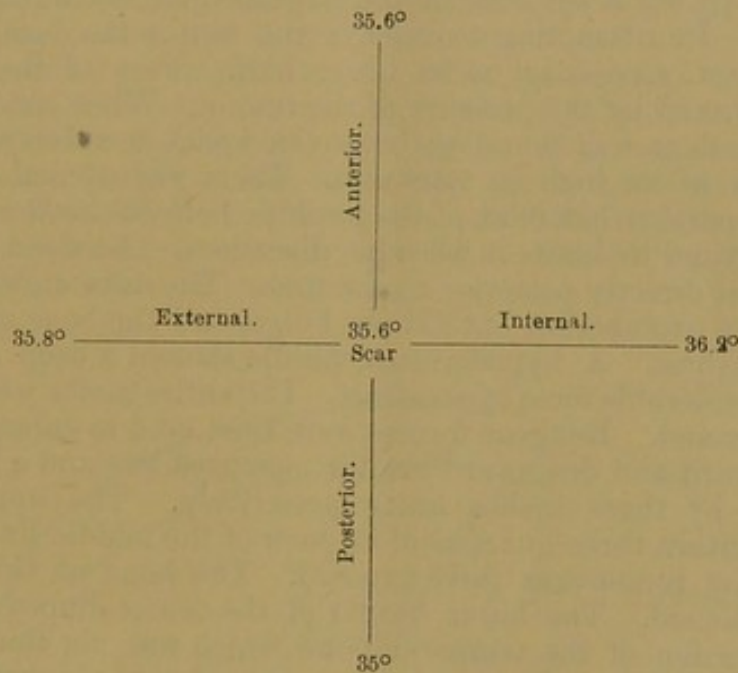
In the fall of 1887 I received several letters written by himself, as well as one from Dr. Davis, desiring an operation. The patient himself was quite urgent, and accordingly came to the city to St. Mary's Hospital in December.

Dec. 8, 1887. The scar finally settled upon as that resulting from his accident at three years of age (though his mother had stated his scalp was not cut), was a quarter inch long and half an inch above and in front of the superior stephanion, two and a quarter inches to the left of the middle line, and three inches behind the external angular process. It was now tender both to pressure and to a slight blow. The temperature over the scar on this side of the head was 95.5° F., and in a corresponding position on the right side 94.4° F. Sway antero-sinistral half an inch each way. Dynamometer, right hand 30° , and

left 35° . Knee-jerk, left, normal; right, subnormal. Reinforcements normal on both sides. Tactile sensibility in both hands normal.

14th. Temperature over the scar 95.5° F; right side, corresponding point, 95° F. Urine, specific gravity 1028, no albumin, no sugar.

15th. An attempt was made to see if the scar was the site of the highest temperature, and the result was as follows: the temperature (Centigrade) was taken over the scar and at four other points, two inches in front of and behind the scar, and two inches distant laterally.



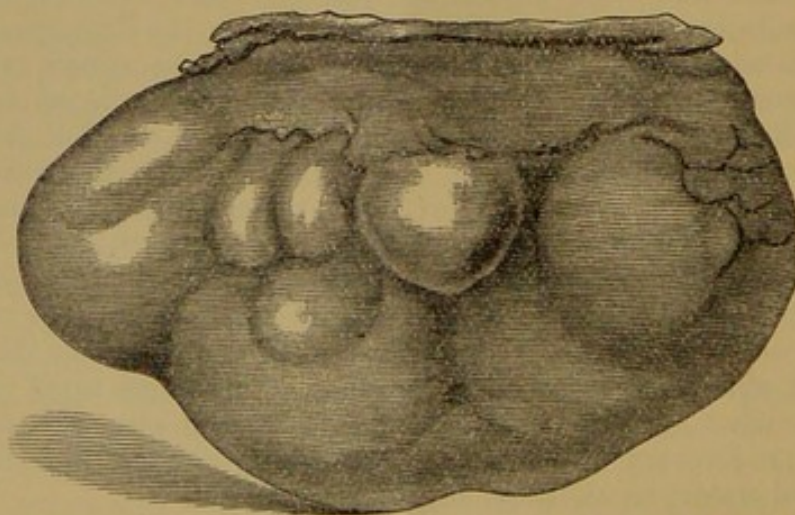
Preparation.—The following was the method of preparation for this and all the other operations here related: The room was uncarpeted, and contained only necessary furniture. The walls and ceiling were carefully wiped the day before, and all the wood-work and furniture, as well as the floor, were thoroughly scrubbed with carbolic solution. New, clean sponges were used that had been kept in carbolic solution, but were used with sublimate solution 1 : 1000 at the operation. In the first operation the instruments were all boiled for two hours, but in the subsequent operations this was omitted, but they were placed in a carbolic solution 1 : 20 for a half hour, then were transferred to boiled water that had cooled sufficiently to permit their being handled. In the first operation also, the spray of carbolic acid was used in the room all the morning of the operation, but not during the operation or at any of the redressings. At the later operations the spray was entirely omitted. The day before the operation the patient's head was shaved, then scrubbed with soap and water, then with ether and covered with a wet sublimate dressing of 1 : 1000, which was retained in its place by bandages until the operation began, when the ether and sublimate washings were repeated. The hands and nails were, of course, most carefully cleaned and disinfected by soap and water, alcohol and sublimate solution.

Operation at 1 P. M., December 15, 1887 Present, Drs. Grove, Mears, Roberts and the resident hospital staff, Drs. S. Weir Mitchell, Mills, White, Oliver and Taylor, and Messrs. Le Conte and Goodwin, medical students. Ether was used. An incision was first made through the scar down to the bone. By a gouge a little nick was then made in the bone so as

to fix the site of the scar. No scar was found on the bone when uncovered. This nick was extremely useful, as alluded to later. A large semi-elliptical flap was then cut three and a half inches across in both directions, the convexity posterior for drainage. The hemorrhage from the flap was very abundant and required twelve to fifteen hemostatic forceps, though eventually only four or five vessels required ligation. The bone, also, when bored bled freely. This ceased without treatment.

A one and a half inch trephine was then applied so as to include the site of the scar, the lower edge of the trephine just including the temporal ridge. In attempting to remove the button the dura was found to be adherent, especially to its lower half. Part of the bone was markedly thinned by the pressure of the tumor. When the button was removed the dura was found to be covered with a velvety outgrowth one-sixteenth of an inch in thickness. There was normal softness at the anterior portion, but most of the trephine hole disclosed a hard mass extending beyond its limits in all other directions. A second button was then removed directly posterior to the first. The dura under the latter was markedly protuberant but did not bulge, and the bone more eroded than was the first. A hypodermatic needle showed a deep mass which required considerable force to penetrate. The entire tumor was evidently not yet uncovered. Rongeur forceps were then used to enlarge the bony opening upward and downward until it measured two and a half inches transversely by three inches antero-posteriorly. The upper margin reached to within three-quarters of an inch of the middle line, when the border of the tumor was fully exposed. The bone at this part was greatly thickened. The lower border of the tumor dipped behind the squamous portion of the temporal bone, which was not thickened, and the tumor reached to half an inch below the edge of the bony opening, as was discovered later. On incising the dura one-quarter inch from the edge of the bone it was found to be adherent to the subjacent mass slightly at the margins, and increasingly so toward the site of the scar as a centre. I therefore severed its connection all round, and was able

FIG. 2.



Appearance of the tumor with dura attached. Natural size. (Drawn by Dr. John M. Taylor.)

now to enucleate the growth by the finger with but very little force, and lift it out from the underlying brain tissue and from the fossa behind the squamous portion of the temporal bone.

Description of the tumor.—Weight three ounces forty-nine grains. Displacement two and a half ounces of water. Size two and seven-eighths by two and a half inches and one and three-quarters inches in thickness; seven and a quarter and six inches in circumference in the two axes. Its long axis lay nearly at right angles with the median line.

Appearance.—Non-adherent to brain tissue; intimately united with the dura; dura and pia especially thickened under the scar, but gradually grew less and less adherent as the distance from the scar increased. In the region of the scar the dura was covered with a velvety fibrous growth. The tumor was very firm to the touch and very dense in texture; nodular on its surface. On cross section and at right angles with the long axis very firm; color pinkish-white; showing divisions into pyramidal compartments, converging toward a centre near the outer surface. Corresponding to the scar was a moderate depression on the surface of the tumor. The two disks of bone which were removed were very much and irregularly thinned, corresponding to the irregularities on the surface of the tumor.

FIG. 3.

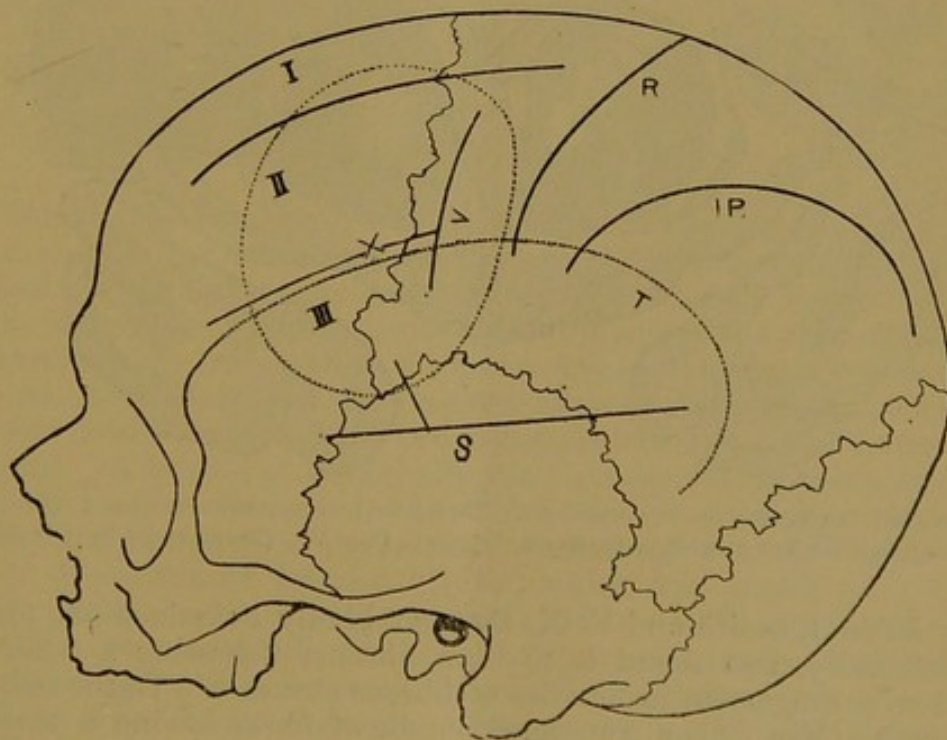


Diagram of the skull showing the site of the tumor.

S, Fissure of Sylvius. R, Fissure of Rolando. IP, Intraparietal sulcus. V, Vertical or precentral sulcus. T, Temporal ridge. I, II, III, the first, second, and third frontal convolutions. The oval dotted line represents the tumor, the cross (X) the site of the scar.

The situation of the tumor was afterward exactly determined thus: The first bone disk was accurately fitted to its corresponding irregularities on the tumor. The nick in this bone disk was at the site of the scar, and the position of this on the skull was one-half of an inch above and in front of the superior stephanion. By measuring from the nick to the edges of the tumor, anteriorly, posteriorly and transversely, and transferring these measurements to a skull from a point corresponding to the scar, its exact location was fixed. On this skull the chief fissures

of the brain were also marked. It was found (Fig. 3) that the tumor reached backward nearly to the fissure of Rolando, forward (two and a half inches) into the bases of the three frontal convolutions, especially the second and third, upward into the external part of the first frontal convolution and downward nearly to the fissure of Sylvius. Taking one of Dalton's sections and applying on it the measurements of the tumor, Fig. 4 shows the region involved in depth in the normal brain.¹

FIG. 4.

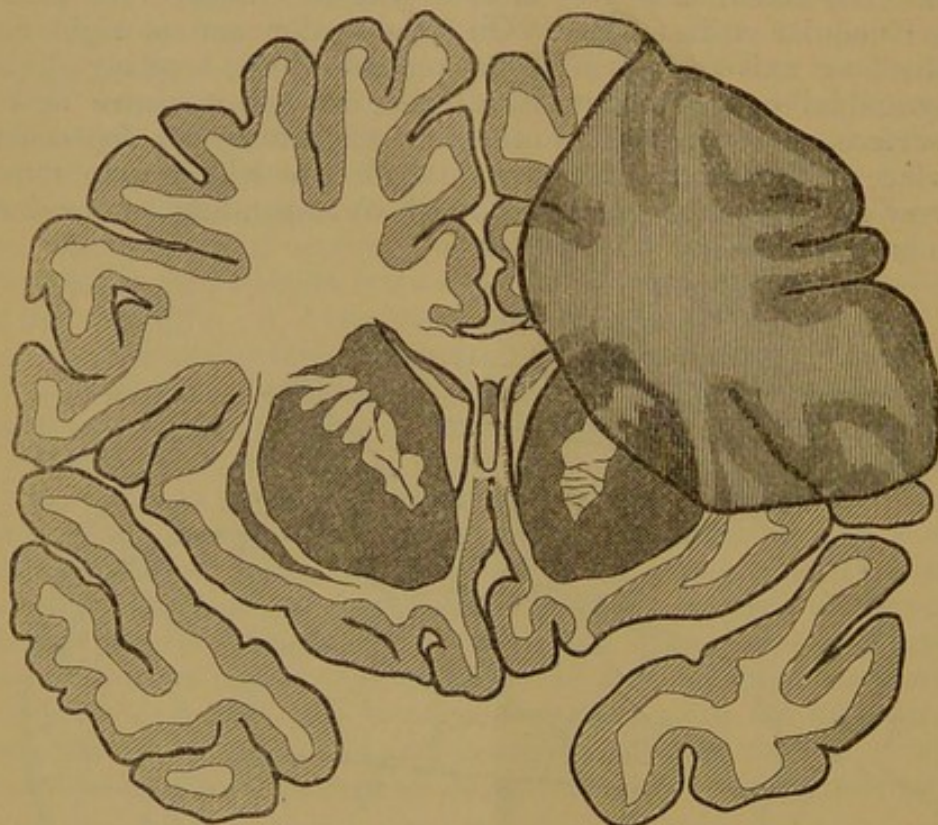


Diagram to show the depth of the tumor in Case I. The shaded part represents the tumor. The section is from "Dalton's Topog. Anat. of the Brain," Series C, Plate VI. (Drawn by Dr. S. C. Wood.)

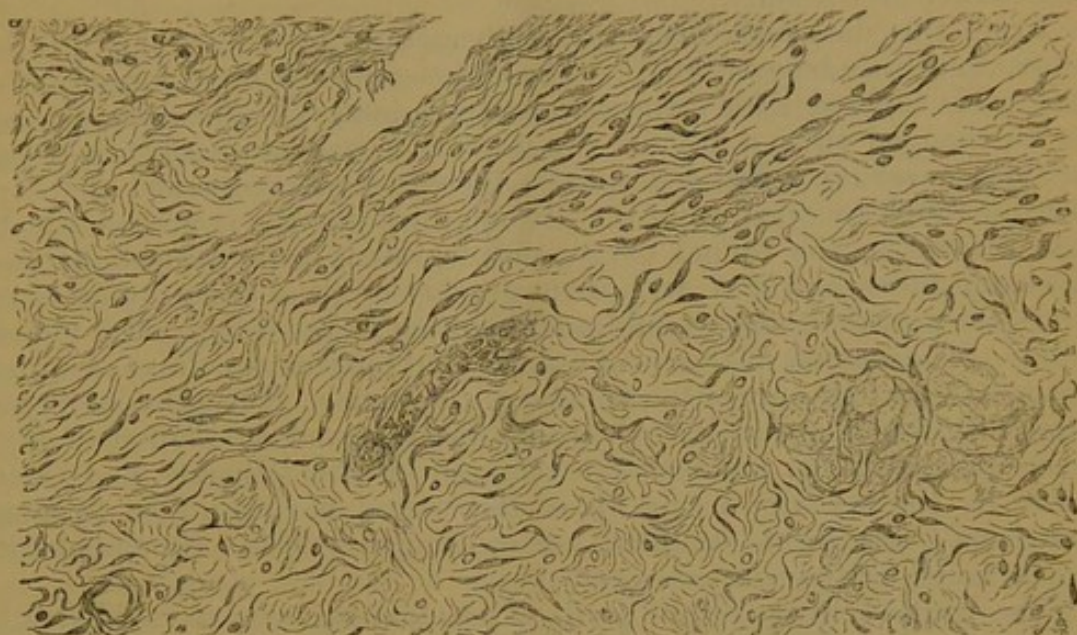
Drs. Allen J. Smith and F. X. Dercum kindly examined the tumor microscopically, and found it to be a fibroma "showing a tendency toward an arrangement in bundles of fibrous elements. To the right in the drawing (Fig. 5) is a transverse bundle of fibres having a peculiar translucent appearance as of some secondary degeneration." They deemed the tumor to be an old and not a recent growth.

No vessels required ligation in the dura, but several large veins of the brain poured out abundant streams of blood during and after enucleation of the tumor. I tied three or four of these with difficulty. Several times, in attempts to secure them, the ligature cut through, either from too tight tying, or tore the vessel completely by slightly unequal traction, either on one end or the other. Most careful gentle traction, evenly applied to the ends of the ligature, just sufficient to arrest the bleeding, answered best. The material used was Kocher catgut. The hemorrhage was still rather profuse. The wound was therefore douched with hot

¹ By an error of my own this is a trifle too deep.

water (115° to 120° F.), and direct pressure by sponges was tried. The bleeding was thus finally controlled.

FIG. 5.



Microscopical appearance of the tumor in section. (Drawn by Dr. Allen J. Smith.)

The bottom of the cavity occupied by the tumor was softened, and in part shreddy, white brain tissue; the margins of the cavity, where disclosed, showed apparently healthy brain convolutions covered by the pia with large dilated and tortuous veins. During the time occupied by controlling the hemorrhage, the cavity left by the tumor had been filled up nearly one-half by the resilient brain tissue. Rubber fenestrated drains were introduced at two points in the posterior border of the wound. A bundle of horse-hairs was then carried from one opening to the other across the wound. I had intended, if possible, to replace the buttons of bone as well as the small fragments that had been kept in a bowl of carbolyzed solution (1 : 40) which was placed in a basin of water maintained at a temperature of 100° to 105°, but the sacrifice of the dura prevented this step. The scalp wound was next united, and a small sponge, with a larger one over it, was placed upon the flap so as to depress it and to some extent obliterate the cavity with a view to prevent hemorrhage, and facilitate union with the flap. A thick dressing of sublimate gauze, rubber dam and muslin bandage completed the dressing.

The operation lasted nearly two hours. Most of this time was required for trephining and checking the hemorrhage. The patient bore the shock and large loss of blood very well. No motor symptoms occurred during the operation. When placed in bed he rolled persistently to the left side and drew both legs up. He vomited four times between 3 and 9 P.M.; probably this was the cause of some slight oozing next noted.

Dec. 15, 9 P.M. Perfectly conscious; called me by name. Aphasia somewhat marked. If pricked by a pin in fastening the bandage, he always said, "the grasshopper picketh." The pupils were equal and

rather dilated; no paralysis; slight pain. Morphia was given as needed, and small doses of lime water and milk given every two hours. As the dressing was saturated with blood, it, as well as his night shirt, was changed. He sat up in bed voluntarily and thrust both arms through the sleeves of the shirt.

From this date for a week the temperature varied from only a little above to a little below 100° F. The catheter was required for only one day. He suffered little or no pain and was hungry. The dressing had to be changed twice a day for two days, as it was saturated with blood or bloody serum. But his aphasia increased markedly and the flap became much rounded upward. By the third day the large clot, which had formed in the wound cavity, disintegrated; part escaped by the drainage tubes, and part, with some shreddy cerebral tissue, by pressure and gentle washing out by sublimate solution followed by cooled, boiled water. The amount of the clot I estimated at four ounces, thus exceeding by one and a half ounces the volume of the tumor. The aphasia diminished almost immediately. One tube was removed on the fourth day. Four of the eleven sutures were removed on the fifth day, and three more by the seventh, nearly all of the wound having united by first intention. His mental condition was continuously clear. No anæsthesia when tested by the æsthesiometer.

The next week was full of peril. His temperature rose rapidly, till, on the tenth day, it reached 104.2° F., but by the fourteenth day was down to the normal. All but two sutures were out by the eighth day, and the second drainage tube shortened to one inch, and all the horse-hairs out but two. But on the eighth day his aphasia, which had nearly disappeared, began to increase again; his right lower face was less mobile, and the catheter was again required. Marked and increasing bulging of the flap was seen, and on the ninth day, without sensory disturbance, his right arm was noticeably paretic, the left showing no change. The dressings were saturated with a watery discharge, but no pus. The second drainage tube was out. By the tenth day the face and arm were distinctly paralyzed; speech very thick, and later unintelligible; aphasia marked; deafness increased. Mind clear throughout. The following day the right leg was paralyzed. Along with the high fever and other symptoms, apparently due to pressure, he had a sharp diarrhœa, with very fetid stools. His bowels had not been moved till a week after the operation in spite of enemata and mild laxatives.

Fearing an accumulation of pus as the cause of all the danger, I reopened the wound with my finger to over half its extent. This disclosed a mass of tissue somewhat discolored, swollen, soft and friable, not very vascular, resembling white brain tissue. The microscope showed no pus, but only fatty and granular cells and *débris*. The sublimate dressings were continued. The diarrhœa was met with opium and acetate of lead and bismuth. His liquid diet had not been changed, but all food was now sterilized. Quinine (10 grains) and moderate doses of brandy were also given.

By the end of the second week the diarrhœa and fever were gone, aphasia and deafness diminishing, and the flap was adherent to the brain tissue, which had now formed a slight hernia cerebri through the crescentic opening. He was so much better that some oysters were given and greatly enjoyed. During the third week his temperature varied but little from the normal. The right leg improved very much, the

arm and face remaining paralyzed till the end of the week, when the face first began to regain its mobility. The aphasia lessened also. The hernia cerebri had increased considerably. Soon granulations sprang up all over its surface, and a small amount of distinct pus was discharged daily. The dressings had to be changed daily, chiefly on account of a limpid fluid which escaped in abundance from two pin-hole openings in the hernia cerebri. This was not glairy, and in appearance resembled cerebro-spinal fluid. This abundant, limpid discharge only ceased at the end of the fifth week.

In the fourth week another sharp rise of temperature took place for two days, up to 102.6° F., and with it a marked purulent discharge from the right ear and constipation. The attack yielded to liquid diet, laxatives and antipyrin, with washing out the ear. His aphasia was now nearly gone, and the facial palsy considerably lessened. On the twenty-seventh day he moved his right arm once at the shoulder only, but could not repeat the movement; on the twenty-eighth he could bend his elbow, the finger movements being barely perceptible. The right nails (as shown by staining with nitric acid) had grown decidedly less than the left. He was hungry and was sitting up.

In the fifth week the temperature twice rose quickly for two days, and one day to 102.4° and 102° F. respectively, apparently due to constipation, for an enema caused a quick decline. With each of these attacks of fever his aphasia and the palsy of the right arm immediately increased, and as quickly bettered with the fall. By the end of this week the extent of motion at the shoulder and elbow was complete, though much feebler than normal, but flexion of the fingers was only perceptible. By the fortieth day the finger flexion had increased to the normal in extent, but only to about half strength; he could extend the fingers slightly, but could not repeat the extension, though he could the flexion. At the wrist he had flexion, but not extension. On the forty-second day he could extend the wrist, and from this time on he steadily gained in extent and power of motion in all directions.

The temperature now fluctuated but little from the normal till he left for home. The hernia cerebri had been strictly let alone, only the sublimate dressings being changed, at first daily, on account chiefly of the watery discharge until the thirty-seventh day, after which time they were only changed every two to three days, the watery discharge having then ceased. The hernia was covered with granulations, but, as they showed very little tendency to cicatrize, on the thirty-fourth to the fiftieth day thirty-four skin-grafts from his arm were used to hasten the process. Of these, all but four adhered; several that became detached during the dressing were immediately reapplied and lived. The potassio-tartrate of iron was used for some days with advantage under the sublimate dressing, and removed a membranous film which existed between the grafts. On the seventy-first day cicatrization was complete. The hernia had been for some days nearly on a level with the skull. The next dressing was on the seventy-fifth day, when the site of the hernia, instead of being an elevation, had suddenly changed to a deep hollow.

March 8 (eighty-fourth day). Went home well. Nails on the right hand still half stained with nitric acid; on the left a barely perceptible band. Surface temperature, left side, one-half inch anterior to the old scar, 95.1° F.; right, corresponding point, 96.4° F. Dynamometer, R. 23° , L. 30° . While using the dynamometer the depressed scar rose to the

level of the skull; any marked expiratory effort or even leaning forward to the horizontal position has the same effect. Front tap marked on both sides. Knee-jerk: right much diminished, left exaggerated. Elbow-jerk: right side exaggerated, left diminished. The hernial scar is a crescent, mottled by the skin grafts, two and three-eighths inches long, seven-eighths of an inch wide and five-eighths of an inch deep. Mind clearer than before the operation.

April 19. Dr. Davis writes that he had an epileptic attack yesterday at breakfast. The attack was slight and came on slowly, the head and body turning to the right. Otherwise well and gaining flesh.

I owe much to the intelligent care and faithfulness of Dr. J. C. Heisler, the surgical interne, and he made most of the observations of the temperature, reflexes, etc. I must also express my obligations to Drs. Davis, Oliver, S. Weir Mitchell, M. J. Lewis, William J. Taylor and J. M. Taylor for help in many ways in all three cases reported.

I append Dr. Oliver's later observations of his eye symptoms. These, with observations from the other two cases, he will publish in extenso later.

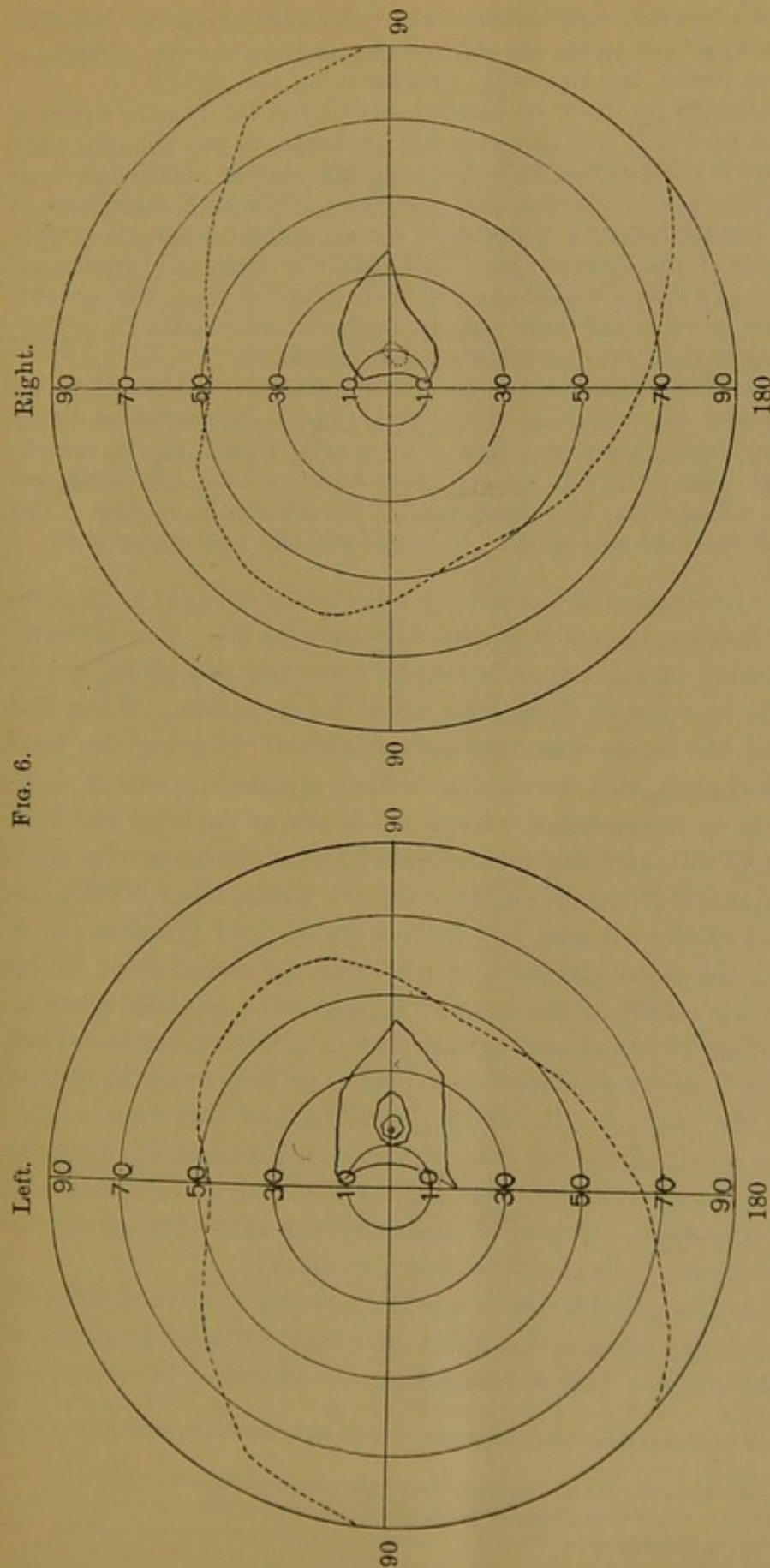
"Immediately following the operation, and at stated intervals of two weeks' duration each, the eye-grounds were carefully reëxamined, the state of the muscles retested and the conjunctival sensibility retried, but in no instance could any changes be found. Of intense interest, however, were other changes. Two months after the operation the fields of vision, although retaining the same positions and embracing the same areas, were found to have gained partial color definition. The left field¹ showed distinct and well-mapped areas for yellow and blue, with a small spot in which red was designated as 'lead,' whilst the right field gave a trace of color differentiation in a small central area. On the same date, the point of best sight with the left eye—even according to the patient's account—had gradually increased to qualitative vision; letters of number thirty dioptry type being properly named when swept across the situation of the best projection in the excentric field. With the right eye nothing definite could be determined, the patient constantly twisting his head in various positions and suddenly exclaiming, from time to time, 'I see a black mark,' or incorrectly calling an exposed letter.

"Careful study of these symptoms, in association with the history, shows that there were most probably two distinct factors in their production: First. An irritative cortical and subcortical growth occupying a position in the left motor zone, encroaching upon, and, in fact, altering the centres for the right upper and lower extremities, the centres for lateral movements of the head and eyes to the right with elevation of the eyelids and dilatation of the pupils and the centre for elevation of the right angle of the mouth; beside indirectly pressing upon and perhaps changing the left visual and auditory centres or their efferent strands² Second. A resultant destructive basilar lesion including portions of both second nerves posterior to the chiasm, parts of both third nerves, filaments of the sensory and motor branches³ of both fifth nerves

¹ In writing to me before the operation the patient, referring to his eyesight, by a curious error called this the "left land."—W. W. K.

² It is probable that the right visual and auditory centres or outgoing strands were in some way impinged upon, possibly by the brain mass itself.

³ The motor involvement of this nerve is, of course, questionable, if the lesion or its indirect results are supposed to have gained access to the nuclei of the motor oculi.



Here four millimetre squares of white, yellow, blue, red and green were fastened in turn upon the carriage of the arc and wheeled in consecutive order into the areas of recognition. In the left eye, white gave the largest area inside of the original form field, followed by yellow and blue that occupied smaller, though seemingly similar, spaces. Red, which was termed "lead color," gave the smallest field, and was designated as "blue" throughout the blue field, before reaching its own area. Green was never recognized, being called "yellow" inside of the yellow field. No scotomata could be obtained throughout all of the areas. The field of the right eye showed a small area just inside of a very doubtful blind spot, in which yellow, red and green were termed "bluish" or "blue," blue being properly designated in these positions.

and both eighth nerves,¹ apparently more profound upon the left side during the acute attack upon account of the passing results of the co-existent irritant lesion, but in reality greater upon the right.²

"At first, although by the most careful scrutiny of the patient's person there could not be found any characteristic sequelæ, it was thought that an old gummatous thickening, with a subsequent basilar meningitis from acquired syphilis, would account for these two distinctive characters of lesion, and, in consequence, he was placed for a reasonable length of time upon large doses of the alteratives. This partially diagnostic treatment not producing any effect whatsoever in five months' time, the growth was decided to be of a different nature, probably traumatic in origin; and, after consultation, an operation seemed justifiable."

For two weeks Dr. Heisler made careful comparative observations on the temperature of the two sides of the body, the points selected being the axillæ, the brow, palms and legs; the results appear in the accompanying tables. The right side generally showed the lower temperatures, except in the palms, where the right was, on the whole, the higher. The temperature of the legs was about 1° lower than the rest of the body.

REMARKS:—I confess that I was very reluctantly brought to the conclusion not to operate when this patient first came to me. But the early history, as detailed in this paper, is largely corrected and pieced out by facts learned later, some of them even after the operation. When first seen, the site of the injury was extremely doubtful. Shaving the head disclosed several scars, and the clinical history reported no scar of sufficient moment to be remembered. Even which side of the head had been injured was doubtful, and the most contradictory statements were made as to the initial symptoms of his fits. On the whole, the evidence was mostly in favor of the left side, but there were no local symptoms at or near the scar; the old suppuration of the right ear raised great doubts as to how far that might be the cause of a right-sided cerebral mischief, while, still further to complicate the problem, Dr. Oliver was of opinion that the ocular symptoms pointed to an old syphilitic lesion in spite of the denial of the patient. It seemed probable that there was a dual lesion, one the result of the ear disease, the other a still existing meningeal trouble, causing irritative discharges, which might be lighted up anew by any operation. But as no improvement came during several months of treatment, I decided, positively, to operate.

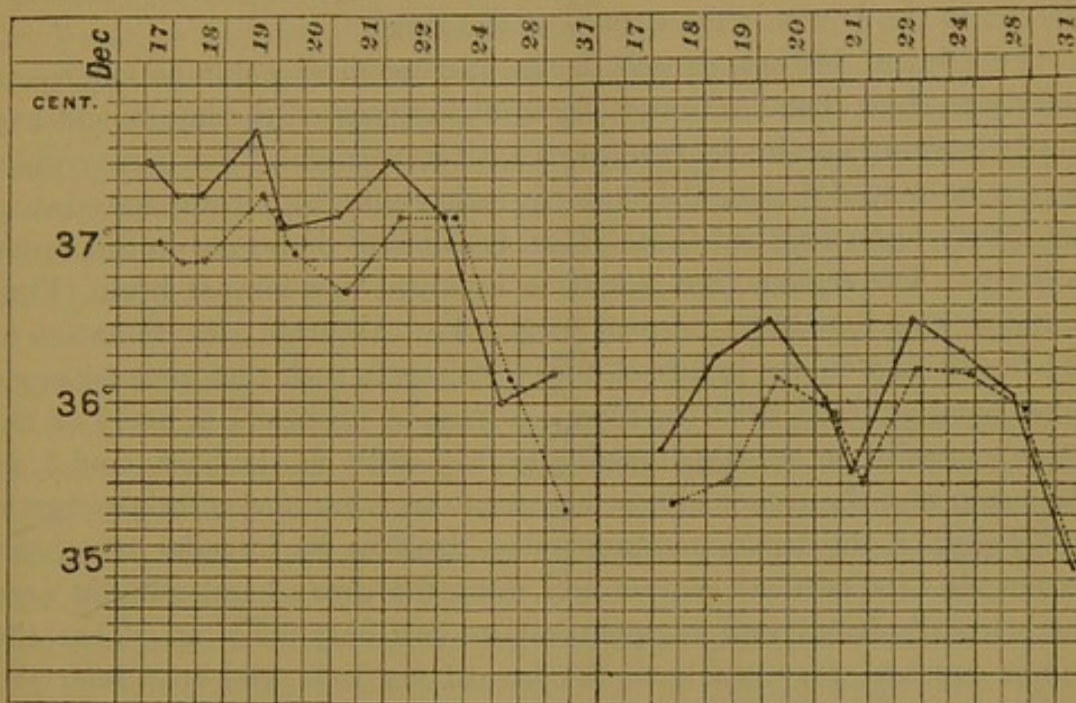
The diagnosis made by Dr. Davis was the one finally arrived at by all of us, the probability being in favor of tumor rather than of exostosis, or cicatricial thickening. This was based on the extent of the palsy, the

¹ A peripheral complication in the acute attack of catarrh of the right middle ear, early in life, should be remembered.

² These conclusions, which, of course, must remain *sub judice* until post-mortem evidence, are rendered still more certain by the results of the operation, where it seems probable that a long-standing, quiet and slowly growing neoplasm at last reached a sufficient size not only to encroach upon the adjacent motor zones and thus give rise, in part, to convulsive discharges, but to cause an actual inflammatory attack, during which symptoms of both irritation and destruction showed themselves; the former gradually lessening and the latter persisting.

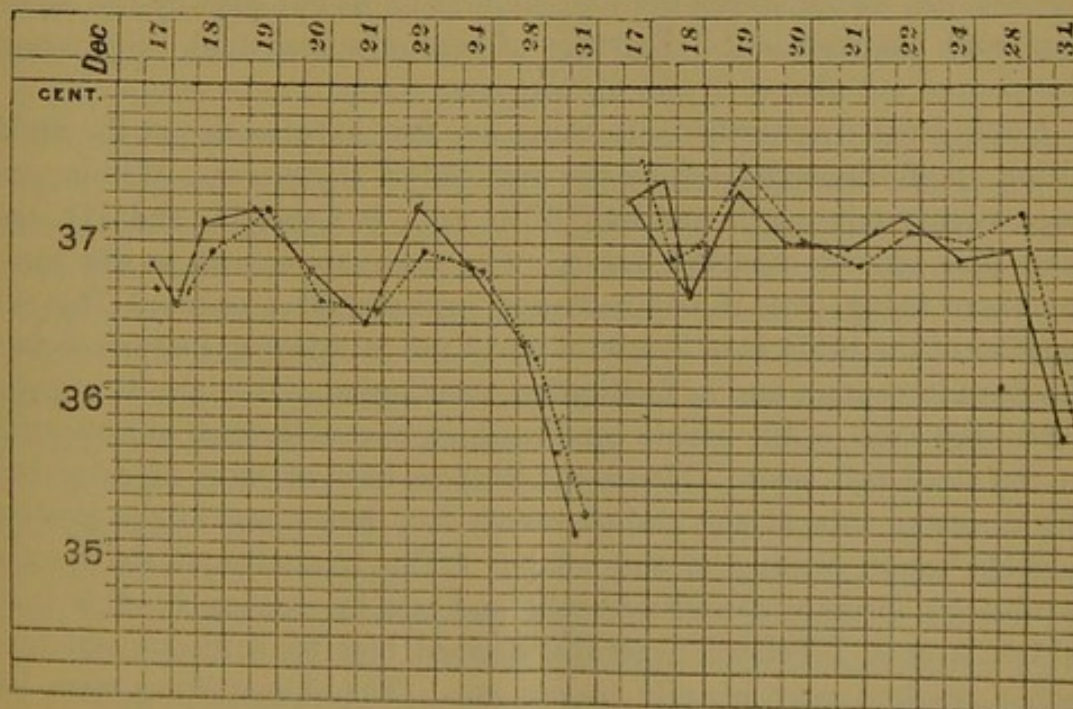
face, arm and leg being all involved, with aphasia; but I did not at all anticipate, nor do I think any of my colleagues did, that the tumor had

FIG. 7.



Brow.

Legs (near crest of tibia).



Axilla.

Palms.

Temperature of the left side shown by continuous lines.
 Temperature of the right side shown by dotted lines.

attained such enormous size. It is not surprising that so large a mass caused epilepsy, aphasia, complete hemiplegia, intense neuralgia, deaf-

ness in the left ear and blindness; but the wonder was that, excepting the ear and the eye symptoms, all the others had passed away except a slowness of speech and the epilepsy, and even this was much better. No function was absolutely destroyed, nor was there any external change in the bones or the sutures of the skull.

The clinical history, as well as the microscopical examination, seems clearly to show that the tumor began at the time of the injury and was slowly growing for twenty-four years until its removal. For twenty years it gave no material sign, although his rather sluggish mental state is undoubtedly to be ascribed to it. Then it suddenly burst out in disastrous activity. The regions that would be involved in a normal brain (Figs. 3 and 4) can hardly be deemed as at all an accurate representation of the localities actually involved, for, 1, its size is such that remoter parts must have suffered from the direct or remote pressure; 2, many of the sequels are due to resultant meningitis, especially at the base; and 3, as the brain and the tumor almost began life together and certainly "grew up" together, the brain accommodated itself to its intruder to a great extent, and its cortical centres and even the great basal ganglia were doubtless displaced into regions that we can only guess at. That the tumor reached very nearly to the lateral ventricle, and that later the resilient rising brain-layer between the tumor cavity and the ventricle broke down, is probable, not only by the sectional diagram of the relations of the tumor and a normal brain (Fig. 4) but also by the abundant and long-continued discharge of cerebro-spinal fluid. Sometimes this poured out almost in two distinct jets.

I was greatly astonished—it being my first experience—at the rapid filling up of the cavity left by the removal of the tumor. Within perhaps twenty minutes it was half filled up. In Cases II. and III. the same phenomenon occurred but only to a moderate extent, as was natural, there being little if any increased intracranial pressure. This expansion of the brain is no doubt of great use in bringing its surface and the flaps in contact and so facilitating their union. It is also to a great extent the cause of the hernia cerebri which pushes through any opening in the skull and scalp. Hence the wisdom, in most cases, of removing the drainage tube at the end of twenty-four hours, and of the earliest possible entire healing of the wound. The treatment of the hernia cerebri by absolute non-interference and not by shaving it off, is that which is now, I believe, generally deemed best by surgeons, and certainly resulted very happily in my case. The skin-grafting upon its granulating surface succeeded even better than it generally does upon other parts of the body.

The hernia was dressed with dry sublimate gauze (1 : 1000) for about ten weeks, yet no ill effects resulted. The first serious rise of temperature could not be attributed to the mercurial, for the wound up to that

time was a mere linear one and had nearly healed. I greatly regretted that I re-opened the wound, thus allowing the hernia to follow and causing such long delay in the healing. Looking back upon the entire history, it is evident that the fetid diarrhœa was the cause of the high temperature and was itself, probably, the result of the prior obstinate constipation. It seemed more probable and reasonable, however, at the time to attribute the diarrhœa, the bulging of the flap, the aphasia and the progressive hemiplegia to intracranial pressure; and concealed supuration was the most likely cause for such pressure. But when he had several later attacks of fever with diarrhœa or constipation, the aphasia and paralysis again fluctuated in a curious and instructive way, more with the general condition, and especially with the fever, than with any possible alteration in the intracranial conditions.

A careful study of the surface temperature of the head was made, as is seen by the notes. The only inferences seem to be that, before the operation, the left side had about the normal greater heat than the right; but it is a rather curious fact that while this was true even of the brow, the right cornea was 0.6° F. hotter than the left. Three months after the operation, too, it is noticeable that the right side of the head was 0.7° F. hotter than the left—a rather curious fact, though Broca gives the right parietal temperature as 1.35° F. higher than the left. The other comparative temperatures are placed at the end of the history.

Dr. Heisler made daily examinations of the urine for some weeks, but, except that it became scanty and high colored during the febrile attacks, there were no other changes.

He also made very numerous examinations of the patellar, abdominal and cremasteric reflexes. Two days after the operation they were all normal but the knee-jerk was not reinforcible. The later observations vary extremely and seem to follow no law. Sometimes the right side was greater than the left, sometimes it was reversed, and in different reflexes it was not always the same side that preponderated at the same time. Sometimes one reflex would be normal or increased, while another would be diminished; sometimes all would vary similarly. There was apparently no relation between the variations of the reflexes and the fever or other physical factor. Before the operation the left knee-jerk was normal; right subnormal. Six days after it, the left was exaggerated, the right much diminished; while in the elbow-jerk the reverse was then found. We had no instrument by which to measure the knee-jerk, and I do not rely, therefore, implicitly on these observations, except that they certainly show a curious variability, seemingly without any law. In its histological structure the tumor is very rare. Only 3 fibromata appear in the 580 intracranial tumors tabulated by Bernhardt and Hale White. It is equally gratifying in the entirely favorable prognosis.

CASE II. *Simple depressed fracture of skull, followed in four months by epilepsy; thirteen months later trephining and removal of damaged brain tissue; recovery in seven days; cure of epilepsy to date.*—D. B. L., of Kansas City, was sent to me April 8, 1888, by Dr. W. C. Roller, of Hollidaysburg. Aged twenty-five; best weight one hundred and fifty-four pounds, present weight one hundred and fifty-two and a half pounds; five feet eleven inches in height; American; civil engineer. Had the ordinary diseases of childhood, except scarlet fever, from all of which he recovered perfectly.

At seventeen, in the summer, while in the engineer corps of a railroad, walking fast to catch a train, he felt dizzy and his head commenced to pain him. He was in bed for a week and in the house for ten days. The headache was not well located. So far as he remembers his headaches were of equal severity both before and after this, occurring from one or two in a month to one in two months. He always could predict them by a twitching of the eyes and by waves as of heated air passing before either the right or left eye. From seventeen to twenty-two he was in school, and since 1885 has been a civil engineer, in the office in winter and in the field in summer.

In November, 1886, he fell one night a distance of nine feet. His face was scratched and he had a serious blow on the right side of the head, without, however, any lesion of the scalp. He was unconscious for a considerable time. When he came to, about daylight, he found himself in bed and entirely conscious. After dressing he came down stairs and took a car to his sister's, where he was confined to bed for three or four days. A week after the accident when he first tried to dress himself again, he noticed that the three left ulnar fingers had lost their feeling. He could move them but they felt strangely unnatural, especially toward the tips. He had some difficulty in buttoning his collar and in other such finger actions. There was no other paralysis, and no catheter was necessary.

The headaches after the accident were about as usual, possibly less severe. He returned to business in about a month.

March 8, 1887. At 9 A.M., while waiting for a street car, he suddenly felt dizzy; starting to walk he swayed to and fro; called a policeman, but before one reached him he fell down unconscious. He recovered in a few minutes, and found that his left hand and forearm were paralyzed. After the policeman had rubbed his hand and arm for a few minutes, he completely recovered the use of them. He is quite sure that his shoulder and elbow were not affected. Though he felt able to go to work he did not resume his place at the office until the following day.

In June, 1887, he had a dizzy spell, which was relieved by the application of hot water to the head.

In September, 1887, being unusually well after his summer holiday, he suddenly felt quite dizzy. Fearing an attack he ran the length of a long hall back to his office, and lay down on the floor and became unconscious. He woke up muddled after ten or fifteen minutes. A brother clerk states that "his eyes were first open and fixed, then his head was tossed from side to side, with considerable general convulsive movement, and later considerable rigidity of the body. He turned his body like a corkscrew, and especially kept his head down pounding on the floor with his forehead. His face and hands were dark blue, cold and damp. There was frothing at the mouth, and later some loss of

memory for some little time." The hands were not affected in any way, but both eyes were as "red as flannel" for three or four days. In an hour or two he returned to his work in the office. These attacks were always ushered in by palpitation of the heart and a rushing sound in the ears. After these attacks, of his own accord, he took bromide (about a drachm a day) until the 25th of February, when he stopped on account of the acne.

March 1, 1888. While walking in the street he felt a dizzy attack coming on. He walked perhaps seventy-five feet and became unconscious. After he recovered he walked home and remained in the house for some days, but not in bed. He was nervous, but otherwise well. His hand was not affected. He was generally constipated before these attacks.

21st. He knew that an attack was coming on by the dizzy feeling and the sensation of numbness which he could not locate; by gasping for breath and by wanting more light in the room. He became unconscious, but did not fall from his chair. The hand was not affected after it. His sister, who was present, states "that his convulsion began with slight movement from side to side, increasing in violence; the face was swollen; the eyes open wide and very red; twitching of the head and face; left forearm and leg stiffened; no convulsive movement, except a little twitching of the left fingers; breathing was snoring and there was frothing at the mouth. He was unconscious for ten minutes. This attack was followed by temporary loss of memory, confused talking, etc." Later on, in the same day, another attack was aborted by the use of cold water on his head, which was very hot.

April 8. Present condition: Urine normal; no albumen, no sugar.

Head.—When his head was shaved two small scars were found, one unaccounted for and one from an old hurt. In addition to this, five-eighths of an inch behind the apex of the right parietal protuberance and on a level with it was a shallow groove running upward and forward at an angle of 50 degrees with the median line, the angle opening posteriorly. The groove was about two and a half inches long and one-half of an inch in width. The ends were not definitely marked; the centre was three inches to the right of the middle line. The anterior end of the groove died out just in front of the bi-auricular line and just anterior to the fissure of Rolando.

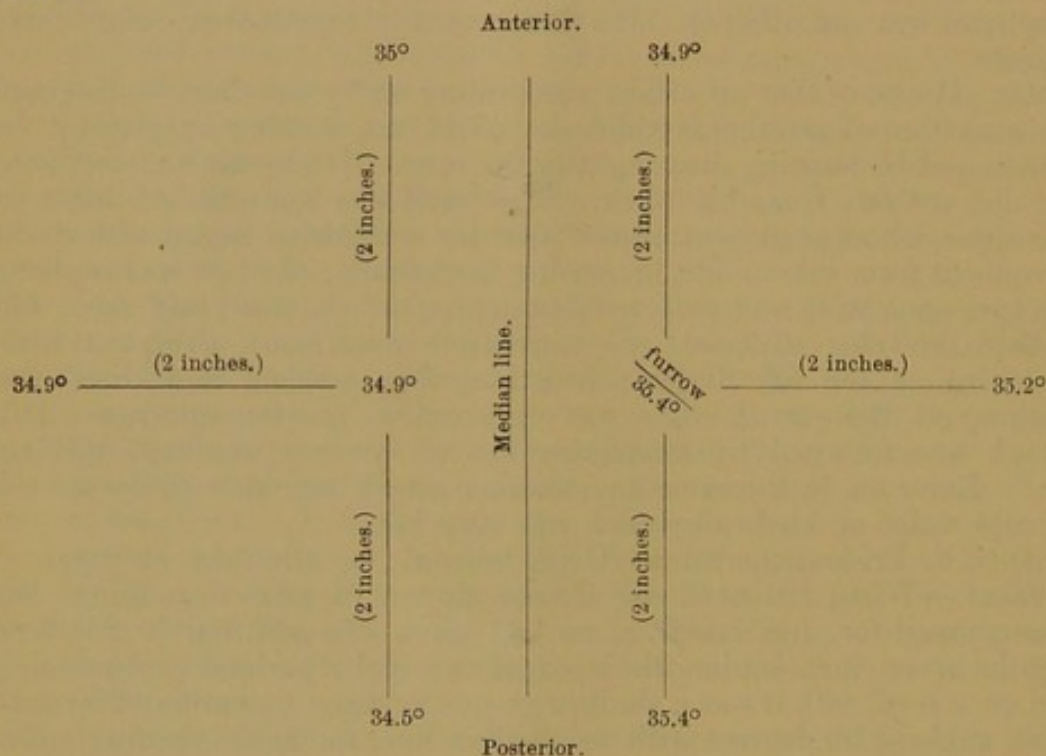
The anterior portion of the groove slightly overlapped the pre-Rolandic convolution, crossed all of the post-Rolandic convolution, and the posterior portion of it was over the supra-marginal. The scalp showed no lesion.

Dr. J. M. Taylor determined the following facts: "Knee-jerk and reinforcement normal. Dynamometer: right, 160°; left, 150°. Sensation in hands by the æsthesiometer, normal and equal. Station, sway one-half of an inch posteriorly, and then three-quarters of an inch forward; to right one-half of an inch; then left one inch. Electric reaction by a faradic current, normal."

Dr. Charles A. Oliver examined the eyes and made the following observations: "Direct vision for form, normal in each eye separately. Range and power of accommodation in each eye, proper for refractive error and age of patient. Fields of vision for form and color, normal in area and sequence. No evidence of subnormal color-perception. Pupils equal in size and shape upon separate and conjoined examination.

Irides freely mobile to light-stimulus, accommodation and convergence. Iris of right eye not so responsive as its fellow to light-stimulus in *monocular* action; there being a difference of one and a half millimetres in the size of the two pupils after the utmost action in myosis. No changes in the eye-grounds except those found in used hypermetropic eyes at patient's time of life. No perceptible anisometropia. Slight and almost imperceptible insufficiency of the interni."

The temperatures were also taken by Dr. Taylor over the furrow and two inches in front, behind and externally, and at the three corresponding points on the left side, with a centigrade surface thermometer as follows:



Diagnosis.—Traumatic epilepsy from depressed fracture of the skull, with probably a fragment of bone broken from the inner table; possibly a cyst of the brain; certainly, secondary traumatic changes. Centre for the left hand and the supramarginal gyrus involved.

I recommended that an operation should be done, and he gladly consented to it.

Operation, April 12, 1888.—Present: Drs. W. J. Taylor, Mills, Sinkler, Lloyd, J. W. White and Morris J. Lewis, of Phila., C. M. Ellis, of Elkton, Md., and Mr. Le Conte, medical student.

I had intended giving the patient a quarter of a grain of morphia to contract the cerebral vessels, as Horsley has advised, but he informed me of the bad effects of that drug upon him, so I substituted one drachm of the fluid extract of ergot half an hour before the operation.

The previous day his head had been shaved and treated as described in Case I. Similar precautions were taken as to hands, instruments, sponges, etc. No spray was used.

Ether was administered and a horseshoe-shaped incision, three by three and one-quarter inches, was made, extending beyond the limits of the depression, with the convexity backward. Hemorrhage from this wound was admirably controlled by the flat band furnished with the

ordinary Esmarch bandage. Eventually only three arteries in the scalp required ligation. The loss of blood from the scalp wound was not over half an ounce. As soon as the flap was raised a sharp furrow, about three-sixteenths of an inch in depth, was seen in the skull, showing evidently the old line of fracture through the entire thickness of the bone. This could not well be appreciated through the thick scalp. An inch and a half trephine was now applied directly at the middle of the depression.

FIG. 8.

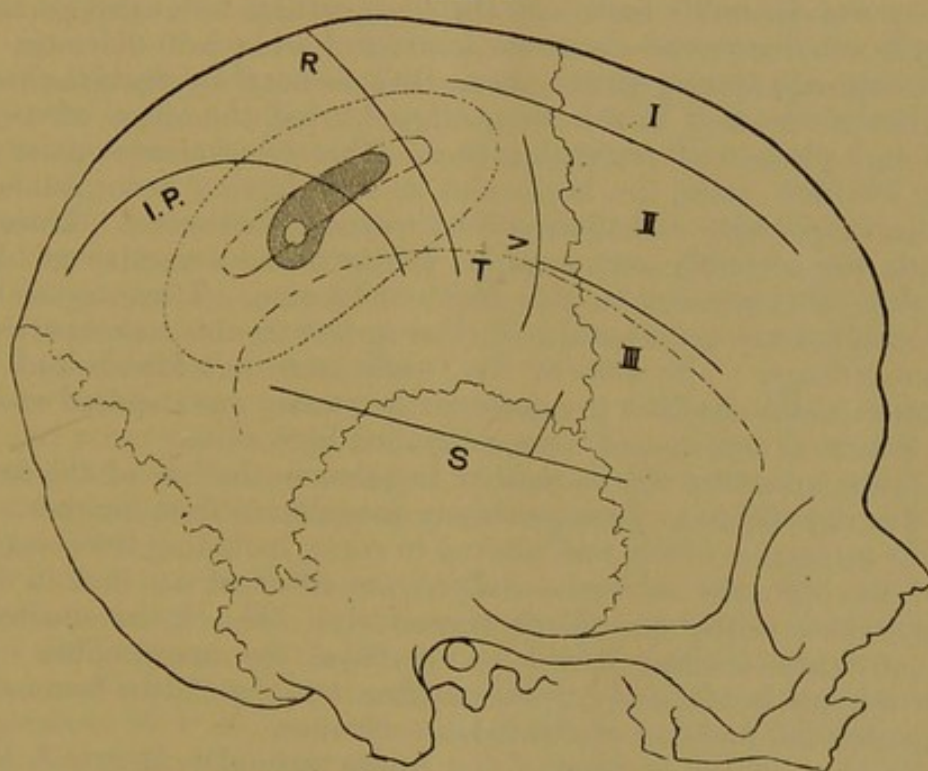


Diagram of skull. (Drawn by Dr. John M. Taylor.)

S, Fissure of Sylvius. R, Fissure of Rolando. IP, Intraparietal sulcus. V, Vertical or precentral sulcus. T, Temporal ridge. I, II, III, The first, second, and third frontal convolutions. The dotted line represents the opening in the skull; the interrupted oval line, the furrow in the skull. The shaded portion represents the part excised; the circle representing the cyst.

Care was taken, on account of the inequality of the surface of the bone, not to cut through the elevated portions in advance of the depression of the furrow. As soon as the disk of bone was removed it was placed in a teacup, in a bichloride solution, 1 : 2000, which Dr. Lloyd was careful to keep at 105° F., by hot water in an outer basin. All the later fragments removed were put in this cup for future use, should it not be needful to remove the dura mater. The inner surface of the button showed a ridge corresponding to the old fracture. There was no bulging of the cranial contents, and they pulsated regularly. The dura mater in a line corresponding to the fracture was dark and thickened, and looked as though a large vein or sinus was under it.

A small opening was made in the dura, and, by means of a probe, it was found to be distinctly adherent to the brain, underneath and beyond the limits of the opening. Accordingly, by a rongeur forceps, the opening in the bone was enlarged three-quarters of an inch backward, to a point somewhat beyond the line of the old depression and half an inch anteriorly, until, finally, it measured three and one-quarter inches an-

tero-posteriorly and one and one-half inches transversely, and exposed all the adherent portion of the dura. An incision was now made in the dura mater, with the convexity backward, one-eighth of an inch from the margin of the opening in the skull, and the whole dura mater was detached from the brain, until the non-adherent portion was reached, both posteriorly and anteriorly. This lifting tore the brain substance to which the dura was intimately attached. The portion of the brain underneath the line of the furrow was brownish-yellow for nearly a finger's breadth, of normal consistence anteriorly, but at the posterior extremity was distinctly hard. In the centre of this indurated portion a small cyst was discovered about one-quarter of an inch in diameter. Its contents were apparently serum. Some little hemorrhage from the vessels of the brain occurred at this time, when I tried the effect of cocaine applied on a pledget of borated cotton. This solution was made with recently distilled water, the bottle and its cork having been disinfected by bichloride solution and then washed with distilled water. The effect of cocaine was certainly very happy. It contracted a number of blood-vessels that otherwise would have required ligation. Three vessels were ligated with Kocher catgut and no further serious trouble was experienced from hemorrhage. The walls of the vessels were not friable and bore the ligation well. Neither pressure nor hot water was required and the vessels that were not ligated were controlled by cocaine.

The brain substance was so matted together in the line of the furrow that it was impossible to distinguish one convolution from another. All the brain substance which was altered in color, including the thickened walls of the cyst, was excised to about one-third of an inch in depth anteriorly and nearly two-thirds posteriorly. The entire amount of brain substance excised would be, perhaps, one teaspoonful. The incision was made vertically to the surface and but little hemorrhage accompanied the removal of the brain substance.

At the time of the excision of the brain tissue Dr. Morris J. Lewis observed the following phenomena, which were all corroborated. How many were due to the act of cutting I leave to the reader to decide: "Patient yawned twice contracting the face evenly (previous to yawn the creases in face were slightly more marked on *right* side). Opened eyes and rolled them slowly; slight external strabismus of both eyes; pupils moderately dilated and equal. No conjugate deviation.

"During the whole of the cutting there were no movements observed in the left arm or hand, but once or twice conscious movements were made with the right arm and both legs, the right leg moving the most strongly.

"A tonic contraction, lasting but a short time, was noticed in *left* leg (a similar contraction in thumb, in palm and flexion of wrist occurred in left arm during etherization and before operation).

"After the cutting, and while the patient was still under ether, the following condition of the reflexes in the legs was noticed:

"*Right* knee-jerk exaggerated; *left* knee-jerk about normal. *Right* ankle-jerk marked; *left* ankle-jerk very slight. A tendency to clonus (one or two throbs) was observed in right foot, none in left."

I had taken my camera and two Cramer plates, No. 28, and at this stage of the proceedings Dr. Morris J. Lewis, at my request, took two photographs of the wound, the exposure in each one being ten seconds. This was the only interruption in the operative proceedings. The day

was cloudy and the light poor and the patient moved slightly, so that the first photograph was worthless, but the second is fairly good.

I then removed the already nearly detached dura mater corresponding to the entire length of the furrow. On its inner surface a small spicule of bone, size one-quarter inch, was discovered. It was attached to the under surface by one end. It was imbedded in the brain substance, but whether it had any relation to the cyst could not now be ascertained, though it most probably had. The button of bone which had been removed was now completely perforated at its middle by the centre pin of the trephine and another hole was made toward its margin. It was then placed on the under surface of the flap and secured in place by a chromic acid catgut ligature, the two ends being passed through the openings in the bone and then through the scalp and tied on the outside to prevent its falling upon the brain substance, and to secure its adhesion to the scalp.

The scalp wound was now united by chromic catgut ligatures placed quite closely together. A rubber drainage tube was brought out of the posterior part of the wound and about a dozen strands of horsehair were passed entirely through the wound. An ample bichloride dressing was now applied to the entire skull.

Twice during the operation his respiration and circulation had been poor and a number of injections of brandy were made in the forearm. He was placed in bed surrounded by hot bottles. The operation lasted one and a half hours and his temperature, at the close of it, was 97° and the pulse 102.

April 12, 6 P. M. As the dressing was saturated with blood the wound was redressed. The left hand was distinctly paralyzed, as follows: The fingers and wrist cannot be flexed. Any attempt at flexion results in extension of both fingers and wrist and separation of the fingers. *9 P. M.* Temperature 98.4° F., pulse 98. Had a very comfortable sleep; suffering no pain; vomited only once.

13th, 8.15 A. M. (first day after operation). Temperature 99° F. He passed a quiet night on the whole. Being hungry, I ordered him to have coffee and rolls for breakfast and milk every two hours. At 11.55 last night the nurse tested his hand and found no power of flexion. At midnight he repeated the experiment voluntarily and found flexion in both wrist and fingers. I examined him, however, and found this flexion is effected by the superficial and deep flexors only, which flex the last two phalanges, but the knuckle-joints, which are flexed by the interossei, cannot be flexed. He makes a fist by flexing the last two phalanges and rolling the flexed fingers into the palm (as in ulnar palsy). He can, however, touch his fingers with his thumb. When he desires to clench the fist tightly he flexes the fingers as described, and then the flexors are put further on the stretch by extending the wrist. As the dressing was saturated with bloody serum and a little blood, it was changed.

13th, 6 P. M. Temperature 99.8° F., pulse 88. The rise in his temperature was probably accounted for by some worry due to his mother's absence, who was a stranger in the city. He has only two complaints to make, one that his right arm is very sore from the brandy injected during the operation, and the other that he is hungry. I directed a more liberal allowance of milk to be given to him with some bread and butter or toast. The dressing was a little moist, just saturated on the

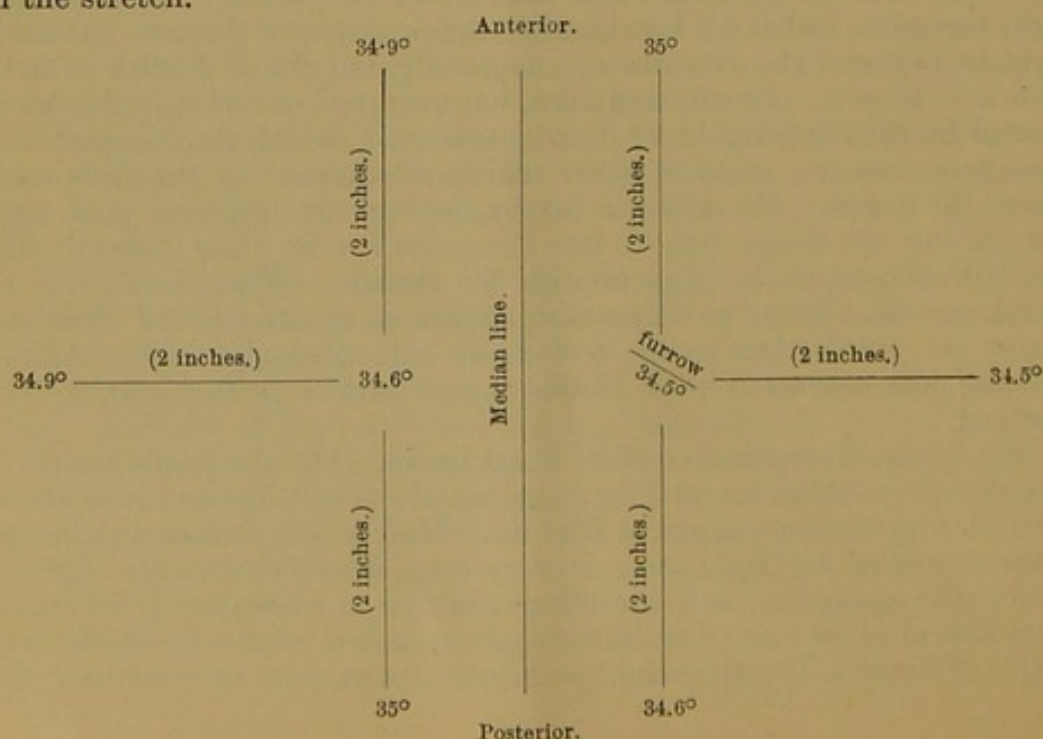
outside with bloody serum only, and was changed. The wound could not look better. The drainage tube was removed leaving the horsehair *in situ*. There was no material bulging of the flap.

14th 8 A. M. (second day). Temperature 98.4° F., pulse 86. 6 P. M. Temperature 98.4° F., perfectly comfortable; has had no pain; feels only a little sore; the right arm more comfortable; knee-jerk about normal, both yesterday and to-day, on the left side; slightly exaggerated on the right; no ankle clonus. By the æsthesiometer on the right fore and little fingers two points were appreciated as one at one-sixteenth of an inch; on the similar fingers on the left side at six-sixteenths of an inch.

15th (third day). Had a comfortable night; temperature normal. As he was hungry I allowed him to take two chops this morning. The only complaint was that it was not enough. During a dream in the night he disarranged the dressing (though the wound was not uncovered), so that I redressed the wound. I removed the horsehairs one by one. There was no discharge and the wound was completely healed, excepting a very small area at the drainage opening. The temperature at noon, by a surface thermometer for five minutes was, in the left hand, 35.4° (C.); right hand, 35.5° ; left forehead, 36.7° ; right forehead, 36° ; left leg, 35° ; right leg, 34.9° . (Dr. Wm. J. Taylor.)

19th (seventh day). The wound was dressed and all the sutures removed. As the suture holding the disk of bone in place was causing no irritation, it was left. The wound was perfectly healed, not reddened, no soreness. The flap is concave to just about the same extent that it was before the operation.

On the 17th (five days after the operation) he was up and dressed. To-day he has taken a walk of one-third of a mile. The only difficulty I have is in restraining him from reading, writing and, in general, too great physical and mental exercise. He is on an ordinary diet. In his left hand he has regained sufficient power to make his grip painful to me. When he wishes to grasp with any force, however, he still increases the power of the flexors by extension of the wrist, thus putting the flexors on the stretch.



23d (eleventh day). The suture holding the disk of bone in place was removed. No irritation at its two openings of exit through the scalp.

24th. Photograph taken. His mother being ill, he goes home tomorrow. Dr. W. J. Taylor made the preceding observations on his temperature (Centigrade) (page 26).

Dr. J. M. Taylor made the following report:

"Dynamometer: right 160°, left 90°.

"Motion. Left index finger closes indifferently well.

"Sensation. Slight impairment in middle forearm and third and fourth fingers, but position of æsthesiometer clearly indicated.

"Knee-jerk: right increased, left normal; reinforcements to normal.

"Station, normal, antero-sinistral; antero-posteriorly, forward three-quarters of an inch and not backward; laterally, right half an inch, left one and a half inches.

"Muscles respond to the mildest faradic currents equally well on both sides. An accident made it impossible to test them for reactions of degeneration."

May 23. The patient called at my office to-day. The site of the operation shows a furrow. The replaced button of bone is perceptible and firmly adherent to the scalp. It is not adherent on the sides of the opening. This is well shown when he bends forward, as the button can be moved by pressure. The scalp is in good condition and protects the opening well. He has no headaches or mental symptoms, except that now and then he fears an epileptic attack, and this worries him. He eats and sleeps well. He makes a fist firmly, with primary flexion of the knuckles; his grip is good, and he has lost entirely the "dead-like" feeling in the three ulnar fingers. When he raises his left hand, and especially if he grips something with it, the left forefinger twitches noticeably.

Dr. Oliver reports the following reëxamination of the eye, twenty-four hours after operation.

"Iris of right eye responds *separately*, as equally and as freely as its fellow, the pupil becoming the same size as that of the left side upon extreme contraction, to light stimulus.

"The isolated symptom of want of proper reaction of the right iris to light stimulus alone (a species of monocular Argyll-Robertson pupil), which was relieved by the operation, consisting in the excision of a portion of the cortex and subcortical tissue in the right supra-marginal convolution, is, as far as the observer is aware, a new observation, and may be of value in further determining and better localizing the situation of interruptions in the light reflex act." In Dr. Oliver's paper later details will be given of the ocular conditions.

Dr. George Dock kindly examined the brain tissue removed, and reports as follows:

"The specimens consist of a piece of dura mater of irregular outline, measuring 4 cm. in length and 2.5 cm. in width, and a part of cortex cerebri of similar outline, down to, and including the white matter.

"The dura is divided into two unequal parts by a curved line in the long axis. This line is marked by loose connective tissue on the outer surface, resembling the course of a meningeal vessel. Near one end a small, smooth spicule of bone is adherent to the membrane. On the inner surface the line is well marked, though only as a thickening and pigmentation of the membrane. The dura varies in thickness

from 5 mm. to 2 mm. It is deeply pigmented, especially on its inner surface. Microscopic examination shows fibroid thickening, especially on the inner surface, corresponding to the line supposed to represent a cicatrix. There is also extensive perivascular and interstitial hemorrhage, and hemorrhage into the arachnoid spaces.

"The piece of brain substance measures 3.3 cm. in length, 2 cm. in width and 1.3 cm. in greatest thickness. The surface is rough and discolored, and shows no normal cortical surface. The edges and inner surface show a few punctate spots, but appear healthy. The small cavity on the surface looks like the site of a cyst, which has been obliterated by the hardening.

"Microscopic examination of specimens from various parts of the surface show extensive destruction of brain tissue. The brownish tags on the surface are composed of broken-down nervous tissue with pigment masses and compound granule cells. Deeper down are perivascular hemorrhages and collections of lymphoid cells, fine granular pigment, compound granule cells and increased number of neuroglia cells. The edges and inner or white matter surface show usually no change. Only at one end are there hemorrhages and collections of small cells in the perivascular spaces, at the margin of gray and white matter. A section from the wall of the cavity mentioned shows no traces of cyst wall proper. The gray matter there shows also vascular dilatation, compound granule cells and slight degeneration of nervous tissue.

"*Diagnosis.* The specimens evidently show results of a chronic meningo-encephalitis, which, in the absence of any discoverable vascular disease, is most probably of traumatic origin. The scar-like alteration of the dura strengthens this opinion, as does also the spicule of bone."

REMARKS.—It was clear from the outset that this patient had suffered from a simple depressed fracture of the skull, and the operation showed that the dura had been torn and a spicule of bone driven through this rent into the brain. The brain substance also had been lacerated, and later a cyst had been formed. The degenerative changes in the brain were very evident to the eye, and the hardening of the cyst walls equally so to the finger. The conclusion is clear. This patient should have been trephined *immediately after the accident*, especially as, with due antiseptic precautions, trephining is not now a dangerous operation. In fact, the patient was lucky to have escaped an acute meningo-encephalitis. Whether the surgeon recognized the fracture or not, I do not know, but the patient, a very quick, bright and intelligent fellow, made one curious observation upon himself that I commend to the profession as it may prove a useful means of diagnosis in other cases. On the morning after the accident he examined the two sides of his head by tapping on it, and he says he observed distinctly a "cracked-pot sound" on the side of the injury. Whether this would be perceptible only subjectively by the patient, or whether the surgeon himself could also perceive it, is a question I have not yet had an opportunity to settle. If not heard by the unassisted ear of the surgeon, I would suggest that

a stethoscope be used while the head is tapped. "Skull percussion" may hereafter render important aid, especially in fissured fractures.

The location of the injury was clearly mapped out as over the hand-centre in the post-Rolandic convolution and over the supra-marginal convolution. The early clinical history indicated the involvement of the hand-centre, and the results of the operation were strikingly confirmatory. The very early return of the hand movements was probably due to the fact that "compensation" had already been effected soon after his accident, and that spoiled, and not normal brain tissue, was removed. The injury of the supra-marginal convolution and subsequent removal of the degenerated tissue would seem to have some causal connection with the "monocular Argyll-Robertson pupil" symptom, noted by Dr. Oliver, and may prove of value in the future.

Normally the left side of the head shows a somewhat higher surface temperature than the right. It is interesting to note that in this case the injured (right) side before the operation was distinctly the hotter of the two, and that only twelve days after the operation its temperature fell about 1° C. below the temperature of the left side—*i. e.*, to its normal relation. It would seem that not only was there no inflammatory heat left as a remnant of the operation, but that the removal of the injured tissue had cut off the source of irritation and resulting heat.

Along with this it is to be noted that there has been no return at present (August 12th) of any fit. Though this period of immunity (four months) is too short to warrant any definite statement of results, yet, if we observe that before the operation the fits, though infrequent, were growing more frequent as time went on; that the fits have not since returned; and that the surface temperature of the right side has fallen to its normal relation to that of the left, it would give reasonable hope that the removal of pressure and of the diseased tissue, in which irritative changes were undoubtedly progressing, will result in a permanent cure.

CASE III. Epilepsy of uncertain origin; attacks beginning in left hand; excision of cerebral centre for left wrist and hand; recovery in eight days; epilepsy improving to date.—W. B., of Maryland, aged twenty; American; clerk in a country store. His best and present weight is one hundred and thirty pounds; five feet five inches in height. The patient is a hearty young man, having had all the diseases of childhood except scarlet fever. At the age of three years he had spasms for six hours from indigestion. He had no subsequent attacks.

At the age of thirteen, he rose one morning at four o'clock to make the fire, and after doing so fell asleep in a chair, from which he fell, and he thinks he struck his head on the stove. He was unable to fix the location of the blow, as there was no cut or bruise on the head. On waking up he found himself on the floor dazed and suffering with headache, which continued all day, but was not sufficient to keep him in bed. His history is quite imperfect in detail. Ever since this accident (?) he has

had epileptic attacks, always preceded by dizziness. Stooping often brings one on, he and his family say (though he could never accomplish this before me). He has never had a hurt in consequence of these attacks. Sometimes they occur in the night. He eats and sleeps well. His friends state that the attacks begin with a fixed or a wild look from the eyes, and when engaged in any action, such as tying a bundle with twine, he would continue the action for an unreasonable time, till he would come out of the attack and resume his work as usual. His head sometimes turned to one side and sometimes to the other before any other part of the body became affected, then the arms would begin to jerk, then the convulsion would become general. The fits would last about two or three minutes, and would be characterized by very marked convulsive movements.

Present condition, April 23, 1888: *Head*. When the head was shaved two small scars were seen, one from a recent blow and one unaccounted for; neither of them seemed important. On the right temple was a distinct furrow, which could be traced over the temporal muscle into the temporal fossa. It began one-quarter of an inch to the right of the middle line, and seven-eighths of an inch in front of the bi-auricular line, terminating below one and one-quarter inches in front of the bi-auricular line and one and three-quarters inches above the zygoma, and one and one-half inches behind the external angular process. At first this irregularity was thought to be the coronal suture, but it was so regular on the edges and so sharply defined that it was thought to be a furrow, and the question was, Might it not be a fracture? No such furrow existed on the left side, where the coronal suture was detected with great certainty. On the right side, the coronal suture, unless it was this furrow, was very indistinct. The temporal artery lay posterior to the furrow.

Dr. Charles A. Oliver makes the following report on his *ocular conditions*: "April 24, 1888. Direct vision for form, normal in each eye separately. Range and power of accommodation in each eye, proper for refractive error and age of patient. Visual fields normal in sequence, though both reduced to more than one-third the average areas, those of the right side being somewhat the smaller. No subnormal color-perception. Pupils normal in size and shape. Irides freely and equally mobile to light-stimulus, convergence, and accommodation. Very slight insufficiency of the interni. Characteristic changes in the eye-grounds usually seen in epileptic subjects with frequent seizures—*i. e.*, a low and chronic form of retinitis, associated with a dirty red-gray appearance of the optic nerve: this being the more marked on the right side.

"*Remarks*.—From this grouping of eye-symptoms, which, with the exception of the eye-grounds and their resultant visual fields, are normal, and hence negative in character, there can be but one legitimate conclusion: a similar condition of the layers of the cerebral cortex, the result of repeated convulsive seizures; the position of the greatest amount of change (indicative of probable situation of irritation focus) being indeterminable."

The friends of the patient insisted on something being done at once, as they desired to take him home. I stated that I would make an exploratory incision in the scalp, and if anything abnormal was found I would go further.

April 30, 1888. *Operation*.—An exploratory operation was done by making a horseshoe-shaped incision with the convexity looking back-

ward, enclosing in its area the suspicious groove before alluded to. Just before the operation another very careful examination was made, and three facts noted of importance: First, the coronal suture could be more distinctly made out than was at first supposed, and it lay behind the furrow; second, the furrow bifurcated in such a way as to suggest a bloodvessel; third, at the lower part of the furrow pressure caused bulging corresponding to the furrow and again suggested a vein. In view, however, of the preparation for the operation and the urgent anxiety on the part of his friends, I deemed it best to make the exploratory incision. The most careful antiseptic precautions, as detailed in Case I., were used, without the spray. Ether was the anæsthetic used. No ergot or morphia was given, as I hardly deemed it probable that I should do more than make an incision of the scalp. On lifting the scalp from the skull nothing abnormal was found. The groove or furrow, so particularly described, was found to be a vein, but I never before felt a vein with such sharp, hard borders, and, until just before the operation, I was very doubtful as to what the furrow was. The patient made an uninterrupted recovery without any rise in temperature.

When he had recovered his family changed their minds, and advised that he remain here under my observation for treatment with drugs, or another operation should anything be found to indicate its being desirable. Accordingly I placed him under the constant care of two trained nurses, who reported to me the character of each fit in its minutest detail. Dr. Sprissler had already seen two attacks from the beginning, and the nurses reported three others which were completely observed. All five of the attacks were practically as follows: Each attack invariably began in the left arm and fingers. The thumb and fingers became rigid and extended, widely separated, the hand and arm in a right line and the elbow flexed; usually both legs were next attacked, the left usually preceded the right and was crossed in front of it; next the face became attacked, the mouth being drawn to the left. (In one attack the mouth was affected before the leg.) After this the convulsions became generalized; the fingers of both hands flexed; the pupils were first dilated and then contracted. These attacks lasted from one to ten minutes. The number of them was markedly increased immediately after the operation of April 30th. Not unusually he would have one or two a day, but they gradually diminished to their normal frequency. Finding, now, that the fits began, so far as was observed, in the left hand, I determined to excise the centre for the left hand and wrist.

Operation May 30, 1888. Present, Drs. William Thomson, J. H. Musser, F. X. Dercum, J. M. Taylor, J. K. Mitchell, Morris J. Lewis, W. J. Taylor. His head was prepared on the day previous with the usual precautions mentioned in Case I. One-eighth of a grain of morphia and a drachm of ergot were given half an hour before the operation. During the etherization he had a fit, as was the case at the former exploratory operation.

A curved incision, $3 \times 3\frac{1}{4}$ inches, was made with the convexity looking backward, the flap lying over the fissure of Rolando. This fissure had been first marked on the scalp by Hare's and Thane's methods; the results of both of which were practically identical. In order to indicate it upon the skull itself, two small incisions were made at the upper and lower end of the line, and with a bone gouge two little nicks were made in the skull through the openings. A one and one-half inch

trephine was now applied, the centre pin one-eighth of an inch back of the fissure of Rolando, the lower margin of the trephine being about a quarter of an inch above the temporal ridge. The bone when removed was placed in a cup of bichloride solution (1:2000). This cup was placed in a large basin of hot water, which Dr. Musser was careful to keep at 105°-100°. The bone and dura both appeared normal; no bulging was observed, and the pulsation was regular. The dura was now partially incised and the brain exposed. The pia was very much infiltrated with serum, producing an oedematous layer much obscuring the brain tissue, especially the sulci over all this area. Two convolutions, running obliquely from above downward and forward, crossed the trephine opening entirely, while at the anterior border a third convolution, apparently in a similar direction, was partially uncovered. Large veins ran in the pia over the sulci. An attempt was made to determine which was the Rolandic fissure and which was the minor fissure by separating the convolutions and determining their depth, but both the sulci exposed were about an inch deep. This, therefore, gave no clew to the point desired. Depressing the brain exposed a further area under the edge of the bone but gave no information of moment. An application of the cyrtometer (disinfected) was then made to redetermine the position of the fissure of Rolando. This ran in the middle of the three convolutions before mentioned (Fig. 9). In order to determine the seat

FIG. 9.

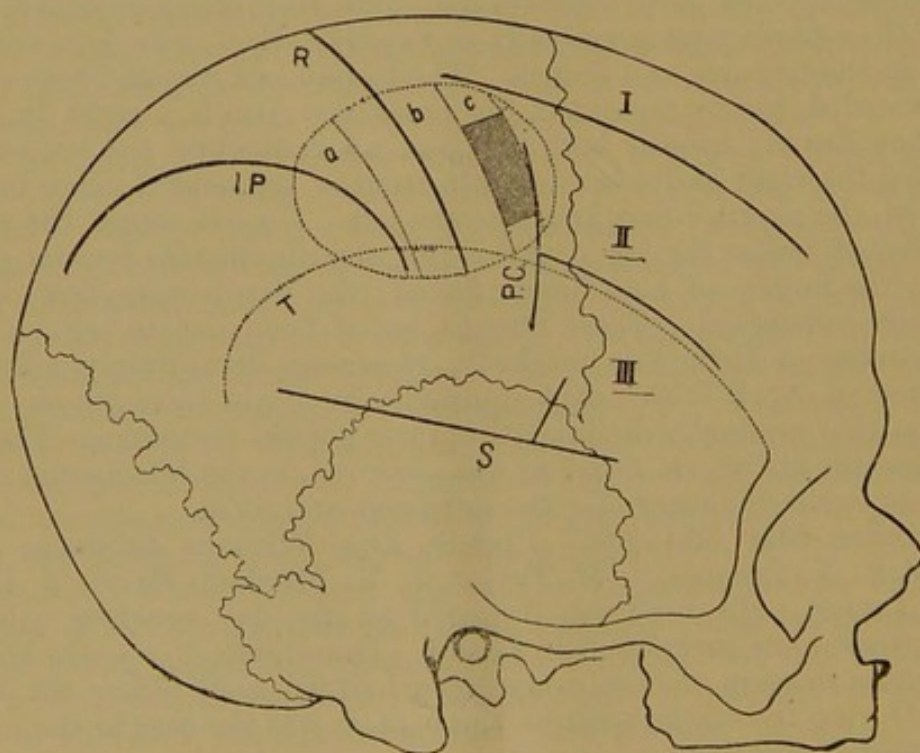


Diagram of skull. (Drawn by Dr. J. M. Taylor.)

S, Fissure of Sylvius. R, Fissure of Rolando. IP, Intraparietal sulcus. PC, Precentral sulcus. T, Temporal ridge. I, II, III, the first, second, and third frontal convolutions. The dotted line represents the opening in the skull; a, b, c, are the three convolutions first exposed in the trephine opening. The shaded lines represent the portion excised.

of the hand centre a faradic battery was then used. The ends of the wire were wrapped in borated cotton dipped in bichloride solution.

Stimulating the two posterior convolutions gave no results, even when the current was perfectly perceptible to my hands and contracted my muscles. On touching, however, the anterior one of the three convolutions the hand instantly moved, the wrist (as observed by Morris J. Lewis) moving in extension in the midline and to the ulnar side at different touches, and the fingers being extended and separated. Above this centre were the shoulder and elbow centres, and below the face centre, as described further on.

The opening in the skull was now enlarged, chiefly forward and downward, till it measured two and a half inches antero-posteriorly by two and a quarter inches vertically, so as to disclose this convolution (*c*) to a larger extent. From the point of application of the centre pin (an eighth of an inch behind the fissure of Rolando and one inch above the temporal ridge) the opening extended forward one and three-eighths inches, backward one and one-eighth inches, upward one inch, and downward one and a quarter inches. In enlarging the opening forward I invaded the territory covered by the flap of the exploratory operation a month before. Under this area the dura was noticeably more adherent to the bone than elsewhere.

The anterior border of this convolution (Fig. 9, *c*) was marked by a fissure nearly parallel with the other two. The portion of the convolution (*c*) containing the hand-centre, about one and a quarter inches long, as ascertained by the battery, was then incised vertically above and below with a knife, the lower incision being three-eighths of an inch above the temporal ridge. The sulci in front of and behind this convolution had been previously freely opened. The lower end of the portion to be taken away was then lifted and the loosened convolution was cut away from the underlying brain substance with a pair of scissors. While this was being done the hand was watched, but no movement was perceived. The wires of the battery were now again applied, while Dr. Lewis again observed. At the remaining part of the convolution at the upper margin of the excised portion, movements of the left elbow (flexion and extension) and shoulder, especially of the latter, which was raised and abducted, were noticed. Touching the part of this convolution remaining at the lower border of the excised portion, produced an upward movement of the whole left face, no one muscle being noticeable in isolated contraction. The platysma was not contracted nor was the angle of the mouth drawn downward. Touching the white matter at the bottom of the excision produced again the movements of the hand. It was deemed, therefore, certain that all the hand-centre had been removed. It was noticed that the convolution immediately behind the part excised was somewhat bruised in the efforts to open the sulci on that border.

Dr. Lewis now took a photograph of the exposed brain. Comparatively little trouble had been experienced from hemorrhage. An Esmarch bandage had been applied to the scalp, but it, probably, was not drawn tight enough, as a few of the vessels bled somewhat freely. These were caught with hemostatic forceps and the bandage was removed. It had been passed only twice around the head. In the brain itself the large vessels were necessarily disturbed to a considerable extent and bled quite freely. Cocaine (four per cent.) and hot water did good service, but for the larger vessels ligation answered best. This was done with Kocher catgut. The tying had to be extremely gentle, with even pulling of the

two ends, else the vessels would give way. The dura mater was now replaced and sewed with fine chromic catgut, two bundles of horsehair having been placed underneath it. The final oozing was so slight that it was not deemed necessary to put a drainage tube under the dura. The disk of bone and some fifteen pieces removed by the rongeur forceps were now replaced on the dura. Two bundles of horsehair were placed between the bone and the scalp and also a small rubber drainage tube posteriorly. The scalp wound was then closed by fifteen chromic catgut sutures. An abundant dry dressing of corrosive sublimate, rubber dam, and a bandage completed the dressing. The operation had lasted about an hour and a quarter. When put to bed the condition of the patient was satisfactory. As soon as he recovered from the ether he was quite violent in his restlessness. Soon afterward he had an epileptic attack ushered in by staring eyes, then the left leg was crossed over in front of the right and the body became rigid. In about a minute the fit was over. No movement of the left hand or face occurred. Immediately after the operation the left hand was found to be paralyzed as to all movements both of fingers and wrist. The elbow was paretic, the shoulder and face perfectly unaffected.

At 6 P. M. the dressing was changed as it was saturated to the margin from moderate bleeding. Again at 3.30 A. M. May 31st, the wound was redressed for the same reason. The oozing at this dressing was much more serous and less bloody. At 12.30 A. M. May 31st he had another epileptic attack lasting about a minute precisely similar to the last one, except that he rolled over on his abdomen.

31st, 8 A. M. (first day after the operation). The patient has been perfectly conscious ever since he recovered from the ether. The only physical change noted was the paralysis of the left hand, which was unaltered. The pupils were unaffected. He slept some during the night, but, on the whole, the night was restless and disturbed. A catheter was used both last night and this morning. The urine was normal in quantity and quality. He complains of discomfort, but states that he has no pain of any moment. He was allowed nothing but ice during the night, but this morning, as he was moderately hungry, he was given some milk. Some rather violent retching followed the operation but it ceased later in the evening. The wound was redressed, as the dressing was slightly moistened with bloody serum, and the drainage tube removed. In the left hand each finger was recognized correctly, but the two points of the æsthesiometer were recognized as only one when so far separated as the entire length of the finger or the entire breadth of the hand. The right hand, however, is but little better than this, as the two points are recognized on the fingers as one at two-thirds the length of the fingers apart and about the same crosswise. His mental condition is such, however, that I do not think this test reliable, saving to show that the left hand, in a general way, is not so sensitive as the right.

June 2 (third day). The wound was redressed although the dressing was scarcely stained. Five out of the fifteen sutures were removed, as the wound was sealed throughout its entire length, saving where the drainage had been. All the horsehairs but six were removed; two of these going under the dura and four under the scalp only. An enema to-day evacuated the bowels satisfactorily. His urine is evacuated only by catheter

twice a day. The bladder seems to have lost its expulsive force. When the catheter is inserted no urine flows except upon pressure over the bladder. The amount is small—twelve ounces in twenty-four hours. Its character is normal.

6th (seventh day). In the last four days his temperature has fluctuated between normal and 100° ; the latter occurring at night. His general condition could not be more satisfactory; his appetite is good; his head feels perfectly clear; and he has had no pain. On the fourth day the wound was redressed and all the stitches removed. The wound was entirely healed. A little œdema exists in the centre of the flap, and pressure on it gives a sensation of resistance almost equal to that over the rest of the skull. Up to last night the catheter had to be used, excepting that he was able to pass his water when he took an enema; but since last night he has passed it voluntarily though very slowly and with little force. He has been up and dressed since the fifth day after the operation. He is anxious to go down stairs to his meals, but on account of the slight rise in his temperature I have not deemed it prudent. On June 3d he had two attacks characterized as before. On June 4th he had one more. The attacks are evidently becoming very much lighter and less frequent. Yesterday and the day before he had two aborted attacks. He, himself, is most annoyed by his left hand which is still paralyzed, though twice there have been slight involuntary movements in it. The elbow has entirely recovered from its slight paresis.

7th (eighth day). As his temperature had fallen to normal and he was anxious to go out, I allowed him to walk to a barber shop and get shaved. The left hand was still paralyzed.

The attacks after the second operation, as after the first, were increased in frequency, but they were not so severe, and they now diminished quite rapidly in severity, frequency, and duration, rarely exceeding one or two minutes in length. At present in an attack the left hand does not move, the eyes are staring, his right arm, legs and body stiffened, but little muscular movement; the mouth drawn to the right and the head turns to the left.

18th. Dr. W. J. Taylor reported his temperature as follows: In the right palm 37° C., the left hand 37.5° C., the right side of the head 37.7° C., and left side of head 37° C.

28th. I examined him carefully to-day, as he was to return home. His skull is perfectly firm, as much so on one side as the other, with very slight, if any, irregularity of surface where the pieces of bone were replaced. Pressure produces no yielding or pain. Except for the two scars one would not know that his skull had been opened. The fits have become greatly diminished, occurring now only once in two to four or five days, and then only of momentary character, practically *petit mal*. There is no convulsive movement whatever, and his mental condition is more satisfactory, inasmuch as he is more cheerful and communicative, and far less morose and despondent than when he first came under my care. His hand and wrist are still as before, but he has ceased to carry his arm in a sling as he did for the first three weeks after the operation.

I made the following measurements: Right biceps ten and one-eighth inches, left nine and three-quarters inches, right forearm two and one-half inches below the olecranon ten and one-quarter inches, and the left nine and three-quarters inches. Unfortunately I did not make any measure-

ments of the same points before operation. Whether this difference is due to wasting or is simply a natural difference in his case of a smaller, because less used left arm I am unable to say.

Electrical responses of all muscles of the arm, forearm, and hand are equal and prompt on the two sides, both by faradic and by constant current. Unfortunately circumstances made it impossible for me to determine whether reactions of degeneration were present or not.

July 20. He writes that motion is beginning to return in the left hand.

Dr. George Dock examined the specimens of brain tissue and reports as follows. In all three cases reported in this paper, I may add, the specimens were placed in Müller's fluid the instant they were removed.

"The specimen was received in Müller's fluid on the day of the operation and examined in less than twenty hours after removal. It proved to be part of a convolution cut off at a right angle at one (lower?) end, at an angle of about 45 degrees to the surface at the other, and with a smooth base. It measured, when fresh, 32 millimetres in greatest length, 10 millimetres in thickness, and 18 millimetres in depth. The surface, from which the membranes had been removed, showed nothing unusual. In making a series of sections of an average thickness of 5 millimetres, a hemorrhagic spot, 3 millimetres in diameter, was found, in the lower third, just below the cortex. Examined fresh, in Müller's fluid, this showed: 1, blood corpuscles of normal color and outline; 2, multipolar cells, with no evident alternations; 3, nerve-fibres, with and without double contours, showing no swelling of the myelin and no apparent loss of it; 4, bloodvessels. The smallest of these showed numerous highly glistening spots in their walls, the larger ones no alteration in structure.

"Having been placed in the hardening fluid so promptly the specimen was soon ready for staining. It was stained by both ammonia-carmin and Weigert's method, the latter giving very satisfactory results. Minute extravasations of blood were found in all parts. Most of these are along the course of small vessels, some confined within the lymph-sheaths, others of irregular shape among the fibres of the white matter and in the cortex. There are no blood-pigment masses and no diffused staining. The large hemorrhage mentioned shows blood corpuscles with well-preserved nerve-fibres, free myelin in small globules and fine granular material. In sections from this part of the specimen there is marked dilatation of the perivascular lymph-spaces. Some of these attain a diameter of not quite one millimetre, being from two to three times as wide as their main vessels. The capillary in them is often distended and the mesh-work, plainly visible, encloses a few corpuscles; in rare cases, however, a large number. The vessels appear normal here as elsewhere. The nerve-fibres are intact, as a rule. In a very few places, in small areas, they do not appear. These areas are in the extreme outer layer just beneath the surface, and when found I have also found small hemorrhages beneath them. The main bundle of white matter shows no diminution in size or failure of reaction to stains. The cortical layer is unchanged, save for the hemorrhages. The ganglion-cells are present in all parts of this layer. Some of them are very pale, but none show atrophic or inflammatory changes. Many of them lie in spaces rather larger than normal, which may be due to an œdema of the space, or to the action of the hardening fluid."

REMARKS.—The first operation, in which the skull was not injured and the flap readhered to the skull and the wound healed without inflammation, teaches one important lesson—the marked lesion within the cranium that may follow a slight traumatism on the exterior. As I extended the bony opening at the second operation I wondered why, all at once, the dura became so adherent to the bone. In a moment I observed that this began just where I encroached on the area under the first flap. As injuries increase in severity their intracranial consequences must increase *pari passu*, so that we can easily understand how severe blows, even without fracture, may be followed by meningitis, or abscess, or, as in Case I., by a neoplasm.¹ Macewen (*Med. News*, Aug. 18, 1888) alludes to this and to the adhesion of the brain to the bone very happily as “anchoring the brain” and points out its deleterious results. I can hardly, however, concur in his inference that a higher temperature at the site of the injury is a contra-indication to surgical interference.

The moment the brain was exposed the marked œdema was the one thing noticed. It extended over the entire area exposed. Over the convolutions the œdematous layer was about one-eighth of an inch thick, and over the sulci three-sixteenths of an inch or more, so that the sulci were at first very hazily seen. Whether this œdema was the essential lesion or not cannot be determined, but, though the brain was carefully examined by touch (in the sulci to the depth of one inch), no evidence of any tumor or other lesion that might cause the œdema was found. The examination of the excised brain by Dr. Dock shows that this œdema was not merely superficial, but extended into the brain tissue throughout all the excised part, and doubtless beyond, how far beyond we can only guess. Besides this, Dr. Dock found numerous hemorrhages, which he believes to be recent, and probably due to the necessary traumatism in separating this convolution from its neighbors and excising it. During the operation I noticed that the convolution back of it showed marked evidences of bruising, though, of course, the manipulation was as gentle as possible. Whether these hemorrhages would have occurred had the vessels been entirely healthy may be easily a question.

But the most interesting question is, as to the location of the centre. I sought for this in the post-Rolandic² convolution just below its middle. (Centres (a) (b) (c) in Ferrier's plates. See Gray's *Anatomy*, last Am. edition.) There were three convolutions exposed by trephining, and the line for the Rolandic fissure ran in the middle of the central one (Fig.

¹ Cf. Horsley, *AMER. JOURN. MED. SCI.*, April, 1887, p. 365, Case VII.

² I have used the terms “pre- and post-Rolandic,” instead of the more common names of these gyri, designedly. The fissure of Rolando is so important and well known that these names are instantly understood, far more so than “anterior central” or “ascending frontal,” etc.

9, *b*). The fissures in front of, and behind convolution (*b*) were of equal depth, and another, also of equal depth, existed in front of convolution (*c*). On the whole, I am decidedly inclined to think that the sulcus in front of (*c*) was the precentral or vertical sulcus, the one between (*b*) and (*c*) the fissure of Rolando, and the one between (*a*) and (*b*) either the beginning of the intraparietal, or, possibly, a retrocentral sulcus. If I am right, the centre for the wrist and fingers which I removed was in the pre-Rolandic gyrus, its lower limit being at three-eighths of an inch above the temporal ridge, and its upper end where it fused with that for the elbow 32 mm. higher up, and the shoulder still higher, while the centre for the upper face was in the same gyrus immediately adjoining the excised portion at its lower end. If the reader will compare Horsley's figures for these centres (Gray's *Anatomy*, last Am. edition, and *AMERICAN JOURNAL OF THE MEDICAL SCIENCES*, April, 1887), he will be struck with the accuracy of their representation. None of the wrist and hand centre existed in convolution (*b*); whether any existed in the convolution in front of (*c*) or not was not tested by the battery, but in view of the complete palsy of the wrist and hand it seems improbable. As one of the few instances¹ in which the results of experiments upon animals have been verified on man it is most important and gratifying, giving us new confidence in this important method of research which has already done so much to make cerebral surgery not only possible, but successful and promises so much more in the future.

The higher temperature² on the right side of the head so long after operation together with the continuance of the fits, may not mean anything discouraging for the future, yet it is in such marked contrast to Case II. that I shall watch it with interest. Probably the œdema will subside slowly. Certainly to date (August 12th), though he has had occasional convulsive seizures and a number of attacks of *petit mal*, yet, on the whole, he shows considerable improvement both as to number and character of the fits, with a decided gain in mental status. By "compensation," it is nearly certain that in time he will regain control of the left hand through the other hand centre, a process already, in fact, beginning.

GENERAL REMARKS ON THE OPERATIVE TECHNIQUE.

My experience in these three cases, as well as assisting at several others, in the new field of cerebral surgery, warrants some general remarks which I trust may prove of value.

¹ Cf. Horsley's paper, l. c., pp. 358, 361, 362, and Macewen, *Med. News*, Aug. 18, 1888.

² The relative temperatures of the two sides of the head before the operation have been unfortunately mislaid.

1. *Shaving the head.* So important do I regard this that I would consider no diagnosis as assured and no operation warranted that had not been preceded by shaving. The unexpected and unknown scars found have surprised me in other cases, as well as in those here related. Besides this, no reliable mapping on the head of the cerebral fissures and gyri can otherwise be made. These can also be now marked on the scalp by the aniline pencil.

2. *Antisepsis.* Practically, the admirable rules laid down by Horsley were followed, nor can they be too strongly insisted upon. (See details in Case I.) No spray was used during any of the operations, though it had been used all the morning in the room in the first case. It is also especially noteworthy that on the day before I operated on the third case, circumstances made it needful for me to operate on a case of cancer of the colon with a fecal fistula and profuse suppuration. Dr. William J. Taylor assisted me in both operations; and our hands were, of course, saturated with infection. After the bowel case we carefully disinfected them with soap and water, alcohol and bichloride, and several times repeated this during that afternoon and the next morning. No infection followed in the brain case—a most valuable lesson as to antisepsis.

3. *Anæsthesia.* In all three cases ether, and not chloroform, was used and I saw no reason for any preference for chloroform.

4. *Marking the bone.* Whether to mark the site of a scar or other lesion, or to fix the site of the Rolandic or other fissure of the brain, the nicking of the bone by a gouge, through one or more small incisions in the scalp, is a most useful preliminary to the horseshoe-shaped incision for the flap. As soon as this flap is raised, all landmarks are lost, and one can only "orient" himself by a reapplication of measuring instruments, which probably have to be disinfected, or perhaps cannot be. Moreover, in my first case, it enabled me, as related, to fix accurately the situation of the tumor.

5. *Access to the brain.* The large horseshoe-shaped flap of scalp is infinitely preferable to the old crucial incision. The large trephines now used (one and a half, two, and even two and a half inches) are also a great help, and I think it a rule, almost without exception, that the bony opening should be ample. Bergmann's opposition to operative interference with large cerebral tumors, on account of the probable consecutive œdema, from want of support by the skull, certainly cannot hold good. In my third case the preëxisting œdema will perhaps find its best relief, indeed, from the operation. The success that has practically followed such operative procedures is its best vindication. Plenty of room, both for observation and for work, should be had. A small opening may defeat the very object for which we operate. A large opening adds no additional danger to the brain, and even if as large as

in Case III., the integrity of the skull may be *entirely* restored. The "surgical engine" may be very useful in rapidly increasing the size of the opening, but it should be used by an expert (a dentist if the surgeon himself is not accustomed to its use) lest accidental injury be done to the brain. The chisel is not only needless but dangerous. It is quite surprising, also, how far beyond the limits of the skull opening we can feel and even see. The brain allows of gentle pressure very readily, and the finger can be inserted an inch all around the opening. The incision in the dura should also follow the margin of the bony opening (one-quarter of an inch away) and not be crucial. It may then be replaced and secured by catgut with ease. I have had some trouble in doing this with the ordinary needles, and have had made a handled needle with a sharp, short curve and an eye in the point. Probably a sharply curved staphylorrhaphy needle would answer well.

6. *Hemorrhage.* For the scalp I used the narrow band of the Esmarch apparatus in the second and third cases, as suggested by Dr. M. Allen Starr. In the second it answered admirably, but in the third was soon cast aside as unnecessary. Generally, I believe, it will be very useful.

Hemorrhage from the vessels of the brain itself is one of the most important of all the operative questions. Morphia, as a preliminary, is useful, I have no doubt, as is also ergot, though I should give the latter in a dose of $\text{f}\frac{3}{4}\text{ij}$ -iv rather than 3j , as I used. The effect of the cocaine applied directly to the brain was certainly very good. I shall, however, try it in a stronger solution (ten per cent.) in the next case. Very possibly, also, antipyrin might be of use in the same way. All such solutions, corks, bottles, etc., should be sterilized. I also used boiling water cooled to 115° or 120° F., to check the hemorrhage, and I could not see that its liberal use did any harm to the brain tissue. Pressure, also, is a most valuable means. But, after all, the chief reliance must be on the ligatures of catgut. They should not be chromicised, as that lasts too long, and may be an irritant, but are best prepared in oil of juniper and kept in alcohol (Kocher). In my second case I had no difficulty in tying the vessels, but in the third, and especially the first, their friability was such that the most delicate manipulation and equal tension on the two ends were requisite for success. It is not the arteries but the large thin-walled veins that give trouble. The cautery in any form should never be used. If there be any trouble in securing vessels of the dura or brain near the edge of the bony opening, this opening must be fearlessly enlarged, so as to give ready access to them. If the middle meningeal (or other artery, of the dura) cannot easily be tied at the cut edge, or even in its continuity, a suture may be passed around it by a needle passed through the dura, but the dura should then be care-

fully lifted so as to avoid any underlying veins. Weir has suggested the application of clamps to the cerebral vessels for twenty-four hours. My experience would make me doubt whether they would hold with such friable tissues, and, if they did, the tossing about of the patient's head might easily displace them, and possibly even involve great danger to the brain itself.

7. *Recognizing the centre sought for.* Only in Case III. did I have a definite centre in view. Ordinarily the gyri and sulci of the surface would be a fairly reliable guide, together with the various methods now used for mapping these out on the surface of the skull. If in doubt, the ordinary faradic battery will serve us excellently, as was shown in this case. The response to the stimulation of various parts of the same convolution was immediate, undoubted, and in every way satisfactory.¹ In order more handily to use this means of diagnosis I have had made

FIG. 10.



by Mr. Flemming this little rubber handle with two insulated poles, the stems of which, being flexible, can be placed near together or far apart as desired.

8. *Photography of the brain.* This can readily be done by an ordinarily expert amateur. Dr. Lewis and I are both of the opinion that the exposure should be practically instantaneous with the most sensitive plates made. Even with such plates they may be under-exposed on a cloudy day. But the danger of movement by the patient and the constant oozing of the blood make it desirable to have the shortest possible exposure. Possibly the "flash powder" may be useful, but if employed the possible firing of the ether should be borne in mind. The photography is scarcely any interruption to the operation in the hands of a competent assistant. But I was disappointed in its results in both my cases (II. and III.). It gave no good details owing chiefly, I think, to the wet, glistening, curved surfaces and deep shadow at the point of excision. I would prefer to have a rapid sketch made by a good artist who understands anatomy.

9. *Drainage.* Combined tubular and capillary drainage answered best in the brain, as elsewhere. The tubing should be removed, as a rule, at the end of twenty-four hours. Whether it would have been wise to do so in my first case, with evidences of increasing pressure, is

¹ Cf. Horsley's Case V., THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, April, 1887, p. 358.

even now, in my mind, doubtful. The horsehair may be removed in three to five days. Everything should bend to the speediest possible healing of the wound, thus preventing hernia cerebri and favoring a quick recovery.

10. *Replacement of the bone.* This most interesting and valuable recent addition to our operative procedure receives further encouragement from the results of Cases II. and III. In the last the disk of bone (one and a half inches) was replaced with about fifteen fragments bitten out by the rongeur forceps. The skull is so completely restored that except for the scars and slight flattening one would not know that it had ever been trephined. Heretofore, when the dura mater has been removed, the bone has not been replaced, but Case II. shows that even then it may be done with ease by attaching it to the under surface of the flap by chromic catgut. Of course, the small pieces cannot be so utilized, so in Case III. I had a lamb in the adjoining room, and if the removal of the dura had been necessary and any large gap been made by the rongeur forceps I meant to replace the trephine button and fill up the remaining gap by another button from the lamb's skull, trimmed by the rongeur to suit the opening. I find that the back of the lamb's skull has nearly the same curve and thickness as man's, and will give one good button from its centre or, at a pinch, two might be got from it.

I had no trouble with the large disks, and do not think it at all needful to chop them up into small fragments as Macewen did. But if the bone is to be replaced, the most minute care must be given to it from the moment of its removal to that of its replacement by one of the assistants, whose sole care it should be. I have recently had to remove a similar one and one-half inch button from a case trephined by a friend. By accident the button escaped observation for perhaps twenty minutes or more after its removal, and so lost its heat, even if it did not become septic, which seems not probable. It gave no trouble for over two months, but then produced an abscess, headache, etc., which were quickly relieved by its removal. It was entirely necrosed. It is, however, proper to say that the skull was unusually thick and almost all compact tissue, and that, soon after the primary operation, the wound had to be reöpened for hemorrhage from the scalp. Even with the utmost care, disks of bone, if chiefly of compact tissue, cannot always be successfully replaced. I recently had to remove three such, much smaller (one-half inch) buttons from one of my cases of trephining of the lower jaw. Yet Dr. J. S. Miller (*Medical News*, liii. 136) has just reported a successful case of reimplantation of one such button in the same bone.

11. *Rapidity of recovery.* Case I., in consequence of the reöpening of the wound and later complications, was long in getting well; but Cases II. and III. were out on the street on the seventh and eighth days, their

highest temperatures having been 99.8° and 100° respectively; Case III. with but little, and Case II. with absolutely no pain and no medicine. No iodoform was used. I get better results without it and its abominable odor.

Thanks chiefly to vivisection and antisepsis, cerebral surgery will show, within the next few years, triumphs as exact, extraordinary, and beneficent as has abdominal surgery.

1729 CHESTNUT STREET, August 27, 1888.

