involved in the general fibrositic changes. In men affected with panniculitis the same clinical picture can often be seen, especially if they are stout and heavy. None of these people show any signs of true myxoedema or thyroid deficiency, and the condition is often met with long before the menopause, when menstruation is regular and when there is presumably no ovarian deficiency. If of child-bearing age these women bear children normally.

With regard to treatment, the principles affecting acute exacerbations and the original underlying causes have already been discussed, leaving for consideration how we may best get rid of the fibro-fatty overgrowth. In patients with a large amount of subcutaneous fat the most satisfactory results are obtained by means of diet and massage. The quantity of their carbohydrate food should be reduced by one-half or three-quarters, exercise suitable to the age and condition of each patient should be taken freely, special medical exercises may be given in addition, and a daily dose of thyroid gland. The last has no specific action on the fibrosis, but assists in reducing weight. This regime should be continued until the patient has reached something like normal weight for the height and age, which often means a reduction of several stones. With loss of fat the symptoms lessen and the massage can be applied much more effectively, as the fibrotic tissue is then more directly reached. Patients of normal stoutness—and there are very many such—do not, of course, require these reducing measures.

The method of applying the massage is a matter of the first importance for successful treatment. It should be directed to the panniculus adiposus, and either powder or a minimum only of lubricant should be used. With the bare hand the grip is too firm and painful, and with much oil too slippery. The manipulation is a little difficult to describe, but very easy to demonstrate. A mass of the panniculus adiposus should be grasped with one or both hands, holding it between the thumb and thenar eminence on the one side and the rest of the hand on the other side, and then the two parts of the hand approximated with adequate pressure and a slow movement. The skin is usually bound down to the subjacent tissues, and it too should be grasped and manipulated with the object of loosening it and making it more flexible. Such treatment is painful, often exceedingly so if not carried out gently, and bruising is very readily produced at first. It may take five or six weeks before any but very light pressure can be borne, but gradually the neuritis is reduced, and then harder treatment can be given. It is always, however, a painful and disagreeable and tedious process. The patient should always be warned that treatment must be continued for six or twelve months or even more, and that during that time several courses of massage of eight weeks or so will be necessary, and that if left untreated the condition is certain to go on from bad to worse. Many patients can be taught to treat themselves to a certain extent.

In cases where the fibrositis is of the hard brawny type dieting often fails to reduce the bulk to a satisfactory degree, the new tissue is much more resistant to massaging, and the prognosis is in consequence not nearly so good, but the symptoms can always be greatly ameliorated. Such patients usually remain "rheumatic" and require renewed courses of treatment from time to time for relief of their symptoms.

Finally, as regards the important question of individual prophylaxis, I have formed the opinion that many sufferers from muscular rheumatism and panniculitis have acquired the fibrositis at an early age from an attack of acute rheumatism, and continue to harbour in a latent condition the specific germ of the disease. After recovering from the acute attack children should be carefully examined and any fibrositic areas massaged while the deposits are still soft and easily dispersed. Further, they should be given at bedtime for some months a nightly dose of sodium salicylate or salicin, with the object of eradicating the infection. After tonsillitis, influenza, and other acute infective causes, all patients should be similarly examined, and, if necessary, treated by massage. Unfortunately we have no specific drugs to help us for most of these cases.

Hunterian Lecture

ON

NEW METHODS OF SURGICAL ACCESS TO THE BRAIN.

BY

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(With Coloured Plate.)

THE problem of obtaining easy access to the interior of the skull has become of increasing importance with the modern demand for large openings, in which it shall be possible to replace the bone without fear of risking its vitality. The problem raises several questions, each of which demands separate consideration. First we must consider how access to the skull itself is to be obtained; secondly, our osteoplastic flaps must be so designed as to secure their blood supply; thirdly, the actual division of the bone presents a mechanical problem of no mean order; and lastly, the control of haemorrhage at every stage of the operation is of vital importance to the patient.

Blood Supply of Scalp and Skull Independent.

It is a primary condition in the formation of an osteoplastic flap that a sufficient blood supply for the bone should be maintained, and with this object it has been customary to turn down the scalp with the bone in one piece. I believe that this is quite unnecessary, and that osteoplastic flaps can be formed with equal security and with far greater facility if the scalp is turned down first. The skull receives the great bulk of its blood supply through the muscles which are attached to it and from the mucous membrane which lines its cavities. The dura forms a periosteal lining, and as such carries its own blood supply, but only minute vessels from this source actually enter the bone. The scalp, on the other hand, is separated from the periosteum of the calvaria by a layer of loose areolar tissue, in which there can be found only a few vessels of trivial importance, which can have no appreciable effect on the vitality of the skull itself. These points will become clearer if we consider certain details in the anatomy of the scalp and the calvaria.

Structure and Blood Supply of Scalp.

The scalp consists of three layers—the skin, the superficial fascia, and the galea aponeurotica. The skin is very thick, the galea tough and thin, and they are bound together by a thick and dense layer of superficial fascia, in which ramify the whole of the blood vessels and nerves. So closely, indeed, are the three layers connected that the scalp must be regarded as a single structure, carrying a blood supply which is for all practical purposes entirely

FIG. 1.—Muscles and blood supply of scalp.

independent. The galea is a tough membrane stretched over the calvaria and really forming the tendon of the occipito-frontalis muscle. Posteriorly it is attached to the superior curved line of the occipital bone; anteriorly it joins the frontalis muscle, and through it becomes continuous with the orbicularis oculi, having no direct attachment to the front of the skull. Laterally it has a weak attachment to the temporal line and to the dense temporal fascia which covers the temporal muscle; but it can be readily separated from this fascia almost down to the level of the zygomatic arch. In the whole of its extent it is separated from the pericranium by a loose

areolar tissue in which a few small veins may be found, but which contains no vessels of practical importance.

The blood supply of the scalp arises from various sources, and all its vessels enter it beyond the limits of the attachments which we have described. In front the supraorbital and frontal arteries are derived from the ophthalmic branch of the internal carotid, and ramify upwards in the forehead. Laterally the superficial temporal branch of the external carotid extends upwards just in front of the ear, dividing at about the level of the upper margin of the lobe into anterior and posterior branches, which ramify widely over the whole of the side of the head. Posteriorly the occipital and posterior auricular arteries, both derived from the external carotid, supply the whole of the back of the scalp. Between these arteries there is the freest possible anastomosis, so that portions of the scalp can be raised in almost any direction without danger to their vitality. The point, however, which I wish to stress is that these flaps can be raised without endangering the vitality of the subjacent bone, since it is in no way dependent upon the scalp for its blood supply.

Blood Supply of Skull.

This will become still more obvious if we consider the blood supply of the skull itself. More than half of its lateral aspect is covered by the temporal muscle and its

FIG. 2.—Muscles and blood supply of skull.

fascia, whilst, behind, the broad surface of the occipital bone below the superior curved line furnishes an origin for the large mass of muscle which occupies the nuchal region. These muscular attachments can be made to furnish ideal hinges for osteoplastic flaps in almost any situation, they carry a blood supply sufficient to maintain the vitality of the bone, and they form, in our opinion, the only means by which the blood supply can be maintained. Their blood vessels are entirely distinct from those which supply the scalp. In the temporal region the chief vessels are the temporal branches of the internal maxillary artery, whilst in the occipital region the most important vessels arise from the occipital artery as it lies deeply beneath the sterno-mastoid and the digastric, actually grooving the occipital bone.

Scalp Flaps in Different Regions.

There are three primary regions from which the brain can be approached—the *temporal*, *occipital*, and *frontal*—and in each instance the scalp flap required presents certain peculiarities to which we must now direct attention. In each instance, however, the scalp flap should be so fashioned, if possible, as to overlap by fully half an inch the proposed incision in the skull.

FIG. 3.—Temporal scalp flap.

In the *temporal region* a flap of any dimensions may be formed, care being taken that the anterior portion of the incision lies well in front of the ear, so as to avoid injury to the superficial temporal artery. In this instance a great advantage is gained by first marking out the pedicle with two small incisions one in front of and one behind the ear, tunnelling through with a blunt dissector in the areolar

layer, passing one blade of a soft intestinal clamp through the tunnel so formed, and with it clamping the base of the pedicle. If this is done there will be no bleeding whatever from the cut margin of the flap itself, and the attention of the surgeon can thus be directed solely to preventing bleeding from the opposite side of his incision. After the incision has been made and the bleeding arrested, the whole flap can be turned down as far as the clamp at its root without the division of anything except soft areolar tissue, and without bleeding from a single point.

In the *occipital region* the scalp can only be turned down as far as the superior curved line of the occipital bone, since below this point it is firmly attached to the muscles. If an attempt is made to raise it beyond this point the origin of the occipitalis muscle must first be divided and the skin must then be dissected away from the muscles to which it is united by dense and vascular fibrous tissue, and bleeding may be considerable. With the methods of approach which we now adopt we always respect this attachment, and never go beyond it. None the less we can turn down osteoplastic flaps in this region and even remove the bone without ever detaching the scalp from the muscles to which it so firmly adheres.

In the *frontal region* superb access to the bone may be obtained by very simple means. If an incision is carried boldly across the bregma, coming down just in front of

FIG. 4.—Frontal scalp flap.

the ear, it will be found that the whole of the forehead can be turned down without the slightest difficulty, even beyond the upper margins of the orbit. It is true that the anterior branch of the superficial temporal artery is divided, but the forehead has an ample blood supply apart from this. I would again point out that even in this region the vitality of the bone is in no way jeopardized, and that an osteoplastic flap consisting of one-half of the frontal bone may be formed with perfect success on the temporal muscle as a base. When the scalp flap is replaced the suture line is entirely out of sight and the nerve supply of the forehead is still intact. I have repeatedly carried out all these procedures under local anaesthesia with a conscious patient; there has been an entire absence of either shock or pain; and in the case of the frontal flap the only additional precaution taken was to cover the patient's eyes and face with a sterile bandage.

Control of Haemorrhage.

The control of haemorrhage from the scalp is a matter of the very first importance to which sufficient attention is rarely paid. Any loss of blood at this point is entirely unjustifiable and may prejudice the further stages of the operation very seriously. Bleeding from the smaller vessels is best controlled by preliminary injection of the whole line of incision with 1/2 per cent. novocain, to which about 1 per cent. of 1 in 1,000 adrenaline has been added. At the same time it is our custom to infiltrate the whole of the subaponeurotic space in the operation area with the same solution. If this is done half an hour before the operation there will be no bleeding at all from the smaller vessels, and only the larger arteries will require attention. These may be seized in special forceps, such as those of De Martel, which grasp the whole thickness of the scalp, or they may be compressed by seizing the galea in artery forceps and drawing it over the cut area. The arteries themselves it is impossible to seize owing to the density of the tissue in which they lie. Personally I use small steel clips which are crushed with forceps on to the margin of the scalp. They hold it quite firmly without injury, they are so small that they are not in the way, and at the end of the operation they are very easily

I.—RIGHT FRONTAL OSTEOPLASTIC FLAP.

II.—OCCIPITAL OSTEOPLASTIC FLAP.

removed. In the case of the temporal flap I have already described the means by which bleeding from its margins is prevented. In the frontal flap the incision lies in a watershed area where vessels are very small, and the only two vessels which bleed are the anterior branches of the superficial temporal artery. The absolute bloodlessness of this line of incision is remarkable and a very great advantage.

Though a detailed consideration of the formation of osteoplastic flaps will be deferred until later, it will be convenient to consider the principles on which they are designed. In the temporal region a flap of any dimensions can be turned down on the temporal muscle. In the frontal region a large flap can be turned outwards, based as a hinge on the thick anterior portion of the same muscle. It is upon this muscle, and not upon the scalp, that the bone is in any event dependent for its blood supply. In the occipital region the whole of the back of the skull, as we shall see later, can be turned down on the nuchal muscles as a hinge, offering superb access to the whole of the posterior aspect of the brain.

The Division of the Bone.

We must now turn to the technical methods at our disposal for the division of the bone. In general terms three methods are in common use. In the first a series of trephine holes is made through the skull along the intended line of section, and these are joined by means of a saw or some variety of cutting forceps; in the second a Gigli saw is substituted for the forceps; for the third method a powerful electric motor is necessary, and the procedure consists in drilling a series of holes and joining these up either by means of a circular saw or some form of burr electrically driven. The first two methods are certainly primitive, and they demand a degree of exertion on the part of the surgeon which is detrimental to his manual skill when he comes to deal with the brain itself. The third method is effective, but it involves the use of a powerful electric motor and of a somewhat cumbersome and costly apparatus.

It has long seemed to me that it should be possible to cut through the skull entirely by hand if the problem could only be reduced to the terms of ordinary engineering. I have now succeeded in devising an appliance by which the skull can be divided entirely by hand with great facility and so smoothly that the operation can be easily accomplished on the conscious patient under a local anaesthetic. The appliance was specially designed for the formation of large osteoplastic flaps, and it enables the surgeon to form these with a facility, a rapidity, and a precision hitherto unapproached.

The instrument (Fig. 5) consists essentially of a stud, A, and a lever, C. By means of a locking device the stud is securely fixed in a half-inch hole previously drilled at the centre of the proposed bone flap. Around this can turn

FIG. 5.

the long lever C, on which slides an adjustable carriage, E, carrying a cutting chisel, F, which closely resembles the parting tool used in turning. This chisel can be advanced from a socket, H, which supports it, by means of a screw, G, so that the depth of the cut can be adjusted with the nicest accuracy. The method of procedure is as follows:

A very large flap consisting of scalp only is turned down. It must be so large as to overlap by fully half an inch the furthest limits of the bone flap which is to be formed. As there is no anastomosis whatever between the vessels of the scalp and of the bone, the turning down of the scalp does not interfere in the slightest degree with the vitality of the bone, whilst it greatly facilitates access to the latter. At the centre of the projected bone flap the muscle and pericranium are divided and drawn aside, and a hole is drilled

with a special brace. Into this hole is inserted the split stud, A, resembling an expanding mandrel, and into the centre of this is screwed a pin, B, which forces it open and locks it into place. The lever C is now dropped over the pin, and held in place by a nut, D, the carriage E is adjusted to the correct radius, and the cutting tool F is advanced

FIG. 6.

FIG. 7.

until it just projects from its housing, H. It will now be found that on swinging the lever round its fixed fulcrum the skull can be cut with astonishing facility, and without the slightest suspicion of violence. The cuts are taken in long sweeps, omitting the base of the flap, which is always so arranged that the skull at this point is thin. After each cut the tool is advanced a fraction of a millimetre and another cut is taken. In a very short space of time it will be found that the thinner parts of the skull have been penetrated and the cutting is now limited to the thicker part, where hard bone can still be felt with a seeker at the bottom of the slot. The form of the tool precludes any possibility of injuring the dura, but as soon as the seeker shows that the dura has been reached these parts of the incision will naturally be left alone. The bone is by this means almost completely divided over three-quarters of a circle, and two flat steel levers are now inserted into the slot which has been formed. Very slight pressure on these levers is required to crack the thin layer of inner table still remaining and the thin base of the bony flap, which is now turned down still attached to the soft parts, usually formed by the temporal muscle. The tool is set at such an angle that the margin of the bone flap

FIG. 8.

is bevelled, and therefore when the latter is replaced it lies snugly in position against the corresponding bevel of the skull itself. I know of no other method by means of which such accurate and firm coaptation can be obtained.

A difficulty in using the instrument arose from the impossibility of holding the head steady against such powerful leverage. This has been overcome by a simple device. After drilling the hole for the centre pin, another small hole is drilled at a distance of one inch from its centre. To enable this to be done accurately a jig is provided consisting of a stud, which fits the centre pinhole and from which a plate extends carrying a hole through which the drill is passed for the formation of the secondary hole. A long lever is provided with a pin, which fits the secondary hole, and with a hole through which is passed the centre pin of the instrument. The lever is thus rigidly attached to the skull, and if its extremity is held by an assistant it absolutely prevents rotation.

There is no instrumental limit to the size of the bone flap which can be formed, and a bony disc six inches in diameter can quite easily be turned down in the temporal region. For most operative work, however, a flap of from three to four inches in diameter will be sufficient. One of the most remarkable features of the instrument is the rapidity with which these large flaps may be formed, the average time taken for cutting the bone varying in my own experience between two and three minutes. The tendency of modern cerebral surgery is to explore the brain through very large openings, and it is for this purpose that the instrument has been devised. It is equally applicable to

any region of the skull, but it will find its greatest utility in the formation of large temporal flaps. The manipulation of the instrument is very easy, but its action is so unusual that it is absolutely essential that, before attempting to use it on the living subject, the surgeon should familiarize himself with its use both on the dried skull and on the cadaver.

The Surgical Motor.

Although the craniotome is so effective there are a few cases to which it is not applicable—where, for example, a flap of other than circular outline is required, or where it is necessary to enlarge an opening already made. For this purpose I have devised a new form of surgical motor which seems to present many advantages. (Fig. 9.) Its general arrangement will be understood from the accompanying illustrations, the simple construction being rendered possible by an entirely new form of universal joint. The entire weight of the operating end is supported by that of the motor, M, which acts as a counterpoise, so that the surgeon has the advantage of a powerful and massive tool, without the inconvenience of its weight.

FIG. 9.

FIG. 10.

Into the nose, N, of the instrument may be inserted drills, burs, or circular saws, and as these are driven slowly and with great power, their action is both safe and rapid.

The saws are provided with guard discs, so that they can be adjusted to cut to any depth from 1 to 10 millimetres. Starting with a large disc and a shallow cut, the size of the disc is gradually reduced and the depth of the cut correspondingly increased until the inner table is all but severed. A series of holes has already been drilled, and as these are joined up by the saw cuts the depth of the skull between each pair of holes can be accurately gauged. In this way the densest bone can be cut with the greatest ease and with absolute safety. As regards asepsis, the two terminal arms of the appliance can be boiled, after which they are encased, for convenience in handling, in a sleeve of stockinette.

Osteoplastic Flaps.

Having shown the possibility of obtaining a full exposure of the bone by first removing the scalp, and having described the apparatus at our disposal for dividing the bone, we are now in a position to discuss the actual formation of osteoplastic flaps. We shall consider these separately as they are required for approaching the lateral, posterior, or anterior regions of the skull.

The Temporal Flap.

Lateral approach by means of a temporal flap is the commonest mode of access to the brain. Not only is it required for the removal of tumours in the sensorimotor region and in the temporal lobe, but it is often the most convenient and effective method of obtaining decompression. A large scalp flap is first turned down, as we have already described, bleeding from the flap being controlled by a clamp across its base, and from the scalp by clips attached to its margin. The total loss of blood should be trivial, and all bleeding must be absolutely checked before the next step is taken. The scalp flap and the exposed area are carefully protected by gauze pads moist with warm saline.

The bone flap required is now marked out with a compass, and the bone is divided round three-quarters of a circle with the craniotome, the temporal muscle which is to form the hinge being carefully preserved. The levers

are inserted and the thin bone in the temporal fossa is cracked, when the bone flap can be turned down and out of the way. The bone usually cracks at a point half an inch or more from the base of the skull, and it is convenient to strip down the temporal muscle as far as the temporal crest and to remove the thin bone with punch forceps. In this way maximum use is made of the opening

FIG. 11.—Temporal osteoplastic flap.

in the skull, and if the bone is replaced the defect left at its base forms a very useful subtemporal decompression.

Although the opening made for exploration can scarcely be too large, it may happen that in the case of an inoperable tumour the opening made for exploration is larger than need be left for decompression. When it is suspected that this may be the case the following plan has been adopted with complete success. After centring the craniotome a preliminary cut is made half an inch within the outline of the proposed flap, the outer table only of the bone being cut through. The carriage is now readjusted to the full size of the flap, which is then formed as described. If, after exploration, it is desired to leave a permanent decompression the outer half-inch of the bone flap is easily removed with bone forceps. The bone now floats as a valve, surrounded by a half-inch gap, across which union cannot occur, whilst the temporal muscle which forms its pedicle furnishes an entirely adequate blood supply. In a case of vascular tumour on which we operated four years ago, in a boy of 12, this arrangement has answered perfectly, and the valvular action is still free.

The Occipital Flap.

Posterior approach to the brain has usually been obtained by piecemeal removal of the occipital bone below the lateral sinuses, and this has been generally regarded as a region entirely unsuited to the formation of osteoplastic flaps. The situation has, however, been entirely altered by the craniotome, which enables huge osteoplastic flaps to be turned down in this region with precision and safety, affording an access to the cerebellum, the brain stem, and the occipital lobes never before achieved. At the same time the bone, in whole or in part, can be replaced with perfect accuracy and with absolute security. The effectiveness of the method can be sufficiently judged from the fact that the whole of the back of the skull, from the lambda to the foramen magnum, can be turned down in five minutes with the utmost ease, without the slightest violence, and often without any change either in the pulse rate or the blood pressure of the patient.

A scalp flap is first turned down, as we have already described, as far as the superior curved line of the occipital bone, to which it is attached. This flap should overlap the proposed skull flap by half an inch. A point is now selected about half an inch above the external occipital protuberance, and here a hole is drilled for the centre pin. The bone at this point is very thick, and it may not be necessary to drill completely through; indeed, it is an advantage not to do so, as a large emissary vein may be encountered. Should, however, bleeding occur, it is immediately stopped by the insertion of the centre pin, which is then secured in place. The skull is cut as usual, and as it is here often half an inch or more in thickness the power of the craniotome is fully demonstrated. A channel is cut which divides the thick bone completely and extends below the lateral sinus on each side. With a specially guarded chisel the extremities of this channel are extended towards the foramen magnum, when it will be found that on raising the bone the whole posterior margin of the foramen magnum is included in the fragment. Seizing the upper margin of the bone in forceps it is drawn forcibly

backwards, so as to avoid injury to the medulla, and it is then turned downwards over the nape of the neck, still attached, of course, to the whole of the nuchal muscles.

The only risk in this procedure is that of haemorrhage from the large emissary vein which communicates between the torcular Herophili and the vascular diploë of the occipital bone. In raising the bone this vein is torn, and the finger of an assistant must be immediately applied to stop haemorrhage. A small piece of muscle, cut ready for the purpose, is now applied and held in place by the finger for three minutes, when it will be found to adhere firmly and to have stopped the bleeding. Occasionally a similar but smaller vein may be torn from the superior longitudinal sinus, but it is easily dealt with in a similar manner. There would seem to be no risk whatever of injury to the sinuses themselves.

The field now obtained is very remarkable. In the centre lies the torcular, the lateral sinuses spreading outwards on each side, whilst above these the occipital lobes are exposed to an extent of perhaps two inches. Ideal access to the cerebellum is offered, and if necessary the posterior arch of the atlas can be removed. But most important of all is the relaxation of the tentorium, which results from the removal of its posterior support, so that it can now move upwards freely and release the pressure on the medulla. Provided there is no undue pressure in the upper chamber this may provide sufficient decompression without any opening of the dura, and we have had a case of midbrain tumour with secondary hydrocephalus in which this procedure alone was sufficient to secure permanent relief. In any case a combination of this with aspiration of the ventricles will give all the relief of tension that can be desired.

Two other points must be noted. The exposure of the occipital lobes renders puncture of the lateral ventricles easy, and the surgeon has at his disposal a simple means of reducing the cerebral pressure to any desired degree. In addition, the full exposure of the sinuses enables him to introduce fluid into the circulation at the end of the operation, often a consideration of the most vital importance. The walls of the sinuses are by no means fragile, and if a fine needle is used puncture does not involve the slightest risk of bleeding, for the opening seals itself at once.

On dividing the dura over the cerebellum it will be found that the mobility of the tentorium is of the greatest advantage, for by displacing it upwards the available space below may be greatly increased. A still further advantage may be gained by freeing the dura on each side for a short distance from the skull, though care must be taken not to injure the large mastoid emissary veins.

Mobilization of the tentorium, so far as I am aware, is an entirely new procedure, and it is only rendered possible by the occipital osteoplastic flap which has been described. Without the craniotome the formation of such a flap is scarcely a mechanical possibility, for it demands the clean cutting of the densest part of the skull over a very large circle. The trauma to the patient which would result from attempting to do this by any other method would be so serious as to prohibit its performance. Moreover, the flap must be turned down with great rapidity if serious haemorrhage is to be avoided from the large emissary vein to which we have referred. With the method here described the actual turning down of the bone flap is practically

instantaneous, and in no case has the bleeding remained uncontrolled for a longer period than two seconds. I am so impressed with the value of mobilization of the tentorium that I feel that this possibility alone justifies the invention of the craniotome.

If removal of the bone is desired it should be peeled off the muscles from below upwards, when it will be found that they separate from it without any bleeding at all. The contrast with the haemorrhage which occurs in the usual method of stripping the muscle off the bone is very remarkable. It will, however, be necessary to cut through the aponeurotic attachments to the superior curved line with a pair of scissors. If the bone is replaced the margin of the foramen magnum and a portion of the thin bone above it may with advantage be removed, as can be done with the greatest facility.

The Frontal Flap.

Anterior approach is rendered much easier by the frontal scalp flap which we have already described. This places the whole of the frontal region at our disposal, and allows the formation of osteoplastic flaps on a generous scale. The thick anterior portion of the temporal muscle, the origin of which extends right up to the angular process of the frontal bone, furnishes an ideal hinge and preserves an adequate blood supply. If the craniotome is used the centre will usually be placed a little above the temporal line, and the line of division of the bone will be just above the superciliary arch and to one side of the middle line, although the latter may be crossed without risk if a really full exposure is desired.

This method of approach furnishes admirable access to the frontal lobe and, if this is displaced, to the falx cerebri, in its anterior portion. It is, however, of still greater value in the approach which it offers to the pituitary gland. If the bone flap is properly formed it will be found that the

whole of the bone overlying the frontal lobe has been removed, and that the lobe can therefore be displaced upwards with quite unusual facility. If the hyperextended position of the head is adopted it will be found that the frontal lobe actually falls away from the orbital plate, so that the route to the pituitary is opened up even without mechanical retraction, and all contusion of the brain is avoided.

In this region, if a very extensive exposure is required, or if there is uncertainty as to the side on which a tumour is situated, it is sometimes an advantage to form a large angular flap, or indeed to expose both sides of the brain at the same time. After the frontal scalp flap has been turned down this can be done with the greatest facility by means of the surgical motor which we have described and a guarded circular saw, after drilling a series of holes as guides to depth. One saw cut should be coronal, one horizontal and just above the superciliary arches, and one sagittal and to one side of the middle line. By this means a double exposure is easily obtained with very little disturbance.

The new methods of obtaining access to the brain which I have thus briefly described appear to offer considerable advantages over those in general use. They are exceedingly precise, they demand very little exertion from the surgeon, they involve a minimal destruction of the tissues,

FIG. 12.—Exposure of right frontal lobe (1).

FIG. 13.—Exposure of right frontal lobe (2).

FIG. 14.—Exposure of right frontal lobe (3).

FIG. 15.—Exposure of right frontal lobe (4).

and they can be carried out almost bloodlessly and entirely without shock. Having now used them in a number of cases of the most varied kind, I can speak confidently of their practical value and of the facility with which they can be applied to varying circumstances. The tendency of modern cerebral surgery is towards larger and larger openings in the skull, in order that its contents may be handled with a minimum of trauma. To form these large openings with ease and safety is the first problem which the cerebral surgeon has to face, and a realization of its importance has impelled me to offer these suggestions as to its solution.

SMALL-POX AND CLIMATE IN ENGLAND AND WALES.

BY

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DURING the last six small-pox seasons—from 1921-22 to 1926-27—there has been a sixty-six-fold increase of small-pox in England and Wales over the figures of 1920-21, calculating from the first seasonal rise in September to the minimum incidence in August. According to the Health Committee of the League of Nations, in 1926 the country of Jenner showed the unenviable record of returning 90 per cent. of the small-pox of Europe, exclusive of Spain and Russia. Data are therefore now available for a study of the seasonal incidence of the disease in this country in relationship to climate, for the weekly returns of the Registrar-General contain all the necessary data on which the accompanying chart is based. In calculating the monthly figures those of weeks including parts of two months have been divided in proportion to the days in each, any possible errors being too small to affect the variations in the curves on which my conclusions are based.

Small-pox and Climate in India.

I was led to undertake this inquiry by the success of my previous study of the Indian data, which furnished the key to the problem and yielded the following results. On charting out the average monthly small-pox mortality of eight provinces of India, together with the monthly rainfall, mean temperature, and both the relative and the absolute humidity or aqueous vapour tension (the last being the actual amount of moisture in the air measured by its pressure in terms of mercury, and essentially a measure of combined heat and moisture), I found the closest relationship between the last-named factor and the small-pox incidence. Thus the disease rapidly sank to its minimum with the rise of the absolute humidity to its maximum of from 0.800 to 0.950—far higher than ever occurs in England—during the south-west monsoon from the middle of June to early in October, and rose throughout the winter cold weather of low absolute humidity, and continued high through the hot season of moderate degrees of the same. Moreover, so close is this relationship that a failure of the monsoon rains, accompanied by lower absolute humidity, produces a slighter fall of small-pox, with the result that the disease subsequently becomes epidemic, and a close examination of the data of over thirty years enabled me to point out how small-pox epidemics can be foreseen in future in India before the actual rise has commenced, as reported in detail in my paper of 1926 (Special Report Series No. 106 of the Medical Research Council).

Chart of Small-pox and Climate in England and Wales, 1921-27.

In the present chart the same climatic data, together with the direction of the prevailing winds, are shown monthly for the past seven years, and it will be seen at once that, with the exception of the unusually late rise in June, 1923, to which I shall return, the seasonal rise of small-pox occurred very regularly in the winter and spring months, and a decline in the summer to a minimum in August or September.

In the upper part of the chart the monthly relative humidity is shown by the lower dotted lines; the absolute

humidity by the middle continued lines, and the mean temperature by the upper curve of broken lines; and it will be seen at once that the small-pox increase occurs during high relative humidity and low absolute humidity and temperature, and the decline of the disease with the opposite conditions. Further, the two upper curves follow almost exactly the same course month by month, although this is not the case in India, as shown in Diagram 1 of the paper already referred to, where the almost total absence of rain in that continental area during the hot season causes the absolute humidity to be much lower than in the cooler monsoon months, and the relative humidity may fall to about 30 in the hot weather; whereas in sea-girt England the relative humidity usually varies only between 65 and 80 in the summer, and the absolute humidity rises with each degree of temperature under such conditions. In view of this Indian experience we may proceed to study the relationship between the absolute humidity and the small-pox curves in England more closely.

The Relationship Between the Small-pox and Absolute Humidity Curves.

When allowance is made for the incubation period, the development, and notification, the influence of any special climatic factor may be expected to show itself on the incidence of the disease in the following month, as I found to be the case with the effect of the monsoon rains and high absolute humidity with the seasonal decline of the disease in India; and weekly charts for the last seven years I have also worked out for this country confirm this relationship. It is therefore very significant that the present chart shows that the January peak of the small-pox curve in both 1926 and 1927 followed the minimum of the absolute humidity curves the month before, and that the rise in January, 1928, has followed the cold weather and very low absolute humidity of December last. Even more striking is the fact that the late April maxima of small-pox in 1924 and 1925 immediately followed the very late March minimal absolute humidity readings of those two years. We also find here the explanation of the remarkable very late small-pox maximum in June and July of 1923, for in May the absolute humidity was only 0.331, against an average of 0.357, and in June by far the record low figure of the seven years of 0.372, against an average of 0.413, favouring the prevalence of the disease, which happened to break out in badly vaccinated Gloucester, with almost two-thirds of the total cases in England and Wales in that one unfortunate county. Truly a prophet is not without honour save in his own country! The still more rapid decline of the disease from the yearly maximum in July to the minimum in August is the most striking in the whole chart, and it is extremely significant that it followed immediately on the highest temperature and absolute humidity in July of the seven years, not excluding the very hot 1921. Gloucester, however, would be well advised not to bank on such remarkably good fortune another time.

During the last five years of considerable prevalence of small-pox the decline to the minimum occurred in August in four of them, in each of which the absolute humidity reached its maximum in the previous July, and it is of interest to note that in 1927 the minimum in September followed the only August maximum absolute humidity in the series. The average reading was 0.505 in July and 0.480 in August; in September the figure was 0.434, and in no year did a great increase of small-pox occur in October.

In October the average absolute humidity fell to 0.351, with by far the lowest figure of 0.309 of the last five years in 1926, and this was followed by much the greatest November rise of the disease in that year. In November the average figure was only 0.261, but it was unusually high in 1924 at 0.296, and in 1927 at 0.282, and in the former year there was a most exceptional slight decline in December, while in the latter year the considerable rise in November, and in January, 1928, was broken by an almost stationary return in December, 1927, following the relatively high absolute humidity of the previous month. On the contrary, the considerable increases of small-pox in December, 1923 and 1925, were associated