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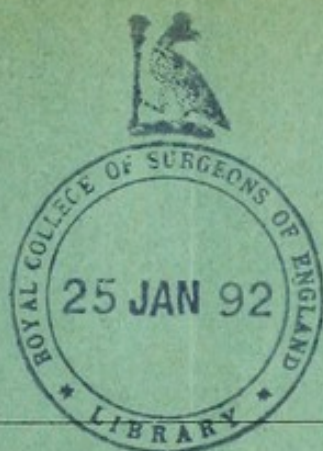
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*Jacksonian Epilepsy; Trephining; Removal
of Small Tumor and Excision of
Cortex.*

BY

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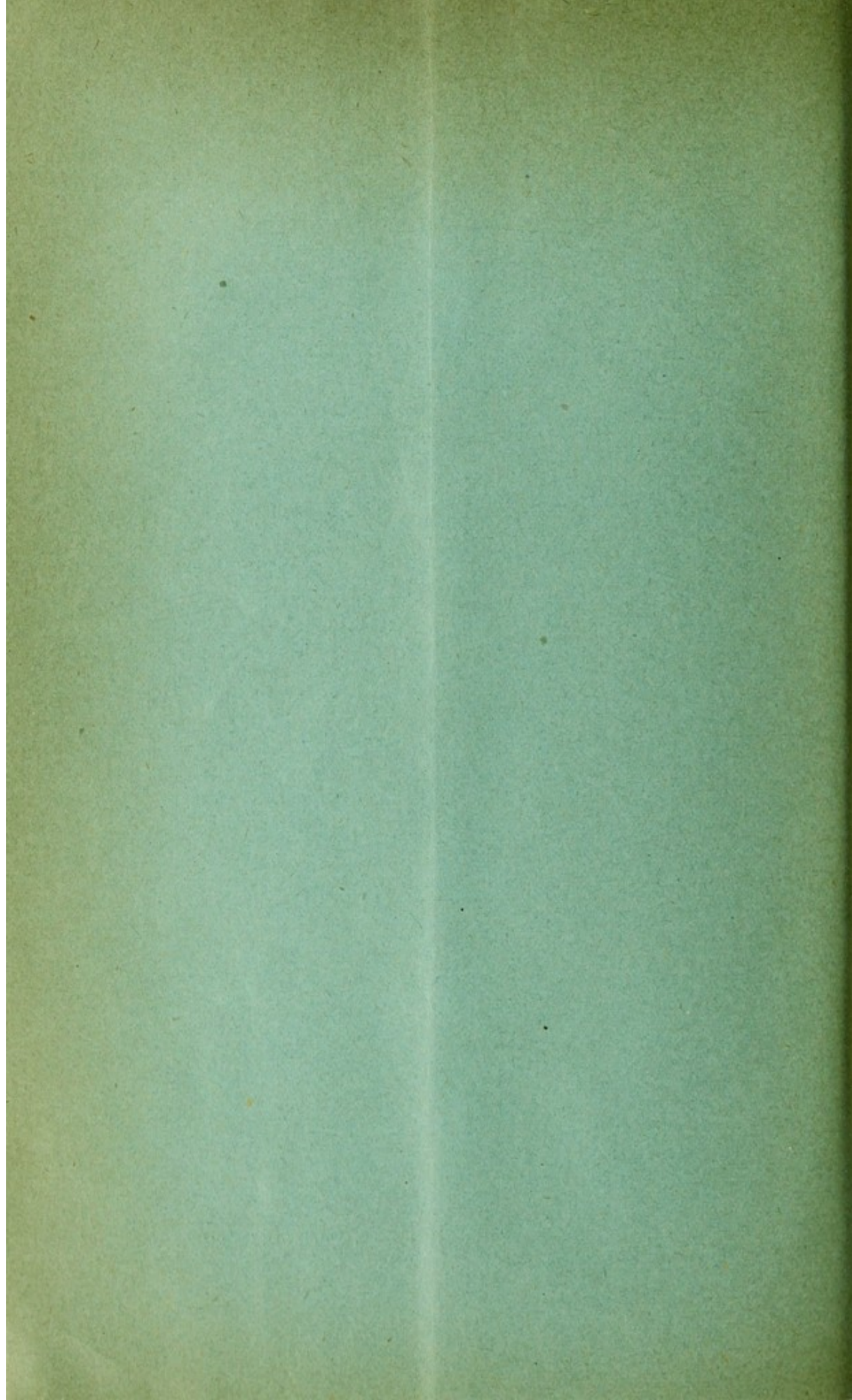
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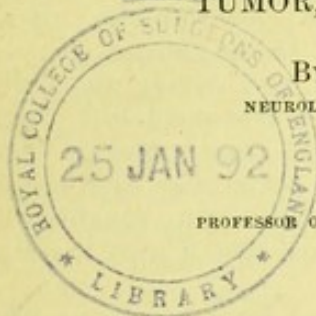


JACKSONIAN EPILEPSY; TREPHINING; REMOVAL OF SMALL
TUMOR, AND EXCISION OF CORTEX.

BY CHARLES K. MILLS, M.D.,
NEUROLOGIST TO THE PHILADELPHIA HOSPITAL, ETC.,

AND

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MEDICAL HISTORY BY DR. MILLS.

S. W., female, twenty-seven years old; height, five feet; weight, ninety-eight pounds. Until the first symptoms of the spasmodic affection for which she applied for treatment she had been in excellent health, with the exception of an attack of chronic otitis when a child, which had left her with a perforated membrana tympani and the occasional recurrence of a slight discharge. Ten years before coming under observation, while in a cold room in the northwest, she had for the first time a slight attack of left hemiparæsthesia; her left hand, arm, and foot became numb and heavy. The sensation passed off in a few moments and was not accompanied by spasm or vertigo; but from this time, at intervals of weeks or months, she had attacks, usually slight, of the same character. Handling or unusual movements of the left arm would sometimes bring them on; at other times they would come on without any apparent exciting cause. Between four and five years after the first of these sensory seizures, she had for the first time, as an accompaniment, a spasm involving both the left upper and lower extremity, but more marked in the former. From this time on she had at irregular, but more frequent intervals, these sensory and motor attacks, the spasm beginning on the left side, but after a time markedly attacking the right arm as well. The seizures increased in frequency, until after a few months she had them almost every day, and often six or seven during the twenty-four hours. The only time when she was free from them for a long period was in the spring of 1890, when, while suffering with a fever, she had no attacks for about three weeks. Although the attacks increased in severity and frequency, they had for many months remained much the same as they were when she first came under observation. She had been treated by various physicians, and on several occasions bromide treatment had been pushed, but always without any improvement, and usually she thought she grew worse under the use of drugs. She was sent to me for diagnosis and treatment by Dr. H. C. Yarrow, of Washington, D. C. Her general health, mental and physical, was good, and she had no evidence of paralysis.

Soon after coming under observation I had several opportunities of witnessing her seizures, and one description would answer for all, with the exception that sometimes her consciousness was more deeply affected

than at others. She would feel a prickling sensation in her left arm, and would utter a plaintive cry. The left arm would immediately extend at the shoulder and elbow, and almost coincidentally the left leg would become spastic in extension, and the head would be twisted to the right.

The right upper extremity would then be strongly flexed at the elbow, and the whole limb carried over the chest, as if the hand was grasping at the precordial region. The spasm continued for a few seconds, passing off with a laughing sound and facial expression. In the shortest attacks she did not appear to lose consciousness at all, and during the early weeks that she remained under observation she never seemed to be completely unconscious during the seizures, and could detail most of what was said and done by others during them. She sometimes complained of having pain in the precordial region. She repelled any touching or handling during the spells, and explained afterward that it hurt her and made her worse.

At first the case was regarded as probably one of hystero-epilepsy, and the patient was treated with tonics and gymnastics to improve her general and nervous health, but in spite of such treatment and the best of care her attacks grew more frequent and severe. About three months after coming under observation, an attack, which began in the usual manner, became extremely violent, and was attended with total unconsciousness. In November the patient began to have day and night as many as ten to fifteen serious attacks. After several consultations with Drs. Mitchell, Keen, Sinkler and Lloyd, it was finally decided that an operation should be performed.

In deciding on a site for operation the history and character of the sensory and spasmodic attacks were carefully considered. The case had begun with sensory disturbance in the limbs of the left side, particularly in the upper extremity. The spasm had first affected this side, and usually, as nearly as could be determined, was initiated with a shoulder movement on this side, although the spasm diffused and extended so rapidly to all parts of the left arm and leg, and to the right upper extremity, that it was sometimes difficult to determine how it began. Sometimes, however, the right side escaped. On the left side the patient showed slight drooping and apparent weakness of the muscles about the mouth, although this was so little marked as to be scarcely more than is not infrequently present normally.

Operation was performed December 10, 1890, by Dr. W. W. Keen. The following were present at the operation: Dr. Roswell Park, of Buffalo; Dr. Raphael Lorini, of Washington; Drs. W. J. Taylor, Wharton Sinkler, J. H. Lloyd, F. X. Dercum, J. B. Deaver, De F. Willard, M. I. Bassette, and J. W. McConnell.

On the day preceding the operation Dr. Bassette examined the patient and made the following report of her condition: Pupils normal; slight drooping of the left upper lip, but otherwise the face normal; no paralysis of the limbs; no impairment of touch, sight, taste, or smell. Hearing much impaired on the left side. Dr. C. S. Turnbull had previously examined her ears, and had reported a chronic otitis media with perforation, which required but little treatment, and which he thought had nothing to do with her brain symptoms. Knee-jerk was present; no ankle clonus. Heart and lungs were normal.

SURGICAL HISTORY AND REMARKS BY DR. KEEN.

On the day before the operation the carpet was taken up, the walls wiped down, and the floor, woodwork, etc., were washed with a solution of carbolic acid, 1 to 40. The patient's head was shaved and carefully disinfected. The position of the fissure of Rolando was outlined first by means of Hare's method, and then by that of Horsley, the cranial index being determined from measurements made as follows:

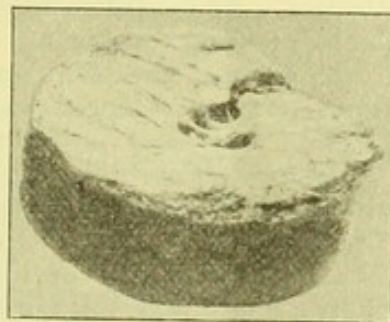
Antero-posterior diameter 19.1 cm.; biparietal diameter 14.3 cm. $14.3 \div 19.1 = 0.748 +$. Practically the cranial index was therefore 0.75; and this corresponded to an angle of 69° for the Rolandic fissure. From glabella toinion was 13.25.

The position for the trephine centre was fixed 1.75 inch to the right of the median line, in the line of the fissure of Rolando and was marked on the scalp by a small puncture in the bone. The fissure of Rolando was also marked at its two extremities by two similar punctures in the bone, so as to identify it after its surface marking was lost by the lifting of the flap.

A large horseshoe flap was made, and on turning this back no abnormal appearances of the skull were found. The centre pin of a $1\frac{1}{2}$ inch trephine was now inserted 1.75 inch from the median line as before determined, the upper edge of the trephine reaching to a point 1 inch from the median line.

Dr. Roswell Park kindly did the trephining for me, so that my hands should not be unsteadied by the muscular fatigue involved in this part of the operation. It was very fortunate that I asked him to do so, for the skull was very thick and the trephining required time and a good deal of muscular effort. The thickness of the button removed varied from $\frac{5}{16}$ inch to $\frac{7}{16}$ inch, and the diploë was almost entirely obliterated.

FIG. 1.



The button of bone removed, showing its thickness and the erosion caused by the tumor of the dura and the vessel supplying it.

The under surface of the button of bone was eroded in a number of connected small pits corresponding to the small growth described below. The little pits resembled a miniature bunch of grapes, the stem of the bunch consisting of a vessel of considerable size which had also eroded the bone. On the removal of the button of bone, free hemorrhage took place from the dura at the margin of the trephine opening where this vessel ran, but the bleeding was soon controlled by a ligature. The tip

of the growth was $\frac{1}{16}$ inch in front of, and the same distance internal to the centre of the trephine opening. The growth was elevated $\frac{1}{4}$ inch above the surface of the dura, and after cutting the dura and lifting the flap, it was found that the granulation or growth had its origin apparently from the pia, and had bored through the dura and formed a nest for itself in the skull. The dura and the pia were adherent at the point where the growth lay.

A triangular bit of the dura, including the growth, was removed by the scissors and placed in Müller's fluid. The exposed pia-arachnoid was oedematous with enlarged veins and capillaries. Nothing else abnormal was found. A fissure corresponding to the line of the fissure of Rolando was seen, and five convolutions were exposed, all of which appeared to be normal. (See Fig. 2.) From the moment that the brain was exposed no antiseptics were applied to it, but only warm, boiled water.

Careful investigations were then made with the faradic current with a view of determining the cortical centres exposed. A small bipolar antiseptic electrode was used. A secondary current was applied; the electrode was connected with the terminal of a Flemming faradic battery, and the current was obtained by passing the switch to the first button of the instrument, and withdrawing the regulating cylinder to a distance of $2\frac{1}{4}$ inches.

Several spots were selected, marked 1, 2, 3, and 4 (see Fig. 2). The first electric tests were made at the spots 1 and 2. From the measurements that had been made, the fissure of Rolando was in the direction indicated by the line seen in the illustration.

Electricity was first applied to the spot marked 1 for a moment only. Movement at once resulted, beginning in the upper extremity on the left side, the first movement being protraction and moderate adduction of the shoulder and upper arm. This was followed by a series of jerks, involving the upper, and to a more moderate degree, the lower arm. No differentiated movements of the hand and arm, and no face or upper leg contractions, were observed. The left toes and foot, however, slightly flexed coincidently with the shoulder movement.

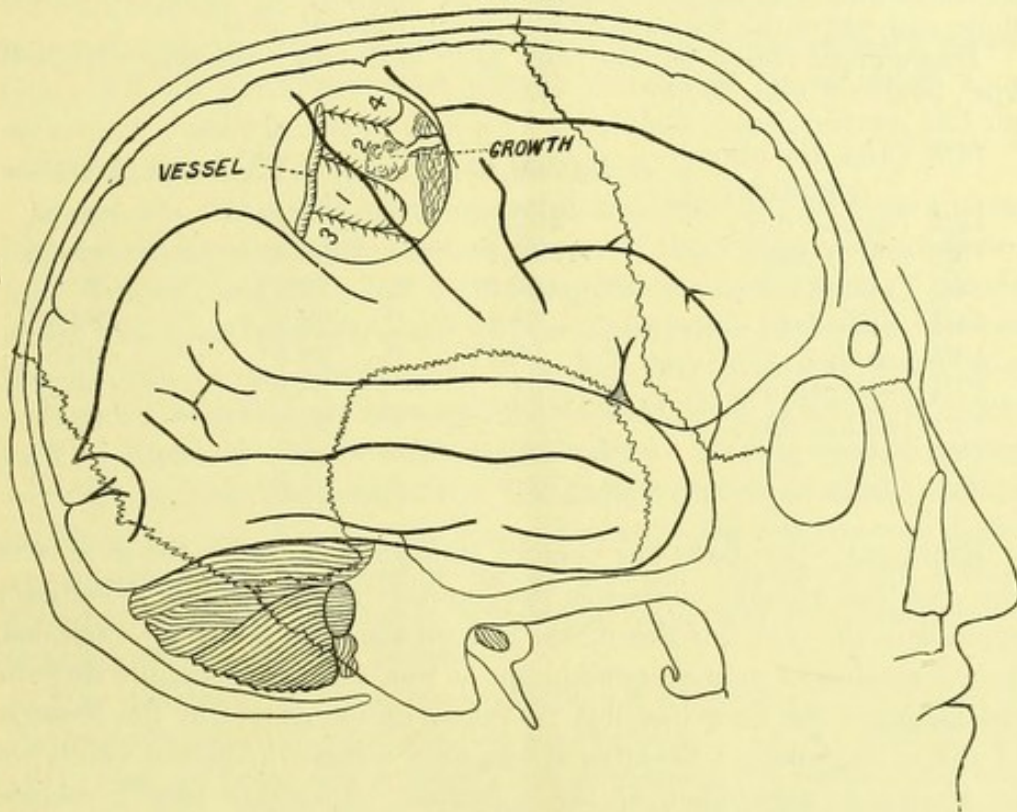
A second application was made at the point marked 2. The effect of this excitation was again to produce decided shoulder and arm movements, with greater adduction and some protraction of the entire arm. The thigh was flexed upon the pelvis at an angle of about 130° , and the leg upon the thigh to about the same, with abduction of the thigh and extension of the toes and foot. At the same time, active, coarse, clonic movements diffused through both extremities. This series of movements of the left upper and lower extremities strongly resembled the spasms which occurred in the patient's ordinary attacks, with the exception that the head was not turned to the right, and no face movements were noted. The application was repeated at 2, with similar results, with the addition that the face and head turned to the left, and the head was drawn downward and to the left, chiefly by platysmic action.

The electrical tests clearly indicated that the centres for the shoulder, upper arm, thigh and knee had been determined, or probably the region which represents the merging of the movements of the upper and lower extremities. A consultation was held with reference to the propriety of excising this region, and it was determined to do this, first, in order to

make a sub-cortical exploration for any further lesion, and secondly, to prevent the recurrence of the spasms by removing what seemed to be their primary seat.

With a pair of scissors and sharp bistoury a portion of the cortex, three-quarters of an inch in diameter, was removed. It included all the cortical gray matter under the tumor and corresponding to the centre for the shoulder as ascertained by the battery. The arm, leg and face were carefully observed during excision, but this mechanical excitation was absolutely without effect in producing movements.

FIG. 2.



After excision the electrodes were now applied to the points 3 and 4 on the border of the excision.

Excitation at the point marked 3 flexed the elbow, hand and wrist with slight shoulder abduction, protraction closely following.

Excitation at 4 caused primary movements of abduction and flexion of the thigh upon the pelvis, and the leg upon the thigh at an angle of 135° or 140° . No foot movements or movements of the upper extremities occurred. In all the trials after the excision of the cortex the movements were confined to the left half of the body.

After the excision had been performed considerable trouble arose in checking the hemorrhage from a large vessel, but this was controlled by two ligatures passed into the brain, and by temporary packing with iodoform gauze. During the operation small bits of iodoform gauze were packed between the dura and the skull to check some hemorrhage. The pulse fluctuated markedly, becoming for a short time weak and rapid. The extremities also became cold. The hemorrhage having been checked by pressure and hot water, after the ligature referred to

had been applied, a small rubber drainage-tube was inserted through the defect in the dura. A small bundle of horsehairs was also passed through and through under the flap, which was then sutured into place and dressed as usual. The bone was not replaced, as this was not deemed wise in consequence of its thickness and its sclerosed condition.

On December 11th, the first day after the operation, the drainage-tube was removed. On the 13th, the third day, the horsehair was removed, and a slight escape of cerebro-spinal fluid occurred. On the 15th, the fifth day, nine stitches were taken out and five were left. On the 21st, the eleventh day, the last stitches were removed from the wound, which was entirely healed except at one or two of the stitch-holes and where the flap was at a slightly different level.

Temperature record for ten days after operation.—December 10. 4.40 P.M., 96.6°; 8 P.M., 100.6°.

11th (first day after operation)	8 A.M., 99.8°; 4 P.M., 99.4°; 8 P.M., 100.2°.		
12th (second day)	" 100.2°	" 100.4°	" 100.2°.
13th (third day)	" 99.2°	" 99.4°	" 99.4°.
14th (fourth day)	" 100.6°	" 99.2°	" 99.2°.
15th (fifth day)	" 98.4°	" 99.2°	" 99.4°.
16th (sixth day)	" 98.4°	" 98.8°	" 98.6°.
17th (seventh day)	" 98°	" 98.8°	" 99.2°.
18th (eighth day)	" 98°	" 98.8°	" 98.6°.
19th (ninth day)	" 97.6°	" 99°	" 98.6°.
20th (tenth day)	" 97°	" 98.6°	" 98.8°.

REMARKS.—The bone was so much thickened and sclerosed as to raise the question whether there was not possibly an element of hereditary syphilis in the case, but this it was learned could be positively excluded. In the absence of such an explanation it was, of course, possible that the thickening of the bone was due to the irritation caused by the pressure of the little growth. Whether it was only a local thickening could not be accurately ascertained at the operation. In either case it seemed unwise to replace the bone.

Accuracy of localization. The accuracy of the localization of the shoulder centre and also of the centres in its neighborhood is worthy of remark. The tip of the growth was found within one-sixteenth of an inch of the point selected as the location of the shoulder centre and the probable seat of the irritation.

The nature of the growth. Its appearance suggested that it was a hypertrophied pachyonian body, but the microscopical examination showed that it was sarcomatous, with some hemorrhagic pachymeningitis. That it was the probable cause of the epileptic attacks seems very reasonable. Unfortunately, the irritation had possibly continued long enough to establish the epileptic habit, and to this may be due the fact that the attacks have continued since the operation, though with lessened frequency and severity; or, as suggested by Dr. Mills, sarcomatous growths or infiltration may be present elsewhere in the brain. Whether

the attacks will ultimately disappear or not is a question which we are not yet in a position to decide.

Excision of the cortex. The operation might have been limited to the removal of the growth and the dura which contained it, and then later, had the attacks not disappeared, a second operation might have been done and the shoulder centre removed. Against this, however, is the argument that a second operation involves a second peril to life, and also that the convolutions might be so adherent to the flap and the new tissue which would fill the opening, that it might be difficult at the second operation to recognize them, and to delimit the centres to be removed with the same accuracy that we could at the primary operation. All the questions which present themselves on reflection upon such cases should be stated with a view to their consideration, and the determination of what is the wisest course.

Drainage. Since this operation was done I have operated on a number of cerebral cases, with absolute closure of the wound without drainage. In two cases there has been considerable accumulation of bloody serum which has been evacuated by gentle separation of the flap between the sutures. In one case this had to be done four times, and in the other but once; so that I am now quite convinced that, as a rule, drainage can be dispensed with in cerebral operations. Had it been dispensed with in this case the apparent risk of a fungus cerebri would have been avoided. In fact, I think this one of the strongest reasons why drainage should not be employed in cerebral cases. Possibly a few strands of horsehair might be used to advantage for twenty-four hours, but a drainage-tube should not be used.

After removal of the dura, cannot the loss of substance be made good by the transplantation of a piece of the pericranium? In the after-history of the case one point was purposely not mentioned, but reserved for consideration here. A few days after the operation the flap bulged to such an extent that I was afraid that the union of the flap to the rest of the scalp would give way, and that a fungus cerebri would appear, especially at the site of the drainage-tube. Fortunately, this did not occur, but the bulging gradually subsided and the wound healed without incident. In reflecting upon this case, it occurred to me that the conditions were most favorable for the formation, almost inevitably, of a fungus cerebri, which I believe actually took place subcutaneously, but fortunately subsided without appearing on the surface. Under the flap was a deep well, corresponding to the thickened bone, the dura, and the excised portion of the brain; in depth perhaps an inch or more.

When the dura is opened and closed by suture there is little danger of a fungus cerebri, but where there is a loss of substance of the dura, and especially where the cortex is excised, there is a marked tendency to the formation of a fungus cerebri, especially where the distance be-

tween the scalp and the surface of the excised portion of the brain is as deep as in this case. To avoid this it occurred to me that we had ready means at hand in the transplantation of a piece of the pericranium similar to the transplantation of skin by Thiersch's method.

On the 10th of May, 1891, in another case operated upon at the Jefferson College Hospital, an opportunity occurred to me to test this. A piece of the pericranium was separated from the scalp, cut loose, and attached by a few interrupted sutures at its margin to the dura, thus filling the gap produced by the excision of a piece of the dura. The transplanted bit was turned upside down, so that the osteogenetic surface lay upward, in order that if bone should form from it, it should grow upward into the gap in the skull, rather than downward, and so possibly press upon the brain. The result was all that I could wish. No fungus cerebri formed, and up to September 1st he had not only been entirely free from his epileptic attacks, but no mischief had arisen from the transplanted pericranium, which presumably therefore has retained its vitality.

Can we differentiate normal from apparently normal, yet, in fact, diseased cortex, by means of the battery? This question I cannot yet answer positively, but I am inclined to think that it may be answered possibly in the affirmative. If we faradize a normal cortical centre (motor) by a single application, for a moment we get response in a single motor expression of its function, and the muscles cease to respond the moment the electrodes are removed. In several cases of visibly diseased cortex, by a similar single and short application of the electrodes, I have evoked not a single motor response, but have started an epileptic fit, resembling in the part in which it started and in its march the fits from which the patient had suffered. After excision of the diseased cortex similar brief stimulation has produced only the normal single motor response. It may be that this is explained by the fact that the first stimulation was of gray matter, and the last of white matter after the excision of the former. In some cases in which I have operated on the brain after injury and loss of brain-substance, presumably cortical (chiefly so, at least), faradization of the diseased and disintegrated brain-substance, presumably chiefly white matter, has started the characteristic fit, and, after excision, faradization of the underlying apparently normal matter has again given me a single normal response. If, then, faradization of apparently normal cortex induces a typical epileptic fit, instead of a single motor response, can we conclude that, though normal to the eye and finger, it is really diseased and should be excised? If so, this will be a most important and valuable aid to us.

My observations on this point are yet too few to warrant a definite conclusion.

MEDICAL HISTORY AFTER THE OPERATION, AND CERTAIN SPECIAL FEATURES OF THE CASE, BY DR. MILLS.

History of loss and recovery of power in the left limbs after the operation; sensory investigation. When the patient came to from the effects of the ether, she had a feeling of numbness and heaviness in the left arm and hand, and also at times in the back of the left shoulder—what she described as a “battery sensation,” or a feeling of prickling. Five hours after the completion of the operation she was cautiously tested for motion and sensation. The tests were not elaborate, for fear of disturbing her too much. The left shoulder movements were paralyzed, but all the forearm, hand, and finger movements were retained, but weak. The power of flexion at the elbow was very feeble, probably abolished; extension was present, but much diminished. So far as could be determined, sensations of touch, pain, and temperature were preserved.

December 11 (first day after operation). The loss of power in the left arm and leg were about the same as noted the day before. Dynamometer: Right hand, 50; left hand, 26. Sensation was carefully tested for and found to be normal.

12th (second day after operation). The paralysis of the shoulder persisted, that of the upper arm was increased, and the loss below the elbow and in the hand and fingers was more marked. The left leg was growing much weaker; the loss of power was most decided below the knee.

13th (third day after operation). The foot movements were almost entirely abolished, but some power of flexion and extension of the thigh remained. The left upper extremity was completely paralyzed. No loss of sensation could be made out in the shoulder or anywhere in the upper or lower extremities.

From December 13th to 20th (third to tenth day after operation) the paralyzed left extremities remained the same—paralysis was total in the arm and almost so in the leg, the only power retained in the latter being that of pushing the leg downward after it had been thrust upward and held by the examiner. On December 20th (the tenth day after operation) the patient had slight power of extension and flexion of the thigh, and marked increase of power of extending or thrusting the limb downward against resistance. Gradually power returned in the lower extremity, as nearly as could be made out in the following order: Thigh extension, thigh flexion, abduction, adduction. Until January 3d (the twenty-fourth day after operation) no foot movements below the knee returned. At this date signs of flexion and extension at the ankle appeared. January 2d, she could flex the leg over the thigh, and cross the left leg over the right, and could perform, but in a feeble manner, all movements of the foot and leg.

No change was observed in the paralysis of the arm until December 29th (nineteenth day after operation) when, if the forearm was slightly flexed, she could extend it; at this time, as above noticed, she had regained considerable power in the lower extremity. January 1, 1891 (twenty-second day after operation) she began to flex the distal and second phalanges, but had no power of phalangeal extension, and no wrist movements. On January 3d (twenty-fourth day after operation) she could flex, extend and separate the fingers and hand, but had no elbow or shoulder movements. On January 6th (the twenty-seventh day

after operation) she gained decided power in flexing and extending the elbow, and on January 7th (the twenty-eighth day after operation) she could elevate the arm nearly in a horizontal line. On January 12th (the thirty-third day after operation) she had regained all movements of both upper and lower extremities, and had been able to walk for several days. The limbs remained weak, and this weakness continued most decided for shoulder movements. All true paralysis, however, had practically disappeared.

The order in which paralysis of different muscular groups appeared and disappeared is of considerable physiological interest.

Knee-jerk was found to be increased on the left side, and ankle clonus was present on the day after operation. Gradually the exaggerated knee-jerk diminished, and on December 23d (thirteen days after operation), when the power of flexing and extending the thigh had greatly improved, ankle clonus disappeared.

History of spasms after operation. At 4.30 P.M., on the day of the operation, the patient had a slight attack without unconsciousness, in which the right arm at the elbow and wrist was flexed, but the arm was not carried over the chest as in the old attacks; the head was drawn to the right. The left extremities and face and the right leg were not involved.

December 11 (first day after operation). She had light seizures at 5, 6 and 8.30 P.M. The spasm affected both arms and the left leg.

12th (second day after operation). Attacks at 4, 7.30, 8.30 and 10.30 A.M., and 12.50 P.M. Both arms and left leg were involved in the spasm; the head was drawn to the left. At 7.30 P.M. she had an attack, the spasm affecting both arms and left leg; the head was drawn to the right.

13th (third day after operation). Attacks at 1.35, 5.40 A.M. Both arms and right leg were affected; the head was drawn to the right. She had other attacks in the afternoon and evening.

14th (fourth day after operation). Attacks at 6.45, 8.30, 9.30 A.M.; none P.M. Both arms and right leg were involved; the toes were flexed; the head was drawn to the right.

15th (fifth day after operation). Attacks at 12.15, 1.15, 7.45 A.M., affecting the arms and right leg; the head was drawn to the right.

16th (sixth day after operation). No attacks.

17th (seventh day after operation). Attacks at 4.30, 6.45, 7.45 A.M., spasm invading both arms and left leg; the head was drawn to the right.

A careful daily record was kept of the spasmodic seizures until February 1, 1891—that is, for a period of nearly eight weeks after the operation. She averaged four or five attacks daily, occasionally only one, two, or three. The majority of these seizures were in the early morning hours, between 1 and 2 A.M. They were commonly of moderate severity, none of them as severe as the frequent attacks which she had had several weeks just preceding the operation. The character of the attacks was usually as already described, but they varied somewhat at different times. As a rule, both arms took part, the right upper extremity becoming spastic in flexion, the left either in extension or extended and affected with some clonic spasm; the left leg was usually extended, but was sometimes flexed. The right leg, when included in the spasm, was usually semi-flexed at the hip and knee. During the week from January 26th to February 1st, the average number of seizures

was somewhat smaller, on the 26th being only three, on the 31st two, and on the other days three, four, and five. So far as the distribution of the spasm in different parts of the body was concerned, their severity was somewhat influenced by the varying degrees of loss and recovery of power on the side paralyzed after the operation. About three days after the operation, as will be recalled, the paralysis of the upper and lower extremity was almost complete, and for several days the left leg took little part, or no part, in the spasm, taking, however, an increasing part as power was recovered. The same was true of the left arm. During most of the time that these notes were taken the spasms preponderated on the right side, the morbid ascendancy of the left side, however, re-asserting itself as power was more and more recovered.

This patient has been seen at longer or shorter intervals from the time of operation—December 10, 1890—to July 7, 1891. Her history has been a monotonous one, and can be condensed into a few sentences. Usually she has had about three attacks of spasm in twenty-four hours, these, as a rule, occurring during the night, most commonly in the early morning hours. Sometimes she has had an attack after daylight, between 6 and 8 o'clock in the morning. Occasionally she has had two attacks in succession. The spasms have never attained the severity or frequency which they had for a short time prior to the operation. She had then as many as twelve to fifteen in twenty-four hours, often with total unconsciousness, involuntary urination, and subsequent great dazing and confusion of mind. At the time of the last examination and report, and for some time previous, the attacks usually began with a feeling of numbness in the left shoulder and a lifting and jerking movement of the entire left arm. The spasm spread, involving the left side and sometimes also the right side. Sometimes she was unconscious in the attack, but as often not. She now has good use of both the left arm and the left leg, all movements being preserved. The left arm, however, shows some general weakness, is easily fatigued, and the patient thinks that over-use of it brings on the spells. Her general health is good—better than for a long time—and she has gained from five to ten pounds since the operation.

The small growth of granulation, with the attached piece of dura mater, and also the excised segment of cortical and subcortical tissue, were placed in the hands of Dr. Allen J. Smith for microscopical examination. Dr. Smith has prepared six slides showing the appearance of the membrane, growth, or granulation, and of the excised cortex. He reports that connected with the growth or granulation are spots of hemorrhagic pachymeningitis, and several points in its interior which are decidedly sarcomatous. He also reports that beyond the engorgement of the vessels and the presence of hemorrhage at the surface, and at one point at the margin, that the excised cortex was apparently normal.

At the time of the operation the general impression of those present was that the small growth was a large, isolated, pachyionian granulation, which had perforated the dura and eroded the inner wall of the skull. The microscopical examination throws a doubt upon that view, and makes it more likely that after all we had a real neoplasm of very small size; but perhaps, without further investigation, the question may not be regarded as absolutely decided. If the growth was sarcomatous,

other sarcomatous foci may be present in the brain; and it was in part because of the suspicion that a subcortical mass might be present that the cortex was excised. It is not improbable that the other hemisphere may contain a growth, as the localizing symptoms were at times confusing. The patient had clonic spasms of the right arm, although, as has been stated in the clinical history, the symptoms began on the left side and the attacks were initiated by both sensory and motor disturbances on this side. Since the operation right-sided spasms have often been a striking feature.

Supposing that the small tumor was a pacchyonian formation, it would be by no means certain that this had not to do with the causation of the spasmodic phenomena; and still another view that might be taken is that such a formation had resulted from the frequent and long-continued localized cortical discharges with their accompanying hyperæmia. The question of pacchyonian formations in general, and particularly of those which we sometimes see either isolated or in small groups, may have some importance in connection with the subject of cortical epilepsy and paresis.

The nature of these granulations is probably still an unsettled matter. Little, at least in late years, has been written about them; but an interesting article is that by W. Browning,¹ from which I may cull a few facts and views applicable to the present case. These formations grow from the pia-arachnoid, both over the sulci and over the crests of the convolutions. It seems to be universally admitted that these formations are limited to certain parts of the pia-arachnoid, showing a decided preference for the sides of the longitudinal sinus and the vicinity. Some, but not all, of these granulations are connected with the veins and sinuses.

Other structures connected with them are the parasinoidal spaces, which occur along the sides of the longitudinal sinus, and are of the largest size at the crown of the head. Browning suggests that these are important accessories to the veins and sinuses as regulators of the cerebral pressure. Sometimes the pacchyonian granulations and parasinoidal venous spaces are combined and connected. When venous spaces are present the granulations are not likely to cause depressions in the skull. It would seem from these facts that whether a pacchyonian granulation would or would not cause greater or less cortical irritation might depend upon its peculiar location, and the presence or absence of venous spaces into which it could grow. A growth such as was found at this trephining may have caused considerable irritation.

On the other hand, as already intimated, such a formation may have been the result of repeated discharges of the adjacent cortical area. As

¹ THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES (N. S.), vol. lxxxiv., October, 1882, p. 370.

Browning states, and as I can verify from abundant experience at the Philadelphia Hospital, many morbid conditions may favor the development of these bodies, one of which of great importance is chronic alcoholism. This writer also states that in cases of brain tumor an excessive development of these pachyonian bodies has often been found. They have often been found in adults and children suffering from meningitis, and probably some granulations, particularly those associated with meningitis, may be inflammatory in origin, and in reality somewhat different from the usual pachyonian growths. Formerly they were all regarded as inflammatory. Browning shows that, while much evidence may be had in support of hyperæmia as their cause, some facts do not harmonize with this hypothesis. He holds rather to a mechanical cause, depending in some way upon the ebb and flow of the blood of the veins just above the sinuses. It is not hyperæmia of the venous blood as such, but the blood acting as any other fluid of its consistence would do.

Some clinical symptoms have been attributed to pachyonian granulations, but only a few can with any positiveness be regarded as due to these formations. Browning refers to cases where such granulations were present near the Gasserian ganglion and the motor nerves of the eye, causing ocular neuralgic and paretic symptoms. Meyer refers various neuralgias to them. Headaches have been attributed to them in some instances, but with doubtful propriety. Possibly they may cause sinus thrombosis. They sometimes produce little flat elevations of bone along the median line of the crown of the head. I do not know of any record of cases of spasm, local or general, which could be clearly attributed to pachyonian bodies. Browning refers to a varix of the sinus longitudinalis which he believed developed from the parasinoidal spaces, and quotes a case of Meschede in which a patient had suffered from epilepsy for thirty years, and after death a varix the size of a bean, which had reduced the bone to paper thickness, was found.

