The meningiomas arising from the olfactory groove and their removal by the aid of electro-surgery / [Harvey Cushing].

MACEWEN MEMORIAL LECTURE, 1927

THE MENINGIOMAS

ARISING FROM THE OLFACTORY GROOVE AND THEIR REMOVAL BY THE AID OF ELECTRO-SURGERY

By

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PUBLISHERS TO THE UNIVERSITY

The Macewen Memorial Lecture
was published in the Lancet
of June 25th 1927 p. 1329 et seq.

GLASGOW UNIVERSITY PUBLICATIONS

IX

MACEWEN MEMORIAL LECTURE, 1927

PUBLISHED BY

JACKSON, WYLIE & CO., GLASGOW

Publishers to the University

LONDON: SIMPKIN, HAMILTON AND CO. LD.

Cambridge - - *Bowes and Bowes*
Oxford - - - *Basil Blackwell, Ltd.*
Edinburgh - - *Douglas and Foulis*
New York - - *The Macmillan Co.*
Toronto - - - *The Macmillan Co. of Canada*
Sydney - - *Angus and Robertson*

MCMXXVII

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1927

PRINTED IN GREAT BRITAIN BY ROBERT MACLEHOSE AND CO. LTD.
THE UNIVERSITY PRESS, GLASGOW.

LIST OF ILLUSTRATIONS

The Macewen Memorial Lecture

THE MENINGIOMAS ARISING FROM THE OLFACTORY GROOVE AND THEIR REMOVAL BY THE AID OF ELECTRO-SURGERY [1]

By Harvey Cushing

The surgeon in whose memory this lectureship has been established speaks in one of his later addresses of having once paid a visit to the farm of Long Calderwood in East Kilbride, a parish near enough to Glasgow, when the wind is right, to be within the sound of her Cathedral bell. Over the lintel of the door of a small roadside cottage were the initials 'J. H.' with a date; and he inquired of the inmates whether they had ever heard of the Hunters who used to live thereabouts, two of whom had become famous. No, they had not; and a suspicious old woman of some ninety years piped up: 'What hae they been doin' that ye are speerin' for them?' And Macewen adds, 'Sic transit gloria mundi!'

The intellectual life of your populous, progressive and prosperous valley, like the Clyde itself, flows on, and why expect the aged occupant of a cottage to know who in particular may have been born in its vicinity two centuries past? Others no less worthy of remembrance, many of them with a Glasgow degree, which only one of the brothers Hunter happened to receive, have since then gone from Lanark, Renfrew, Ayr and Dumbarton to other parts of the Kingdom, to become famous. What prompts us to go 'speerin'' after them? It is because we of other ancestry would like to know your secret—would like to possess the humoral recipe which gives to your chivalrous race those enviable blends, of thorough-

[1] Delivered at the University of Glasgow, June 22, 1927.

ness with frugality, of intellectual vigour with physical stamina, of independence in thought with steadfastness of purpose, shown by those who go forth to leave the imprint of Scottish character in every corner of the world.

Should you scratch deeply enough a man of pioneering spirit, the chances are that you will draw Scottish blood. But one need not go to a distance to blaze a new trail. One may show, as did Macewen, the spirit of a pioneer in his work at home ; for not all Scotsmen migrate sooner or later, despite the impression outside of Scotland that they so do. The earth may be peopled with Thomsons who have got their education here, yet a sufficient number remain for you to fill with distinction five professorial chairs in your several faculties at one and the same time. The vigour of a university, no less than the vigour of a race, is in direct proportion to its capacity promptly to fill the vacuum made by the call to other fields of its highly developed and much sought-after product.

What can there be in the medical traditions of Strathclyde to touch closely the heart and stimulate the thoughts of a surgeon in a distant land ? Probably more than you imagine. I will tell you of certain reminders within reach of hand or eye as I write. The oldest of them will carry us back three centuries and more when there was printed a surgical treatise whose black-letter pages were soon to be thumbed to pieces by the untutored barber-surgeons of the day ; for, in imitation of the works of Paré, it had been impudently written in the vulgar tongue. The compiler, whose name you will already have guessed, signed himself ' Peter Lovve, *Scottishman,* Doctor in the faculty of Chirurgerie at *Paris* and ordinary Chirurgion to the French King and *Navarre* ' ; and the dedicatory epistle was penned ' at my owne house in Glasgow, the 20, day of December in the year of our Lord God, 1612.'

Here at least is a good beginning, even though the Royal Charter which Peter Lowe secured in 1599 was subsequently to cause your Senatus Academicus a deal of trouble. For it gave to him and Robert Hamilton, rather than to the Uni-

versity, and in perpetuity to their successors, soon to become the Faculty of Physicians and Surgeons of Glasgow, the privilege to try and examine all men upon the Art of Chirurgerie in the West of Scotland, and to determine who was worthy and who unworthy to profess the same.

Medicine—far less that Cinderella, Surgery—was not yet recognized as deserving a place beside Divinity and the Law in scholastic circles. And largely for this reason we shall have to jump something more than a century—not a long period, after all, in the life of that most enduring of human institutions, a University—before we come to the upheaval which infused a new spirit into academic pursuits and led to the real awakening of Medicine in your fifty miles of valley that stretches from Lanark to Greenock.

Just one hundred years after Peter Lowe had written his 'Discourse,' there was born in the town of Lanark a boy who came to be the most celebrated and influential man-midwife of his day. A decade later in the nearby town of Hamilton there first saw the light another child destined to be even more famous and who may very properly be regarded as the founder not only of your medical school but indirectly—through his one time apprentice and favourite pupil—of the present-day medical schools in London. The influence and teachings of these two men, William Smellie and William Cullen, in their maturity spread fast and far; and that their published works got into the eager hands of a back-country practitioner in far away New England I have evidence, for copies of the *Treatise on Midwifery* by the one, and of the *First Lines of Practice* by the other, in their first American editions, bearing the signature of ownership of my great-grandfather, have come down to me through a line of medical forebears.

To be sure, the studious William Smellie, after some years in practice in this valley, licensed be it said by Peter Lowe's 'Faculty,' went up to London at the age of thirty-two, there quickly to establish a world-wide reputation. He was a friend, we may recall, of John Gordon, Smollett's teacher, and of the irascible Tobias himself, who professionally fared less well in his invasion of London than did Smellie—to which

accident we owe it that *Peregrine Pickle* and *Roderick Random* have a place in a doctor's library.

No less was Smellie a friend of that greater William from Hamilton, who after four short years in your Chair of Medicine was lured away to become the mainstay of the School at Edinburgh ; and of an even more famous William, him of Long Calderwood, Cullen's inspired pupil over whom London also cast its spell, for there primarily to be under Smellie's guidance he went to forge his career.

To have inspired two of the great geniuses of the eighteenth century—Joseph Black and William Hunter—would alone have sufficed to give Cullen enduring fame. As he handed the torch to Joseph Black, so Joseph Black made possible the invention of that young instrument-maker from Greenock, his pupil James Watt ; and now a century-and-a-half later you may expect to find in charge of the engine-room of every steamship on the seven seas a responsible person who likely enough has a ' Mac ' to his name.

Just so, through Cullen's influence on William Hunter, through John in turn, through Cruikshank and Matthew Baillie—Scots all, either born or bred in Strathclyde—there was let loose upon the world through the investigative spirit of the Windmill School a new conception of experimental pathology which has influenced medicine in ways as yet scarcely fathomed. It was in the hope that a similar spirit might come to pervade its quarters that a modest foundation set up at the Johns Hopkins Medical School some twenty years ago was called The Hunterian Laboratory of Experimental Medicine.

From the Hunters one can never get very far away, and though London and the English have made much of sturdy and untutored John, who doubtless had the greater intellectual force, William the elder brother had perhaps the more engaging and many-sided personality—possibly too many-sided. He was, among other things, as you have reason to be aware, a bibliophile—a dangerous and time-consuming thing for a doctor to become. He at least must have spent much time, and incidentally have emptied his purse, at the sale of Anthony

Askew's library held at the establishment of S. Baker and G. Leigh, York Street, Covent Gardens, on the 13th of February, 1775, and *in undeviginti sequentes Dies*. He at least, to judge from this annotated catalogue of the sale at my hand, appears to have been one of the chief buyers,—his name rivalling, among others, that of King George, the British Museum, and of M. de Bure, who, according to Dibdin, was bidding for the King of France in competition for the choicest items.

It was primarily to see William Hunter's varied collections, scarcely less worthy of a pilgrimage than those of his brother John in London, that, in company with my medical colleague, Thomas McCrae, my first visit to Glasgow was paid just twenty-seven years ago. We had three objects in view: to browse in the Hunterian Museum, to visit Lister's one-time wards, and to see Macewen at work. A memorable visit it was! I recall exclaiming with delight over Calcar's portrait of Vesalius when a voice from an inner room was heard to say, 'Who may that be who offends my ear with a Northumbrian accent?' and out stumped no less a one than the Keeper of the Museum, John Young of blessed memory. I said it was McCrae, a 'Hieland mon,' whom he had overheard; but he would have none of it, and accused me of what he said was a villainous burred tongue.

Atonement was quickly made for this rude greeting, and so it is that I have a copy of Professor Young's delightful account of the Hunterian Library prepared for the ninth jubilee of your University. And nearby are other cherished reminders of that visit, among them John H. Teacher's catalogue of the museum specimens, and photographic copies of those precious sheets supposed to carry Calcar's original drawings for the illustrations in Vesal's *Fabrica*. These memorabilia are no less prized and take up far less room than does the Baskerville edition of William Hunter's *magnum opus*.

But lest there be no end to this my preamble, which is merely to show how your traditions reach out across the sea, I must tear myself away from the Hunters and *Hunteriana* and move on to things more recent. Here, framed on my wall, is

a letter from Lister to his house surgeon, Archibald Malloch, which shows the motivating spirit and enthusiasm of his Glasgow days. It was dated ' Sept. 10th, 1868,' from Ventnor in the Isle of Wight where Lister had gone for a needed rest ; but his mind was full of the patients he had left behind, and of concern for their progress. He was fairly seething with suggestions for new tests to be made with the antiseptic shellac dressings, and he urges Malloch ' not to lose a day in getting the things tried.'

Nor is this by any means all. Here are some old anatomical classics bearing on their fly-leaves the signature of the lamented John Cleland. There stands the two volumes of John Ferguson's *Bibliotheca Chemica*, the most perfect example of how a bibliography may be done, but never before so well. Here on another shelf is Sylvanus P. Thompson's sketch of Lord Kelvin. On still another is a row of books by doctor-poets, among them, bearing the imprint of James MacLehose, a small volume entitled *Echoes*, which goes to show that in this countryside of Robert Burns, scholarship, medicine and poetical gifts may be combined in one person.

And here, finally, is a volume, one of the first medical books I ever purchased, entitled *The Pyogenic Diseases of the Brain and Spinal Cord*, a landmark in the surgery of the nervous system of which Macewen may well be considered one of the founders. The studies were made in Glasgow ; the volume was published in Glasgow ; in Glasgow the author was born, lived, worked and died.

It would have been appropriate to have devoted this first memorial address to an account of Macewen's life and an appraisement of his work. But this has been done far better than I could possibly have hoped to do it in an admirable oration delivered a year ago by his worthy successor.[1] In both his physical and mental attributes Macewen was a man out of the ordinary, towering above his fellows, conspicuous in every assembly. This may have bred in him a consciousness

[1] ' Sir William Macewen.' An Oration delivered in the University at the Commemoration of Benefactors, on June 23, 1926. Glasgow: Jackson, Wylie & Co., 1926.

of isolation which may well account for his reputed aloofness and hauteur. An ardent American friend and admirer, Professor Emmet Rixford, has likened him to one of the giant Sequoias of our Pacific Coast, a tree which in its vigour and nobility of bearing towers above the common forest.

On his last visit to America Macewen passed through California on his way round the world, and Rixford arranged for a motor trip to ' the Giant Forest '—at once the greatest and most beautiful of the Sequoia groves. Arriving at dusk Macewen walked among the mighty trees, put his hand upon them and with his eye measured their three-hundred feet of height. That he caught the spirit of the mountains and the forest was shown by his question, ' Can you not arrange so that I might sleep out and watch the stars through these tree-tops ? ' And at break of day, his companion tells me, he was found among the majestic trees—wholly absorbed in their grandeur ? No, deeply engrossed in the antics of a lively chipmunk. Susceptible as he was to the wonders of nature, it was the minutiae of life that chiefly aroused his curiosity and secured his attention.

After all, it is attention to minutiae which breeds success in the paths Macewen trod, and I am quite sure, were he to listen to an address in his honour, he would much prefer to hear something of the progress made in subjects to which he was an early, painstaking contributor, than to be embarrassed by plaudits of his pioneering efforts. He would perhaps be especially eager to have some account of the advances in neurological surgery, particularly in so far as these advances concern the alleviation or removal of brain tumours, which in his younger days seemed to offer a most hopeless surgical problem.

We merely stand on the shoulders of our predecessors, and the sturdy contemporary figures of Macewen on one side and of Horsley on the other are what support the arch of modern neurological surgery. In his Oration, a year ago, Professor Young pointed out that as early as 1879 Macewen had operated upon a tumour involving the frontal bone which in all probability was of meningeal origin. To be sure, here was a

lesion presenting itself to view, whereas in the celebrated Godlee-Bennett case operated upon five years afterwards, the presence and location of a hidden lesion were determined solely by its neurological signs; and for supposedly the first time under such circumstances an actual tumour of the brain (glioma) was surgically disclosed. Macewen must have been well aware of the difference, which probably accounts for his silence at that memorable meeting of the Medico-Chirurgical Society of London on May 12, 1885, when the report of the Godlee-Bennett case made such a stir in neurological and surgical circles.[1]

Thus it was that nearly fifty years ago the first efforts were courageously made surgically to combat the effects of tumours involving the brain. And since Macewen was apparently the first to operate upon a tumour of meningeal origin compressing the frontal lobe,[2] I propose to devote the remainder of this address to a description of certain of these tumours which are recognizable because of their peculiar syndrome, and which until very recently have been regarded as quite inoperable lesions.

[1] Though Macewen had previously operated upon several correctly localized intracranial lesions, he had the ill fortune not to have happened upon a true brain tumour. In his Presidential Address on Brain Surgery before the Annual Meeting of the British Medical Association in Glasgow in 1922, he stated that 'there were several tumours in the motor cortex and one of the paracentral lobe diagnosed [in 1883] and operated on. All of them were diagnosed and the neoplasm successfully removed from the brain with restoration of function.' This statement is misleading since the seven cases to which he refers as having been operated upon up to 1883 had been reported in his memorable address given thirty-four years previously before the same Association at its meeting in Glasgow in 1888. These seven cases included the frontal tumour [meningioma (?)] operated upon in 1879 and a 'syphilitic tumour' operated upon in 1883. The lesions in all the other cases were non-neoplastic, being either cerebral abscesses or haematomas of sorts (cf. *Brit. M. J.*, Aug. 1888, pp. 303-305). Nevertheless, to Macewen belongs the distinction of having been the chief pioneer in cranio-cerebral surgery.

[2] The case was first briefly reported by Dr. J. W. Anderson 'from Dr. Macewen's wards' (*Glasgow M. J.*, 1879, xii. p. 210) as the 'usual fungus tumour of the dura mater.' It was subsequently included (Case III.) in Macewen's notable address at the meeting of the British Medical Association in Glasgow, August 9, 1888 (cf. *Brit. M. J.*, August 11, 1888, p. 304).

MENINGIOMAS IN GENERAL.

The meningeal tumours (commonly called dural endotheliomas) as a class have long been made the object of an accumulative study, the results of which may some day perhaps come to be given in print. They represent about 12 per cent. of all intracranial neoplasms, there having been up to May 1 of this year in my series of 1,398 histologically verified tumours 167 examples, a sufficient number, one might well suppose, from which to draw definite conclusions as to aetiology, diagnosis, pathology, prognosis and treatment. It doubtless would be were all of these tumours, like the acoustic neuromas for instance, tumours of a uniform symptomatology and comparable behaviour.

The meningeal tumours in contrast may arise from the arachnoid membrane almost anywhere in the cerebrospinal chamber and may therefore press upon almost any surface area of the brain or cord. The process is a slow one and the nervous tissues, protected by the limiting pia, give way before, and accommodate themselves to, the advancing growth. Hence in certain silent or comparatively silent regions of the brain the lesion may reach an amazing size before any suspicions of its presence, either on subjective or objective grounds, are aroused.

There are, to be sure, notable exceptions to this rule. Meningeal tumours arising in the spinal canal, for example, must, owing to the restricted space, necessarily soon give evidence of their presence and situation. Due to this fact Gowers and Horsley in combination were enabled in 1887 to localize and for the first time to remove one of these characteristic lesions, a brilliant performance the report of which set the medical world fairly agog. So too in Macewen's first operation to which I have referred as another historical landmark, the situation of the lesion was unmistakable because of the extracranial appearance of the growth. However, no one in the 1880's would have been likely to conceive that the neoplasm in these two celebrated cases had the same histogenesis.

It has been said that the car of progress advances on square wheels, slowly and with many a jolt. In the surgical treatment of these meningeal growths, apart from those found in the spinal canal, an excellent account of which has just been made by a member of your medical faculty,[1] unusual difficulties are encountered. This would seem contrary to all expectations, for the lesions are, comparatively speaking, benign, well-encapsulated and approachable, and the X-ray often proves of the greatest value as an aid to localization when neurological signs are wanting. They, however, are tumours which take their origin from the arachnoid-cell clusters in the region of the intracranial venous sinuses. In consequence, the vascularity of the adjacent structures from the effect of long-existing stasis may be so overwhelming as to necessitate an operation in successive stages, with no little hazard to life at each one of them. Some of the tumours, moreover, particularly those which arise from over the hemispheres, are soft and rapidly growing, so that implantation with recurrence is prone to occur unless they are removed with the capsule intact, often a difficult matter since they may be as irregular in shape as a budding potato. What is more, when a meningeal tumour has widely involved adjacent dura and bone by penetration, continuance of the growth can only be forestalled by the extensive removal of these outlying tissues.

The surgeon's path consequently may be beset by disappointment even in the case of the more accessible and supposedly easily-removable tumours which overlie the paracentral convolution and consequently call early attention to themselves. One young woman, upon whom I first operated in 1919, owing to my having broken in two an hourglass-shaped tumour during its removal, I have since operated upon eleven times for recurrences. Another patient, whose highly cellular and rapidly growing meningeal tumour was similarly broken at the time of its first removal eight years ago from the same supposedly favourable region, has since been operated

[1] Learmonth, J. R.: On Leptomeningiomas (Endotheliomas) of the Spinal Cord. *Brit. J. Surg.*, 1927, xiv. 397-471.

upon five times, there having been removed, all told, on these various occasions recurrent tumours the combined weight of which has been 608·5 grams, practically the weight of a cerebral hemisphere. At the conclusion of each session I have felt that I had made a complete extirpation, only to be disappointed by a return of symptoms in course of time. From such experiences as these it can be appreciated that when one speaks of having had a series of 167 patients with verified meningeal tumours it means a vast deal of time-consuming work. For if we are permitted to include first- and second-stage procedures as well as subsequent operations for complications and recurrences, these 167 patients have been subjected, all told, to 301 operations.

There are of course other far more favourable types of meningioma than those just described—tumours which have undergone fibrotic changes or which even become psammomatous in character so that they are more resistant to handling. These varieties are more apt to arise from the basilar meninges and consequently are less easily diagnosed, less easily approached, and less often operated upon. They are distinguished as a rule by a finely nodular, mulberry-like surface quite different in gross appearance from the smoother surface of the usual meningeal tumour met with on the upper surface of the brain.

In years gone by the pathological diagnosis of these growths has suffered from the subtleties of histological nomenclature, in the tangle of which their common family relationship was entirely lost. It was in consequence of this that the proposal was made five years ago [1] to scrap the terminology based on their finer microscopic architecture whereby they were variously designated as endotheliomas, sarcomas, psammomas, cylindromas, fibromas or combinations of these terms, and to classify them all as co-related ' meningiomas.'

With this accomplished we may well enough begin again, though on a sounder basis, once more to subdivide them ; for there are grossly different pathological types which have a

[1] The Cavendish Lecture. ' The Meningiomas (dural endotheliomas) ; their Source and Favoured Seats of Origin.' *Brain*, 1922, xlv. 282-316.

distinctive appearance and distinctive behaviouristic qualities. One only comes fully to appreciate this after actually exposing and handling a large number of the lesions during life. What is more, each type has its seat of predilection in the cerebral chamber, and consequently not a few of them have a clinical syndrome peculiar to themselves which makes their pre-operative recognition possible.

It is a sound principle that more rapid progress is made in the solution of a clinical problem if it is attacked from all sides by a single group. Experts in overlapping departments must necessarily be called upon for their opinions, but the final responsibility of a surgical operation is inseparable from the making of the clinical diagnosis which precedes it, and should include the pathological study of the tissues which follows it. The neurologist acting independently is handicapped as he does not have the illuminating experience of personally putting his diagnosis to the therapeutic test; the surgeon acting alone and interested primarily in matters of operative technique is prone to throw the onus of a mistaken diagnosis back on the neurologist and to lose interest in the case; the pathologist working over such tumour fragments as come under his microscope without having had the opportunity of seeing and handling the growth in its fresh state as exposed at the operating-table is often at a great disadvantage. With the best intentions for co-operation progress under these circumstances is as awkward as in a three-legged race.

To know before operating, not only *where* a growth is to be found but *what* its nature will be, must be one's aim if he is successfully and intelligently to deal with an intracranial tumour of any kind. Forewarned is to be forearmed, and nothing may be more disconcerting in this particularly difficult sort of surgery than, when ill-prepared, to turn down possibly an insufficiently large boneflap, and to stumble unawares upon a huge vascular meningioma. What was looked forward to as a simple procedure may suddenly be transformed into one of magnitude and exceptional gravity. And by ill-prepared I mean without the precaution of having raw muscle at hand for implantation; of having the patient's

blood grouped, a donor selected, and a separate team prepared to give a transfusion ; and possibly too of having at hand the electro-surgical adjunct to which I particularly wish to call attention in this Macewen Lecture. A surgeon who takes a flying leap at one of these operations rides for a fall.

MENINGIOMAS IN PARTICULAR.

In times past surgeons have regarded themselves as fortunate if a tumour could be localized with sufficient accuracy for it to be brought to view at operation. To-day we aim to do far better than this, namely to determine before operating not only the precise seat of the tumour but also its pathological nature—even in some cases its particular subvariety.

I shall give an example of what I mean. Patients of middle age, whose primary, and often enough, sole complaint is loss of vision, have long frequented ophthalmological and neurological clinics and are now seen in those given over to the treatment of neuro-surgical conditions. The ophthalmoscope quickly tells—what is of chief moment—whether the optic nerve shows either a papilloedema or the pallor of a primary atrophy. We find, let us suppose, the latter—a primary optic atrophy ; whereupon the perimeter is called into play and more or less symmetrical bitemporal field defects are disclosed. Since a pituitary adenoma pressing upon the optic chiasm is the most common cause of such a combination of symptoms, cranial roentgenograms are consulted and to one's surprise they show a normal sella turcica.

What, then, is the probable diagnosis in the case of a middle-aged person who shows, in the practical absence of all other symptoms, nothing more than a primary optic atrophy, a bitemporal hemianopsia, and a sella of normal configuration ? Among the possibilities are aneurysm, a primary glioma of the chiasm, or a congenital suprasellar cyst which has failed to give symptoms at an earlier age and whose presence is not betrayed by the usual areas of calcification in its walls. But a far more common source of the syndrome in question is a

small midline meningioma which takes its origin from the meninges over the sulcus chiasmatis or tuberculum sellae whence it spreads back over the diaphragm covering the pituitary fossa and in the course of its further enlargement elevates and stretches the chiasm (cf. Fig. 1).[1]

These basilar meningiomas fortunately represent a fairly firm type of tumour that grows slowly, tends to undergo psammomatous transformation and by proper manoeuvres is most favourable for surgical removal. At a recent clinic when a series of these cases was exhibited, I found that neither the neurologists nor ophthalmologists present were aware that such tumours existed, much less that they could be removed with preservation of vision. Yet here is a lesion, scarcely known even to pathologists except as an accidental postmortem finding, which elicits a clean-cut and hardly mistakable syndrome, whose ophthalmological features usually lead to the mistaken diagnosis of 'retrobulbar neuritis.'

FIG. 1.—Heinrichsdorff's case of suprasellar meningioma ('Psammom'): an unexpected postmortem disclosure in a patient with generalized arteriosclerosis.

These suprasellar tumours, with the particular syndrome thus briefly described, are comparable in a way to the meningiomas which arise in the spinal canal, in that the seriousness of the symptoms they provoke is out of all proportion to the size they have attained. While the tumour is still small, persistent lancinating pain in the case of a spinal tumour, optic atrophy with advancing blindness in the case of the suprasellar meningiomas, brings the patient under observation early in the course of his malady. It is quite a different

[1] Heinrichsdorff, Paul: 'Ein Psammom im vorderen Chiasmawinkel.' *Klin. Monatsbl. f. Augenheilk.*, 1914, xvi. 185-187.

story when one of these tumours takes its origin from the leptomeninges covering some relatively 'mute' portion of the brain. For, under these circumstances, as is well known, the growth may attain a large size before it gives any alarming symptoms, or may indeed not infrequently be an unlooked-for postmortem finding, there having been during life no suspicion of tumour whatsoever.

THE OLFACTORY-GROOVE TUMOURS.

As the central subject of this Memorial Lecture I wish to call attention to another group of meningiomas which have a syndrome no less characteristic than the primarily supra-sellar lesions. These are tumours which arise from the meninges of the anterior fossa of the skull, usually though not always in the mid line, and which we customarily speak of as olfactory-groove meningiomas. There is perhaps a special justification in the selection of this topic for consideration here in Glasgow as a compliment not only to Macewen, whose early operation for a frontal meningioma has been referred to, but out of deference as well to his colleague John Cleland. What is more, if one may correctly interpret an account of an operation for a 'tumour of the hypophysis' as described by Macewen, he had actually encountered and removed, in part at least, one of these very tumours in question.[1]

In my Cavendish lecture, in which the meningeal tumours were dealt with from a general point of view, I had the satisfaction of pointing out that Professor Cleland had probably been the first to make clear that they originate from the cells of the pia-arachnoid rather than from the dura as commonly supposed.[2] One of the tumours which he had studied had been found while dissecting the body of a female said to have been fifty years old, who for many years had been an epileptic with impaired mental faculties and who had finally died of

[1] Macewen, Sir W.: 'Brain Surgery.' *Brit. M. J.*, 1922, ii. 160. (Tumours of the hypophysis.)

[2] Cleland, J.: 'Description of two Tumours Adherent to the deep Surface of the Dura Mater,' *Glasgow M. J.*, 1864, xi. 148-159.

bronchitis. Cleland's sketch of the lesion (Fig. 2) shows a symmetrically placed olfactory-groove meningioma of

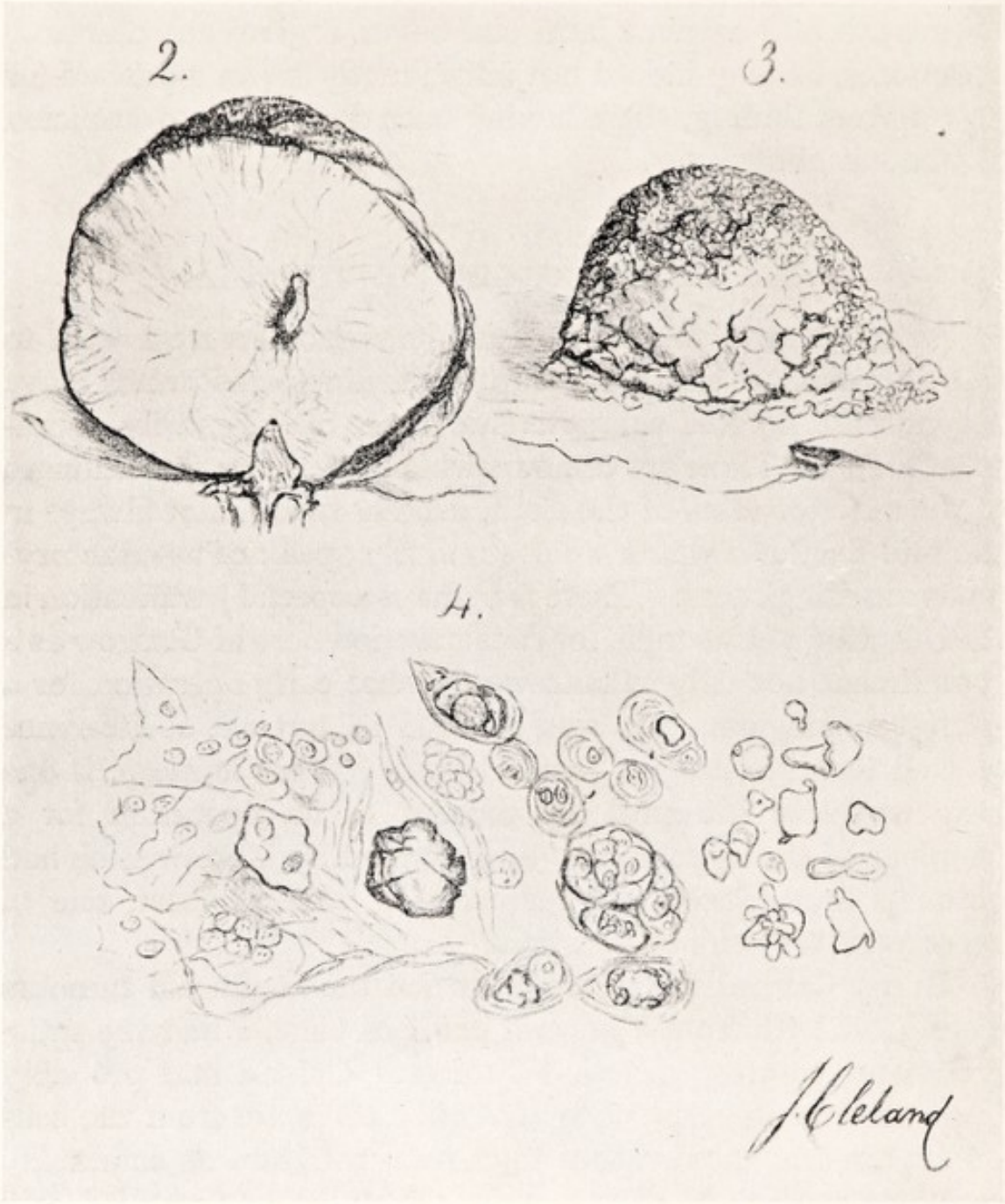


FIG. 2.—Cleland's sketch showing (3) the characteristic, finely-granular external surface of a basilar meningioma; (2) the tumour on transverse section showing the position of the crista galli as well as the small central area of calcification; (4) the cells and corpora amylacea which led him to ascribe the lesion to the arachnoid.

moderate size of which he gives the following excellent description:

The tumour was seen upon more careful examination to be closely adherent to the crista-galli and cribriform plate of the ethmoid. It was deeply cleft in front by the falx cerebri, which however was quite

free from it, nearly to its base. Near its base it was attached to the dura-mater by delicate tissue, quite distinct from the proper texture of that membrane, and which was easily divided with a needle. In this way it could be detached from the dura-mater as far as the orifices of the larger perforations in the mesial border of the cribriform plate, with the processes of dura-mater lining which it appeared to be closely connected. By its bulk it had pressed not only on the brain, but to a slight extent on the left orbital wing of the sphenoid. . . . The surface was nodulated, and partly smooth, partly papillary and villous. The villosities when pressed asunder easily allowed deep cracks to open between them. . . .

When a transverse vertical section had been made, the cut surface exhibited a uniform appearance similar in colour to the grey matter of the brain. The centre of the section passed through a small irregular plate of bone about a couple of lines deep and twice as long, placed vertically in the mesial line, about half an inch above the crista galli, and slightly connected with the falx in front. It presented the lacunae and canaliculi of true bone, and was exactly similar to the ossification frequently met with in the edge of the falx.

Small portions of the tumour, prepared for microscopic inspection, when slightly rubbed against the glass cover, allowed a large quantity of granular matter to separate from them, rendering opaque the fluid in which they were. A large bulk of the tumour consisted of such matter, which was composed in great part, if not entirely, of nucleated cells, of which numbers were seen about 1-3000th of an inch in diameter. . . . But the most remarkable elements of the tumour were of a concretionary character, partly based on the cellular, partly on the fibrous element. The cellular concretions were round structures, strongly refracting light, and capable of being cracked by pressure of the glass cover. The largest of them were about 1-200th of an inch in diameter, and much resembled the corpora amylacea found in brain-substance, or spherical prostatic concretions.

This particular tumour Cleland called a ' villous tumour of the arachnoid,' and he conceived that it perhaps originated from the pacchionian corpuscles. But he was not the first to picture one of these lesions. Cruveilhier, for example, thirty years before had given in his celebrated atlas [1] an excellent illustration (Fig. 3) of a similar case. Tumours of this sort unexpectedly encountered in a postmortem examina-

[1] *Anatomie Pathologique du Corps Humain*, tome 2e. Paris, 1835-42. Livraison VIIIe. Pl. 3.

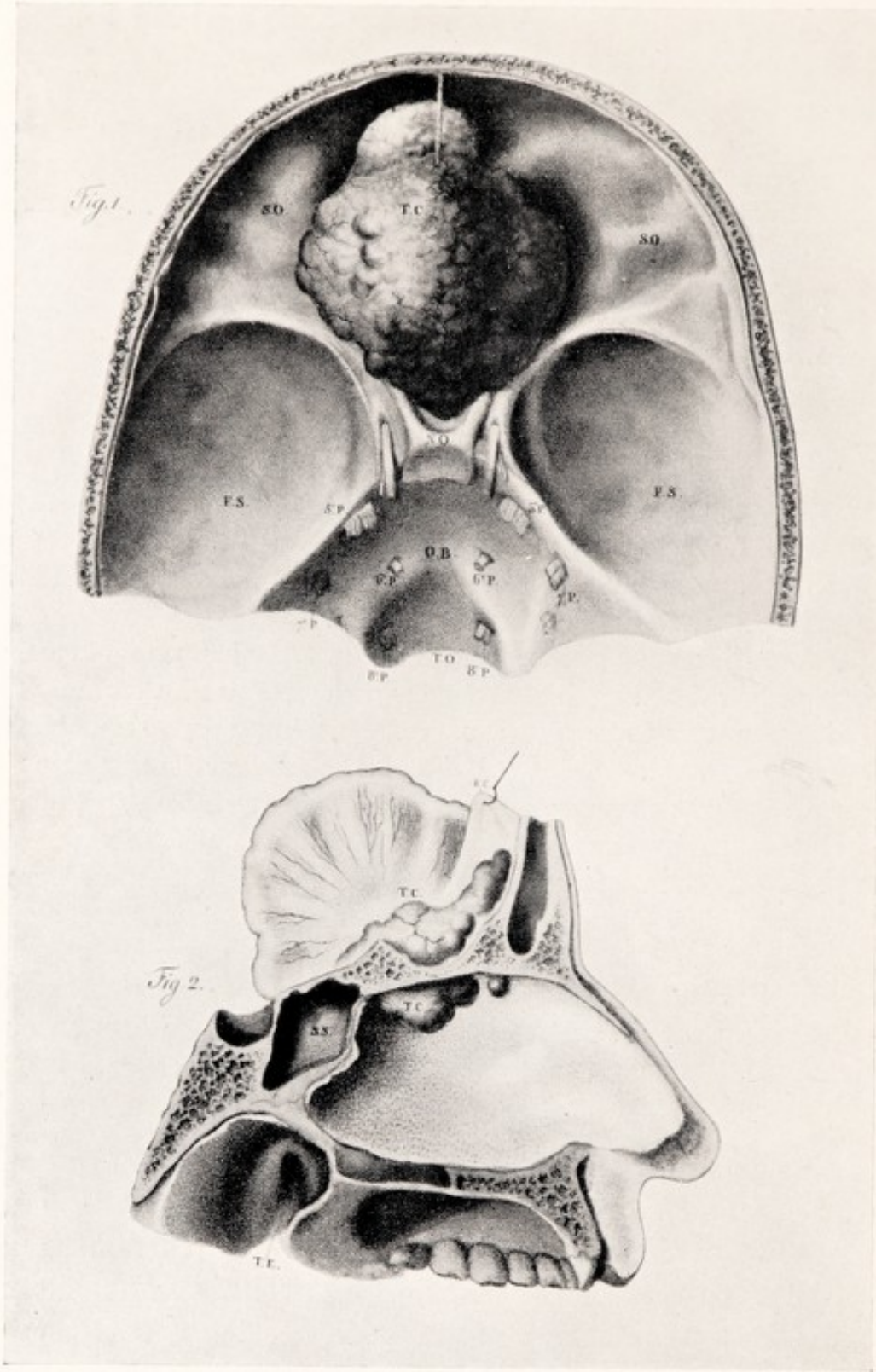


FIG. 3.—Cruveilhier's illustration (1835) of an olfactory-groove meningioma called a ' tumeur cancéreuse des méninges.'

tion have naturally aroused interest, and the specimens are apt to find their way into pathological museums. There is a typical example labelled psammoma in the Charcot Museum at the Salpêtrière (Spec. D. III. 16); and in the museum of the Royal College of Surgeons in London may be seen (No. 1452.1) a small tumour which serves to indicate better than do the larger ones their characteristic point of origin (Fig. 4). Virchow in his classical work on tumours[1] describes and pictures just such a case, the small, cherry-sized growth having

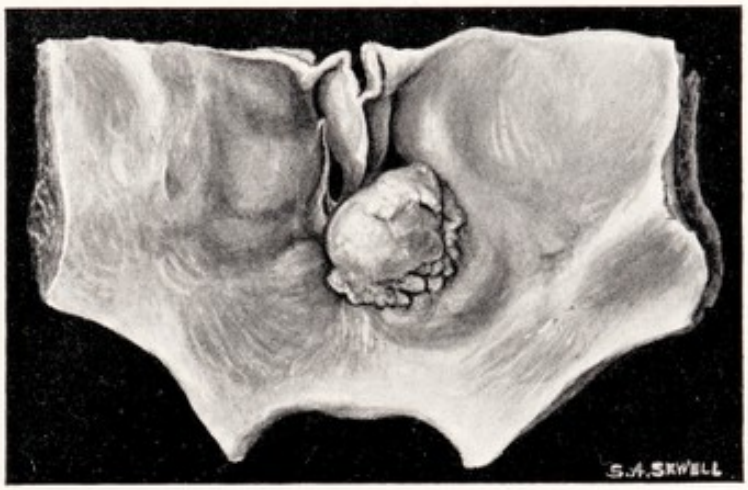


FIG. 4.—Small olfactory-groove meningioma (nat. size) from the Museum of the Royal College of Surgeons (Lond.). Kindness of Prof. Shattuck.

been situated 'close behind the crista galli and the attachment of the falx in the median line.'

My first personal experience with one of these olfactory-groove tumours was sixteen years ago; and during the life of the patient I had no preconception of what the lesion would prove to be. The tumour had advanced to such a stage that there was complete blindness, mental deterioration and distressing headaches. There were also unmistakable evidences of pituitary insufficiency, with a sella turcica shown by the X-ray to be largely destroyed. A subtemporal decompression was performed without avail, and the poor man not long afterwards was released by death from his troubles.

Owing to my special interest at the time in pituitary

[1] *Die krankhaften Geschwülste.* Berlin, 1864-5. Zweiter Band, p. 115.

disorders the case happened to be reported [1] as an example of hypopituitarism secondary to an adjacent tumour. The photographs (Figs. 5-7) show that the lesion had reached a large size ; had spread backwards to overlie and compress the pituitary body ; had extended into the ethmoid cells ; and, what the photograph does not show, had forced its way without invading the brain, into every crack and cranny of

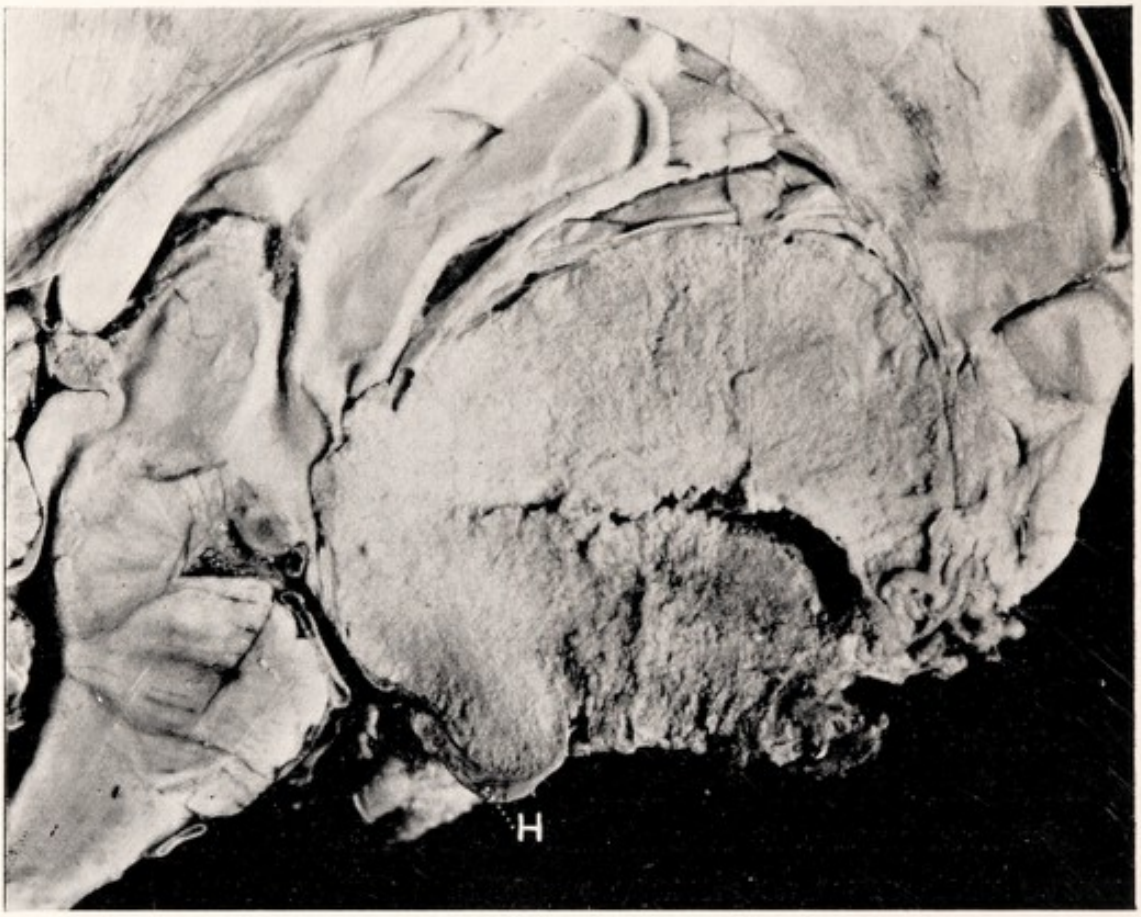


FIG. 5.—Photograph of the tumour in the author's first case (1911) of olfactory-groove meningioma (undiagnosed). Note the backward prolongation of the tumour projecting into the pituitary fossa and flattening the hypophysis (*H*). (Nat. size.)

the neighbourhood even down into the sheaths of Schwalbe almost as far as the eyeball. One of these tumours in this terminal stage is of course hopelessly inoperable, and in 1911 when this case was observed I little expected ever to see another example.

However, the lesions prove by no means to be rare. Another case of precisely the same kind came to autopsy on March 15,

[1] *The Pituitary Body and its Disorders.* Philadelphia : J. B. Lippincott Co., 1912. Case VIII.

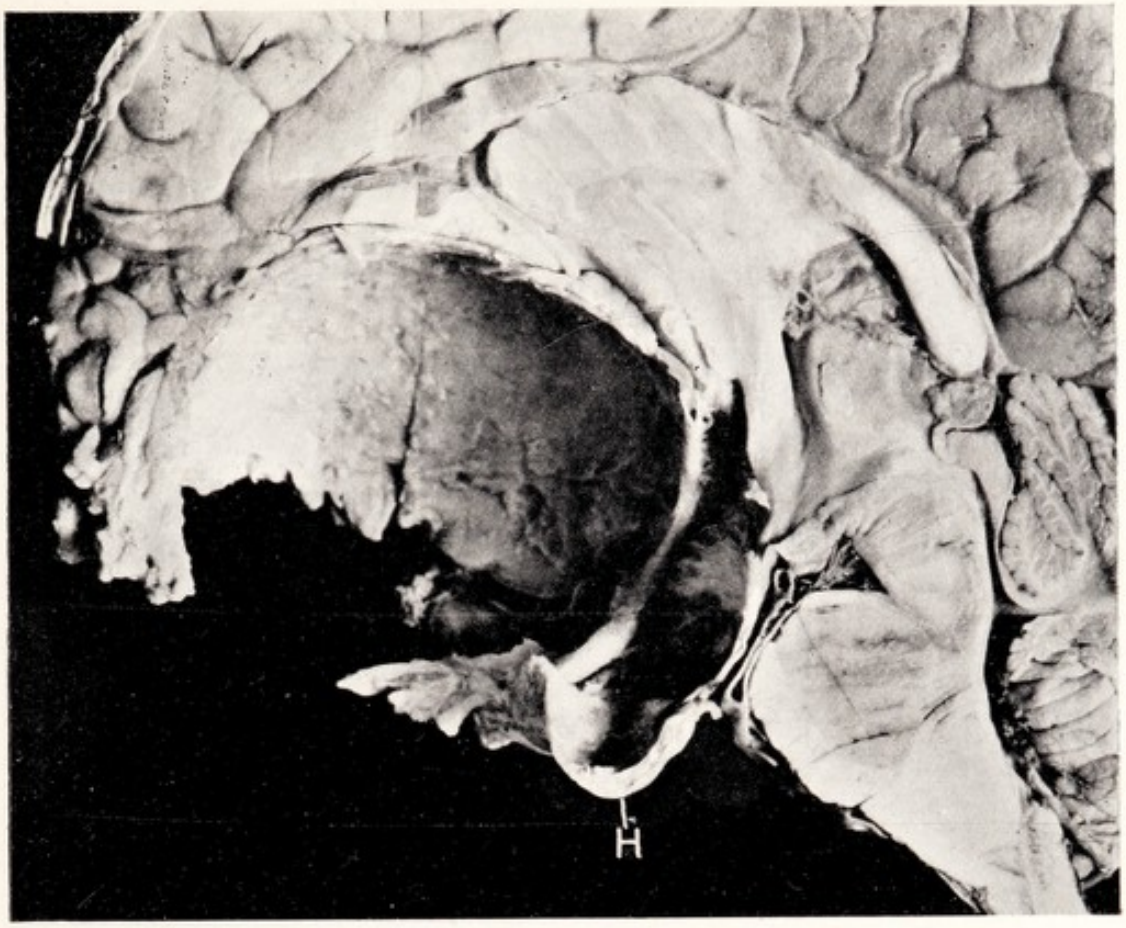


FIG. 6.—(Cf. Fig. 5.) To show (nat. size) the ' nest ' in the right frontal lobe after removal of the right half of the symmetrical lesion (cf. Fig. 7). Note : (1) the flattened cup-shaped hypophysis (*H*) ; (2) the elongated and compressed infundibulum and distorted third ventricle ; (3) the ridge made by the elongated anterior communicating artery passing up from the internal carotid.

FIG. 7.—The right half of the tumour (nat. size) removed from its nest in the right frontal lobe. Note : (1) the finely nodular surface ; (2) the rounded prominence in the lower left field which lifted out of the hypophysial cup. (Cf. Fig. 6.)

1921, after an ineffectual decompression at my hands for an unlocalized tumour. The accompanying photographs (Figs. 8 and 9) will show how closely the tumour resembles the preceding one, its point of origin from the olfactory groove being more apparent as the growth was not broken in removal

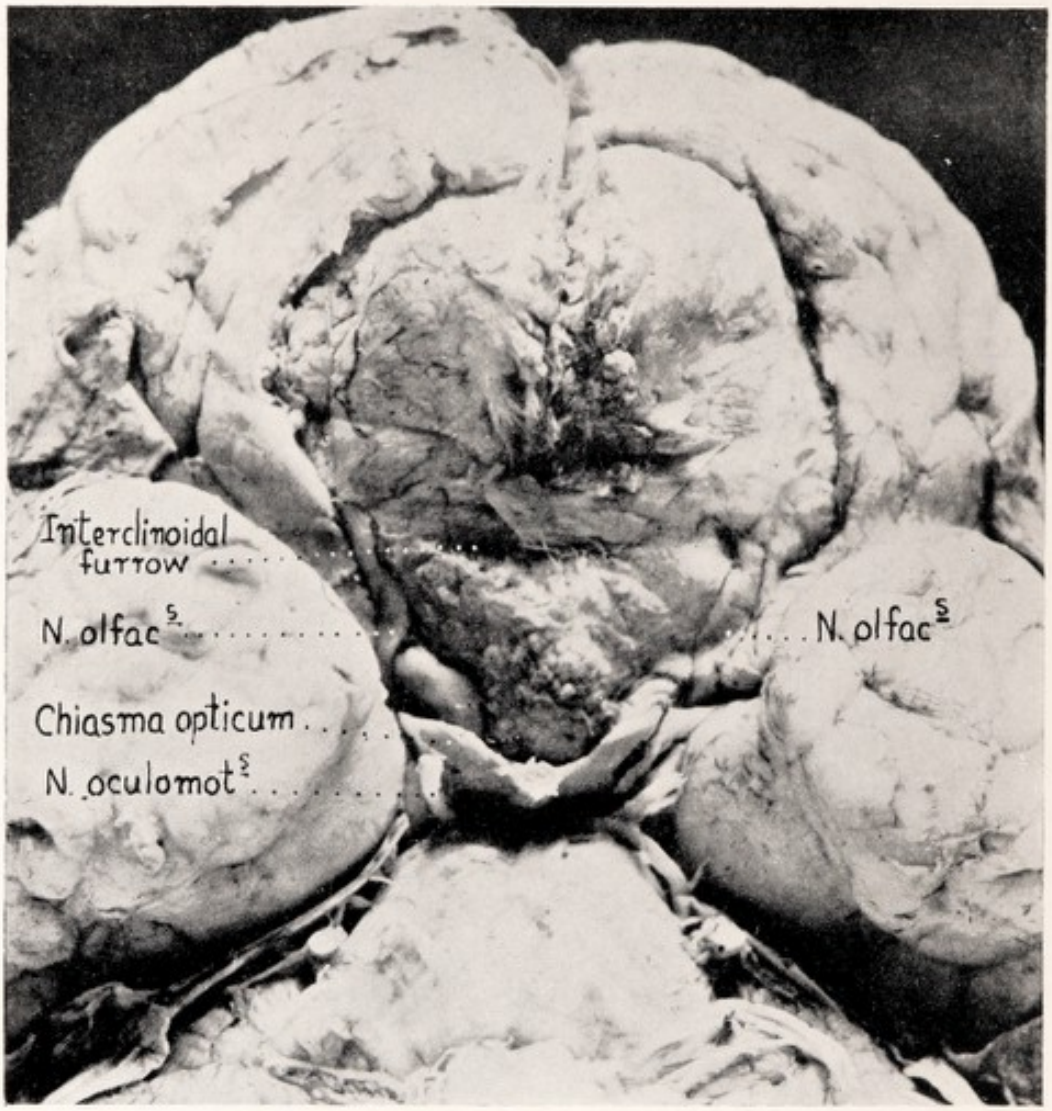


FIG. 8.—The author's second clinically unrecognized case, showing the under-surface of the lesion (nat. size). Note the median position of the tumour, cleft anteriorly by the falx; the median dark area corresponding to the olfactory-groove attachment of the growth; the transverse groove in the tumour between the ends of the widely separated olfactory nerves made by the inter-clinoidal ridge; the overhang of the growth filling the pituitary fossa and crowding the chiasm backward. Weight of tumour 82 grams.

(cf. Figs. 9 and 5), and the photograph of the under-surface shows the prolongation of the lesion into the pituitary fossa with backward displacement of the chiasm.

My curiosity naturally enough was aroused by the similarity of these two tumours, and during the intervening years I have gathered, from one source or another, photographic records of

other cases, some of which may be here reproduced in order to emphasize how closely in their situation and gross appearance the lesions resemble one another (Figs. 10-15). The specimens for the most part represent postmortem disclosures on patients who, because of mental symptoms, had come to be confined

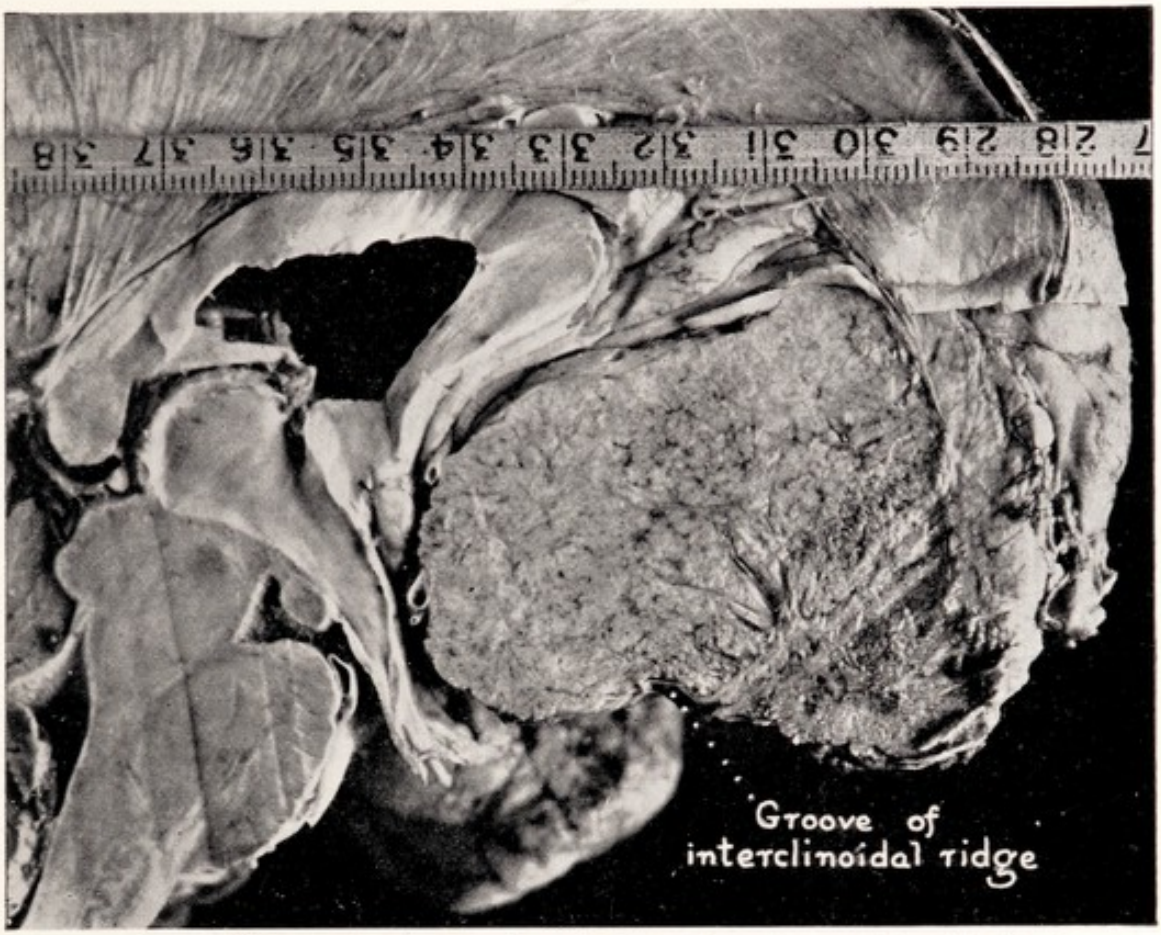


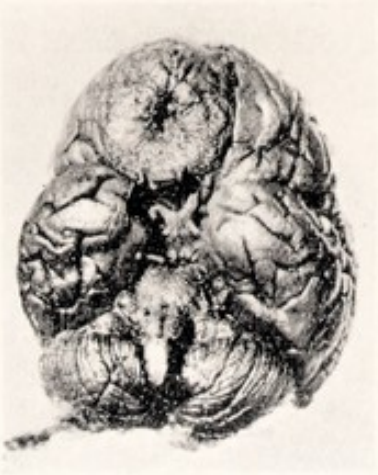
Fig. 9.—Median section of tumour in author's second case, for comparison with Fig. 5. Note the overhang of the tumour posterior to groove of inter-clinoidal ridge; also the cross-section of the anterior communicating artery at the posterior border of the lesion (slightly reduced).

in asylums for the insane and in whom the presence of tumour was unsuspected.

PREVIOUS METHODS OF OPERATING.

Meanwhile our knowledge of these meningiomas of the anterior fossa was increasing year by year so that they could be diagnosed correctly, and now and again one of them was exposed at operation, but at best only partially removed. Under ordinary circumstances every effort is made to enucleate a meningeal tumour intact even at the risk of causing greater

damage to the brain than would a piecemeal removal. But in dealing with one of these large subfrontal tumours, the likeli-



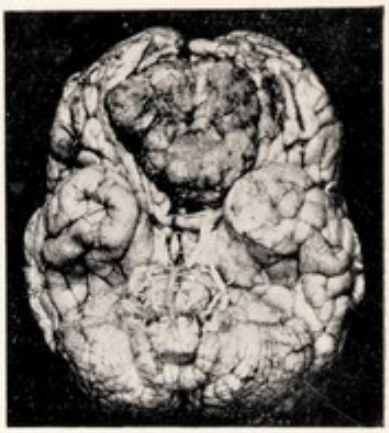


Fig. 10 Fig. 11 Fig. 12

Fig. 10.—I. W. Blackburn's first case, Government Hospital for the Insane, Washington, D.C. From *Intracranial Tumours among the Insane*, Washington, 1903. Case 842. 'Spindle-celled endothelial sarcoma.'

Fig. 11.—Weber and Papadaki's case: 'Altérations du Tissu Cérébral dues à la Présence de Tumeurs.' *Nouv. Icon. Salp.*, 1905, xviii. p. 146, pl. xxiv. The author called the lesion an 'angio-sarcoma.'

Fig. 12.—Case reported without illustration by Foster Kennedy; 'indurated endothelioma.' *Am. J. Med. Sc.*, 1911, cxlii. p. 355.

hood of further damage to the already impaired mental functions, through contusions of the frontal lobe, makes such a procedure one of questionable propriety.

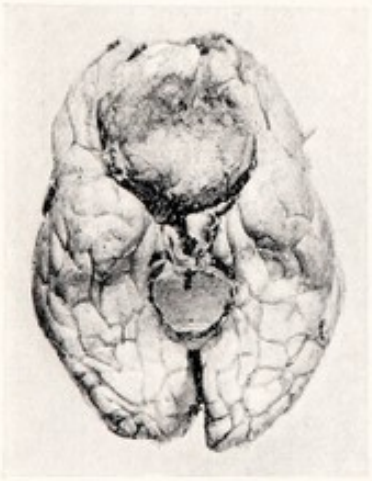


Fig. 13 Fig. 14 Fig. 15

Fig. 13.—M. A. Baehr's case; Central Indiana Hospital for the Insane. 'Endothelioma.' *Indiana M. J.*, 1920, xxiii. p. 366.

Fig. 14.—Moses Kerschner's case; Montefiore Home, New York; 'endothelioma.' Death followed lumbar puncture. *J. Am. M. Ass.*, June 17, 1916, lxvi. p. 1913.

Fig. 15.—Case reported by C. E. Royce as 'sarcoma' of the base of the skull. *J. Am. M. Ass.*, 1916, lxvi. p. 1288.

These meningiomas of the frontal base, as I have said, are apt to be firm, even psammomatous, in character; and finally

in a desperate attack on one of them, which happened to be largely unilateral in position, I had been forced into what, for me at least, was a new manoeuvre, whereby the firm and comparatively non-vascular lesion was gutted or cored, leaving its partly collapsed rind to be removed at a second session. Since it was this manoeuvre that suggested the adoption of electro-surgical methods for accomplishing the same end with less risk I shall report the case in full. The history, which among other things shows the importance for diagnosis of a chronologically exact sequence of symptoms, will serve as a contrast to the case history to follow.

CASE I.

Surg. No. 15922. **Unilateral olfactory-groove meningioma with the syndrome of homolateral optic atrophy, contralateral papilloedema, anosmia and mental deterioration. Partial first-stage excavation and complete second-stage removal of growth. Sacrifice of boneflap. Recovery.**

On *January 13, 1922*, Mrs. Samuel M., aged sixty-two, was referred to the Brigham Hospital on the advice of Dr. Charles H. May of New York, with the complaint of failing mentality and loss of vision.

Anamnesis. She had enjoyed excellent health until the mid-summer of *1920*, when a reduction in vision was first observed. By *January 1921* this had progressed to approximate blindness in the left eye. At this time the fundus in the affected eye showed little change, whereas in the other eye a low grade of papillœdema was present. A diagnosis of retrobulbar neutritis had originally been made, but as the papillœdema in the right eye progressed and the nerve-head in the left began to show evident pallor, doubts were felt. She was seen in consultation by many persons who made various suggestions such as aneurysm of the internal carotid, ethmoidal disease, frontal tumour, pituitary tumour. An extensive intranasal operation was finally performed without disclosing a trace of infection. This was followed by a prolonged series of X-ray treatments of the pituitary region. Meanwhile evidences of mental deterioration, shown by untidiness, loss of memory, euphoria and other dispositional changes began to appear.

Examination on admission. This was quite negative apart from the neurological findings. She was a well nourished and vigorous-appearing woman who admitted no discomforts. To be brief, she was found to have : (1) *complete anosmia* (which so far as could be told had been present before the intranasal operation) ; (2) *a primary atrophy of*

the left optic nerve with total blindness; (3) an atrophic *pallor of the right optic nerve, apparently secondary*, vision being reduced to 2/200 and visual fields impossible to take; (4) *mental symptoms* shown in slow cerebration, euphoria with inco-operation, loss of memory for recent events, occasional disorientation, and impairment of concentration; (5) *exceedingly inactive deep reflexes;* (6) slight *erosion of the wing of the left sphenoidal ridge* and *pressure enlargement of the sella* shown by the X-ray.

The presumptive diagnosis of an endothelioma arising from the left olfactory groove was made, and on *January 20, 1922*, under ether-anaesthesia a low left frontal osteoplastic flap was reflected, the extra-cerebral tissues proving to be highly vascular. An extremely tense dura was disclosed and an immediate subtemporal decompression was made. The exploratory brain-needle detected a large firm tumour occupying a large part of the frontal lobe. The boneflap was replaced for a second session.

Fig. 16.—Case 1. Fragments (nat. size), weighing 78 gms., pieced together after being excavated from the anterior pole of a large unilateral olfactory-groove meningioma.

On *January 28th* the flap was again reflected and the dura opened along the margin of the sagittal sinus. At the lower part of the field the anterior pole of the tumour was disclosed. The tumour was so nodular and irregular in shape that the brain could not be brushed away from it easily. What is more, the growth proved to be of such an unexpectedly large size that to remove it intact would have caused, through dislocation and contusion, irreparable damage to the enveloping nervous tissue. Consequently, the intra-capsular method of enucleation, long put in use in the surgical treatment of acoustic tumours, was called upon to get us out of our difficulties. Accordingly, with a sharp spoon, cup-shaped fragments were scooped out of the anterior pole of the tumour until a large cavity was produced. This was a

tedious procedure since it was necessary, after the removal of each fragment, to delay until bleeding from the raw surface could be checked. All told, an amount of tissue (Fig. 16) weighing 78 gm. was thus removed. The patient's blood-pressure by this time had begun to fall off and it was deemed wise to postpone the attempt to dislodge the remaining mass of the growth for a third session.

A sufficiently generous excavation of the tumour had been made to permit the firm encircling edges of the cavity to be collapsed and sewed together. The sutures were left long so that they could be tugged upon in the hope thereby of drawing the growth forward at the subsequent operation should she survive to have one. In withdrawing from the incompleted enucleation not only was it impossible because of the contusion and œdema of the frontal lobe to resuture the dura, but it was found that it would even be dangerous to replace the osteoplastic flap without risk of compression. Consequently the cranial portion of the flap had to be sacrificed and the scalp alone was closed over the raw surface of the brain, protected merely by an intervening layer of gutta-percha tissue. At the conclusion of the operation, owing to loss of blood, transfusion was necessary, and it was some hours before she was regarded as out of danger.

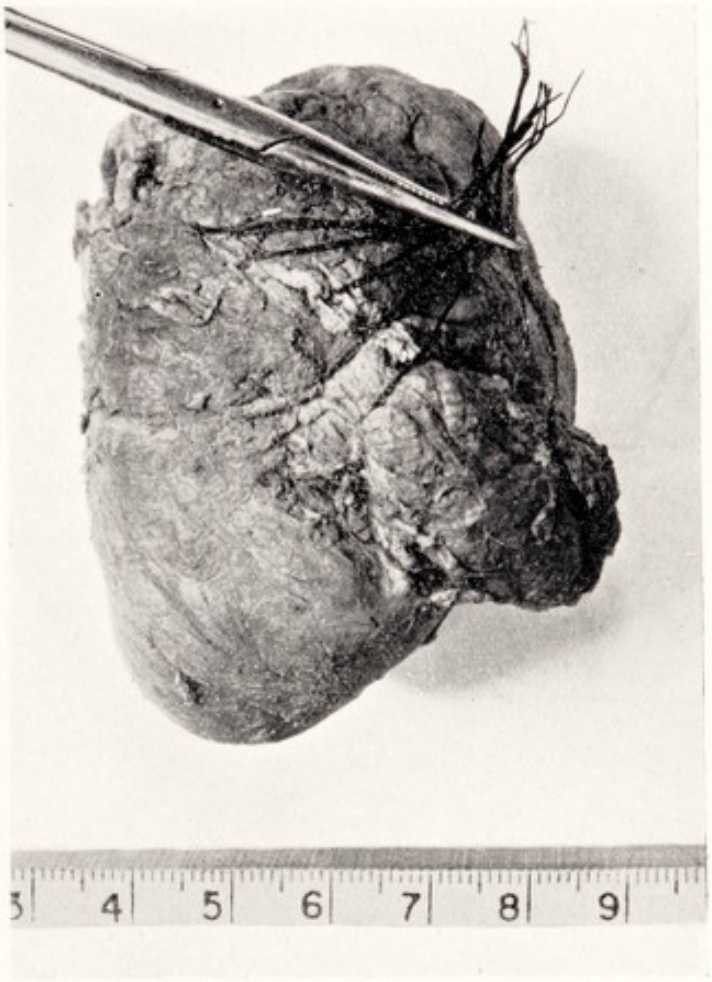


Fig. 17.—Case I. Anterior view (nat. size) of posterior portion, weighing 126 gms., of large unilateral olfactory-groove meningioma removed at second session. Sutures close the cleft from which the fragments (cf. Fig. 16) had been previously removed.

The convalescence was stormy. Owing to tension the wound barely held, and fearing that it might part and a fungus cerebri develop unless the remaining portion of the tumour was soon removed, we were forced into a final-stage operation on the ninth day.

Accordingly, on *February 6, 1922*, the flap was again reflected and the tumour exposed. By drawing upon the previously-placed sutures

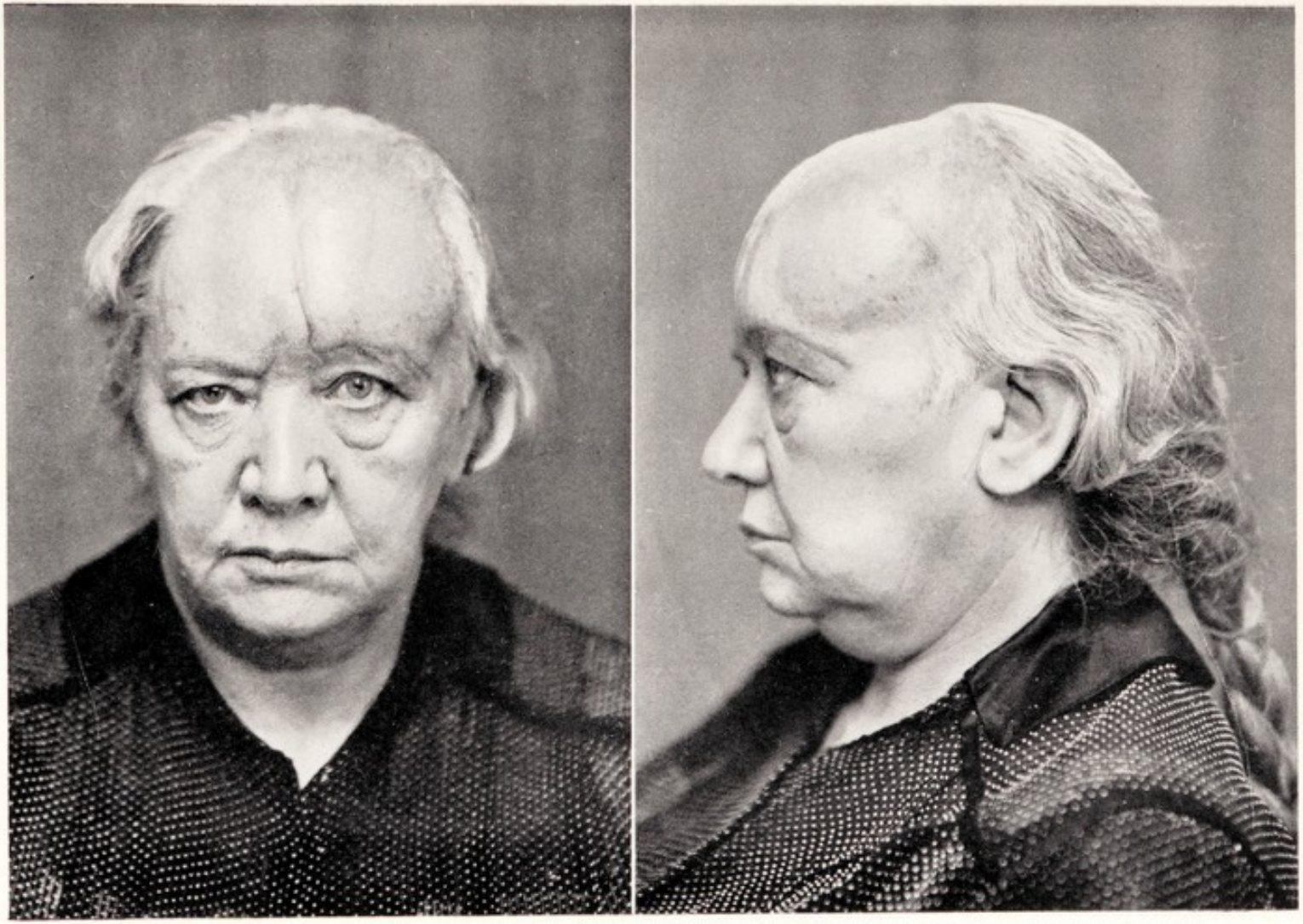
the remaining portion of the growth could be held while the nervous tissues were being brushed from its smooth surface; it was finally drawn forward and tilted out of the wound. (Figs. 17 and 18.) Some bleeding occurred from a definite point of attachment in the right olfactory groove, but this was promptly checked by the placement of raw muscle obtained from an operation on another patient. There was a considerable fall in pressure, but on the whole this final stage was better borne than either of the preceding ones. After as complete hæmostasis and as careful toilette of the wound as possible, the scalpwas replaced and the wound re-sutured as accurately as the unfavourable circumstances permitted.

FIG. 18.—Case I. Lateral view of posterior portion of tumour removed at second-stage operation. This is a smooth-surfaced meningioma of the more rapidly growing variety without psammomatous changes.

The convalescence was again stormy. Where the edges of the flap had become thinned by tension a cerebrospinal fluid-fistula developed, and it was six weeks before this had closed. Not until *April 2nd*, nearly three months after her admission, could the patient be safely discharged. It had been a long battle and, though symptomatically she was a transformed individual with normal mentality and a marked and most unexpected improvement in vision, she was left with an ugly frontal cicatrix which was ill-concealed by wearing her hair low on the forehead (Figs. 19 and 20).

The end-result has been excellent. Practically normal fields with reading-vision have been restored to the right eye, and ability to count fingers in the previously blind eye. At this present writing, five years later, she remains well and is leading, for her years, an active life.

Some idea of the total bulk of the 78-gram fragments removed at the



FIGS. 19 and 20. Case I. After third-stage operation, showing unsightly scar due to necessary sacrifice of boneflap and prolonged cerebrospinal leakage.

first session and of the 126-gram portion subsequently removed may be gained from the photograph (Fig. 21) of the tissues laid in position on the base of an adult skull.

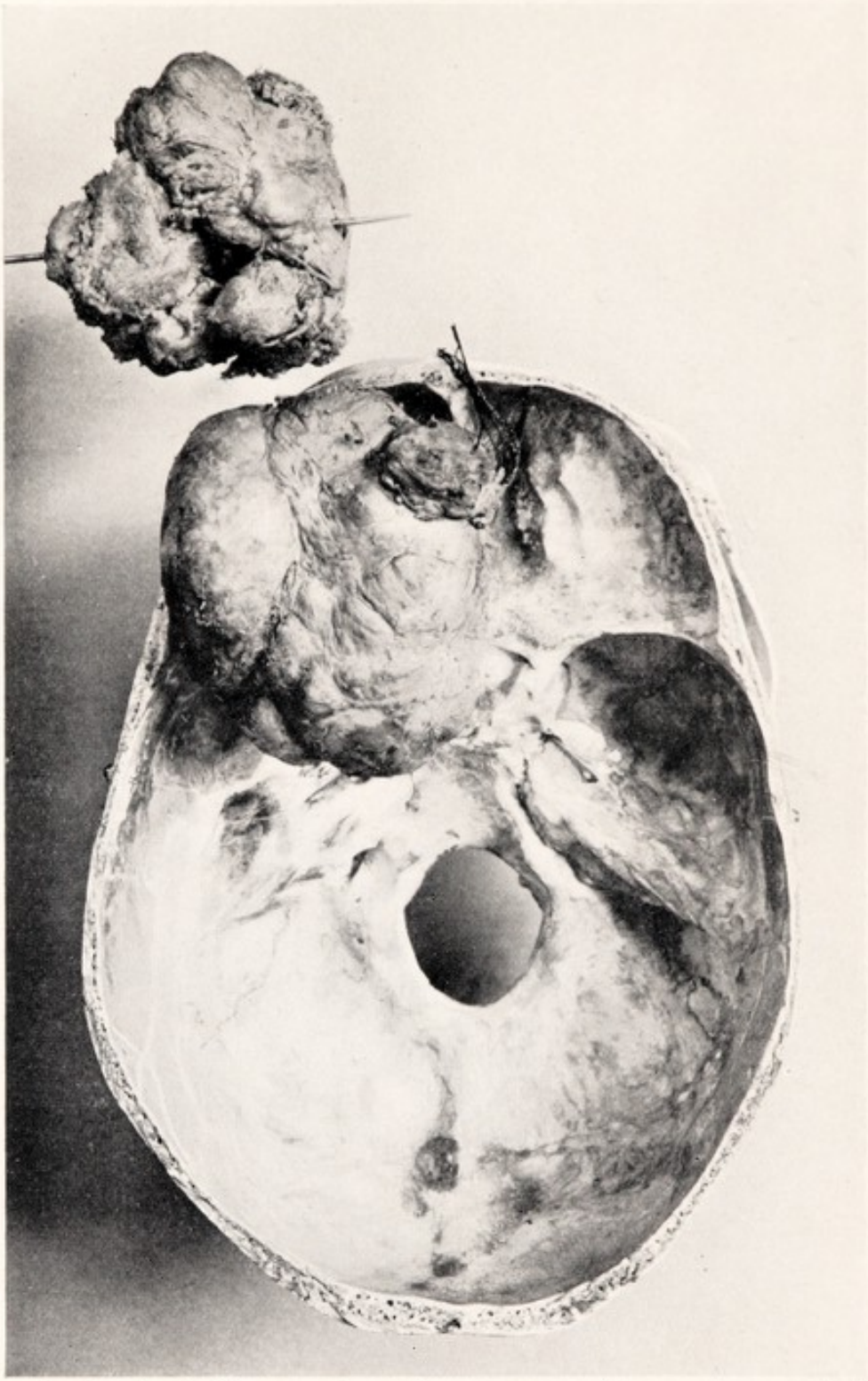


FIG. 21.—Case I. The two portions of the tumour removed in successive stages placed upon an adult skull to give some idea of the size and position occupied by the 204-gram lesion.

Here, then, was a woman of advancing years with a combination of symptoms which in all probability appeared

in the following chronological order: (1) a primary left anosmia (unobserved); (2) a homolateral failure of vision due to optic atrophy from direct pressure by the tumour on the left optic nerve; (3) complete anosmia (observed) due to further enlargement of the growth implicating the right olfactory bulb; (4) an increase in intracranial tension from the same cause with consequent papilloedema of the right optic nerve; and (5), also from the same cause, mental symptoms due to compression and deformation of the left frontal lobe.

To this particular syndrome attention was first called by Foster Kennedy in 1911 in an article with a somewhat misleading title,[1] in which a variety of lesions such as sub-frontal abscesses and tumours of various kinds had caused unilateral loss of the sense of smell with an ipsolateral optic atrophy due to direct pressure, and contralateral choked disc due to intracranial tension. In the first of his cases, which had been observed on the service of Sir William Gowers at the National Hospital, Queen Square, there was found at autopsy after a fatal operation a sub-frontal endothelioma which was said to have originated from the dura over the crista galli.[2]

The tumour in Dr. Kennedy's case, of which he has kindly given me a photograph (Fig. 12), proves to be a bilaterally symmetrical or fairly symmetrical meningioma, whereas in the case I have just described in such detail the lesion was largely unilateral. The bilaterally disposed lesions are apparently more common, and I know of only one good example in the literature of a large unilateral meningioma of the olfactory groove accompanied by satisfactory illustrations. This case was reported by Blackburn and Hough some years ago.[3] The patient was a coloured woman, thirty-six years of age, who died in the Government Hospital for the Insane.

[1] Kennedy, F.: 'Retrobulbar Neuritis as an Exact Diagnostic Sign of Certain Tumours and Abscesses in the Frontal Lobes,' *Am. J. M. Sc.*, 1911, cxlii. 355-368.

[2] Two other cases with a similar syndrome, operated upon by W. E. Dandy, have also been reported from an ophthalmological standpoint by Albert B. Siewers, 'Eye Signs in Intracranial Tumours of the Anterior Fossa,' *Arch. Neurol. and Psychiat.* [Chicago], 1921, vi. 424-428.

[3] Blackburn, I. W., and Hough, W. H.: 'Endothelial spindle-celled Sarcoma of the Dura Mater Penetrating the Brain.' *N. York M. J.*, 1906, lxxxiii. 689-694.

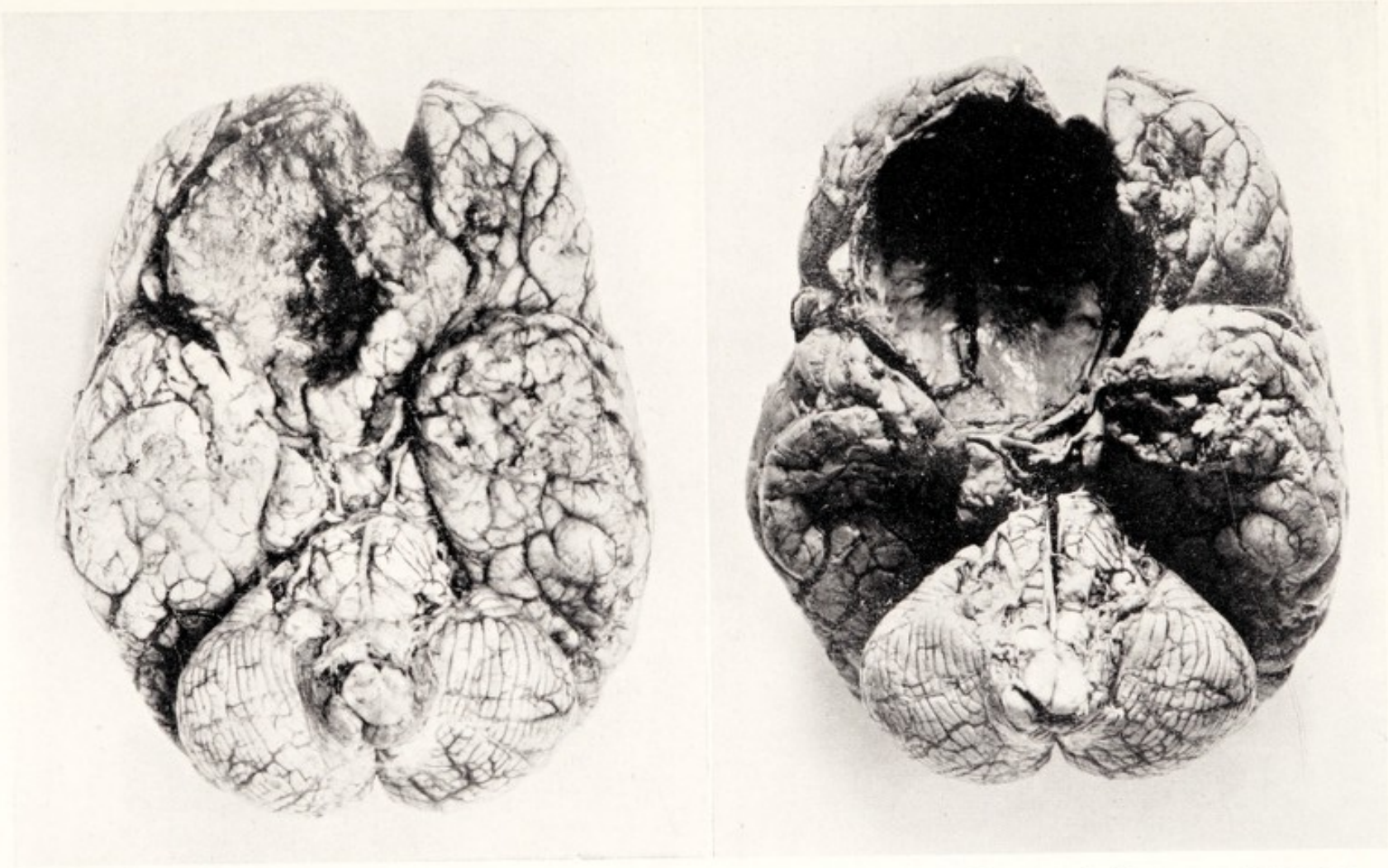
The brief clinical history states that she had been blind for some time, that she had been having epileptiform convulsions, and that there was marked mental impairment which reached an extreme degree of dementia before the end. Tumour was unsuspected. The illustrations show (Figs. 22 and 23) that the growth chiefly involved the right frontal lobe, though the left was markedly indented by it. The tumour, so far as I can judge, occupied precisely the same situation as that removed from the patient whose case is under discussion.

Since the weight of this tumour figured by Blackburn and Hough was only 140 grams, whereas the total weight of Mrs. M.'s tumour was 204 grams (cf. Figs. 22 and 21), some idea is thereby given of the magnitude of the undertaking. For the removal of this tumour three hazardous major operations were necessitated, with ultimate sacrifice of the boneflap, leaving an ugly scar. Seven hours, all told, were expended at the operating table, and untold hours at the complicated daily dressings during the tedious postoperative periods of cerebrospinal drainage, all of this necessitating an unduly prolonged hospital sojourn.

THE NEWER SURGICAL METHOD.

My reason for dwelling in such detail upon the operation in this case is for the purpose of contrasting it with a present-day operation upon one of the still more inaccessible, bilaterally-placed olfactory-groove meningiomas. As will be seen, the operation can be so simplified by the technical device to be described that it can be carried through at one session with preservation of the boneflap and an invisible scar. But the underlying principle remains the same, namely, the partial intracapsular excavation of the tumour in order that its walls may be collapsed and the large growth be brushed away from the enveloping brain and removed with minimal contusion of the nervous tissues.

The removal of a meningioma intact has ordinarily in the past, as already told, been the desired goal of operation. To accomplish this even when the growth is in a situation easily



FIGS. 22 and 23.—Case reported by Blackburn and Hough as an 'endothelial spindle-celled sarcoma of dura mater.' Tumour was not suspected. (*N. York M. J.* April 7, 1906, lxxxiii. p. 692). It is a largely unilateral lesion of the type of Case I. Fig. 22 shows the base of the brain before, and Fig. 23 after removal of the tumour from its bed.

approached may be a formidable undertaking because of the great vascularity of the adjacent tissues. It consequently is loss of blood that makes successive-stage operations more often necessary in the case of the meningiomas than of any other variety of brain tumours.

The great problem, then, is to control and to diminish the effects of bleeding so far as possible. Among the devices towards these ends may be mentioned the use of silver clips, of muscle implantation, of tissue-fixation *in situ*, and, if necessary, the coincidental or subsequent employment either of blood-transfusion, or of re-fusion with the patient's own blood which has been collected from the wound by a suction apparatus. Latterly, still another principle, that of electrical surgery, has come to be employed not only as a means of perfecting hæmostasis in intracranical operations in general but as a direct aid to the successful extirpation of certain brain tumours, it being particularly adaptable to the meningiomas.

Electrical currents of one form or another under the general term of diathermy have been utilized for therapeutic purposes in both medicine and surgery for nearly twenty years. The underlying principle concerns the generation of heat in the tissues when a current is passed through them because of the electrical resistance which they offer. I need not go into the history of the subject other than to recall the announcement in 1907 by Professor Pozzi of Paris that certain superficial and even some deep-seated malignant growths might be effectively destroyed by the action of sparks of high frequency and high tension given off from the terminal of Oudin's resonator. This original procedure, called fulguration, in which the tissues to be attacked were ' sparked ' from a distance, has in later years become so far developed and improved upon that local dehydration and coagulation of the living tissues can now be produced by currents brought into direct contact with them.

For these purposes alternating currents of exceedingly high frequency are employed. Whereas the ordinary alternating current supplied by the usual city power-plant changes its

direction of flow 120 times a second, in the usual electro-surgical apparatus the current oscillates several hundred-thousand times a second. Such a rapidly oscillating current has been shown to have no effect on the tissues other than of heating and cutting, the familiar physiological reactions produced by low-frequency alternating currents being absent. Since, by the employment of a small (' active ') electrode and a large (' indifferent ') electrode, all the cutting effects can be confined to the tissues in the immediate vicinity of the active electrode, it constitutes a surgical tool which bids fair to replace the scapel in certain fields of work.

Naturally enough, following Pozzi's lead, this new adjunct to surgery has for obvious reasons been chiefly restricted to the removal of malignant growths and has therefore remained largely in the hands of specialists who are called upon to treat malignant disease in inaccessible places. Those who have seriously employed these methods in the extirpation of carcinoma about the mouth and other body orifices have written enthusiastically on the subject. But meanwhile, owing to the variety of trade names which have been introduced, no little confusion has arisen as to the meaning of fulguration, diathermy, endothermy, and so on. No less has there been confusion in regard to the various forms of current that are employed, whether unipolar or bipolar, whether for cutting, dehydration or coagulation. For purposes of simplification, therefore, it would seem better for the time being to utilize the single term of electro-surgery for all these procedures.

The general surgeon, by long tradition wedded to the scalpel, will doubtless be slow in adopting this novel procedure. Only a small part of his work has to do with malignant disease, and I confess to have been somewhat sceptical about the adaptability of this new procedure to my own purposes after having made a few trials with the form of apparatus on the market in which the single tool was a needle to be used either to part the tissues by dehydration, or to char and coagulate them.

To my colleague, Professor W. T. Bovie, Director of the Biophysical Laboratories of the Cancer Commission of Harvard

University, I am wholly indebted for my renewed interest in the subject, and for what little I know of the physical principles involved. Dr. Bovie has interested himself in perfecting, for use in the Collis P. Huntington Memorial Hospital, an electro-surgical apparatus in which both the coagulating and cutting currents are combined in one machine, and, through the agency of a pistol-grip which he has devised, the current can be conveniently let on or off by the operator's finger pressing a trigger. In this machine the high frequency of oscillation has been increased from the usual five- or seven-hundred-thousand cycles a second used in diathermy, to a million-and-a-half cycles, so that the current is not only far more powerful than any which has been heretofore used, but by a modification of its character the degree to which the incised tissues are coagulated (dehydrated) may be controlled. The current, moreover, is so powerful that, for purposes of cutting and coagulating, a loop may be employed rather than, or at times in place of, the straight needle in common use.

A CASE IN CONTRAST.

When I first had the good fortune to see this loop being used bloodlessly to scoop out bits of tissue from a malignant tumour for purposes of biopsy, I foresaw that a new tool had been put into our hands to facilitate the piecemeal removal of at least some of the heretofore inaccessible intracranial tumours. With Dr. Bovie's co-operation, during the past few months I have gained sufficient familiarity with the instrument to realize that it holds out untold possibilities for the future of neuro-surgery. For the purposes of this address it will suffice to report a single experience with one of the hitherto inoperable bilaterally-placed olfactory-groove meningiomas such as occur in the preceding photographs (*e.g.* Fig. 8). When compared with the account just given of an operation for a far more accessible tumour of like kind which was removed without the aid of electro-surgery, the contrast between the old and the new method will be the more conspicuous.

CASE II.

Surg. No. 28026. **A patient with the syndrome of bilateral anosmia, optic atrophy and altered personality. A small area of calcification near the olfactory groove disclosed by stereoscopic roentgenograms.**

On *January 18, 1927,* John T., 45 years of age, a printer's assistant, was referred to the Peter Bent Brigham Hospital by Dr. William C. Muncy of Providence, R.I., with the complaint of loss of vision.

Antecedent history. Previously a man of good health, the father of a family of healthy children, the patient had first consulted Dr. Muncy on *March 23, 1926,* owing to recent obscuration of vision in his right eye. A primary atrophy was disclosed with symmetrically contracted field, the left eye being quite normal in all respects. Nothing was found to account for the condition. The Wassermann reaction was negative ; the paranasal sinuses were investigated and showed no signs of disease.

Dr. Muncy did not see him again till nine months later, when on *December 20, 1926,* he reported to say that when leaning over at his work the sight in the left eye had suddenly in like fashion become greatly blurred. Owing to poor co-operation and seriously impaired vision a dependable perimetric observation could not be made. Sphenoidal trouble was suspected, and he was given some intranasal treatments consisting of tamponing with argyrol, etc. Since this treatment was ineffective and some absorption of the sella was disclosed by the X-ray, a suspicion of pituitary disease was aroused, and he was referred, as stated, to the Brigham Hospital.

Physical examination on admission. This showed a well-nourished middle-aged man, whose statements regarding the course of his malady were most unreliable. He had an impaired memory for dates and incidents, coupled with a distinct euphoria and indifference to the seriousness of his plight. He was somewhat garrulous and grandiloquent, his manner suggesting an early stage of dementia paralytica. Except for an occasional slight morning headache he disclaimed any physical discomforts whatsoever.

Aside from these mental peculiarities the only positive clinical findings were : (1) *a complete loss of the sense of smell* which the patient ascribed to the nasal treatments he had recently received ; (2) a *bilateral optic atrophy* with blindness on the right, and vision on the left estimated at 20/200, dependable perimetry being impossible ; (3) a possible *right abducens paresis* causing a slight internal squint ; (4) the presence of a *minute area of calcification* shown, on stereoscopic

roentgenograms, to lie slightly to the left of the mid line and about a centimetre above the level of the roof of the orbit. (Fig. 24.) The sella turcica itself was of normal configuration though somewhat atrophic from pressure.

Comment. Here, then, was a healthy-appearing individual with obvious mental peculiarities, a complete loss of the sense

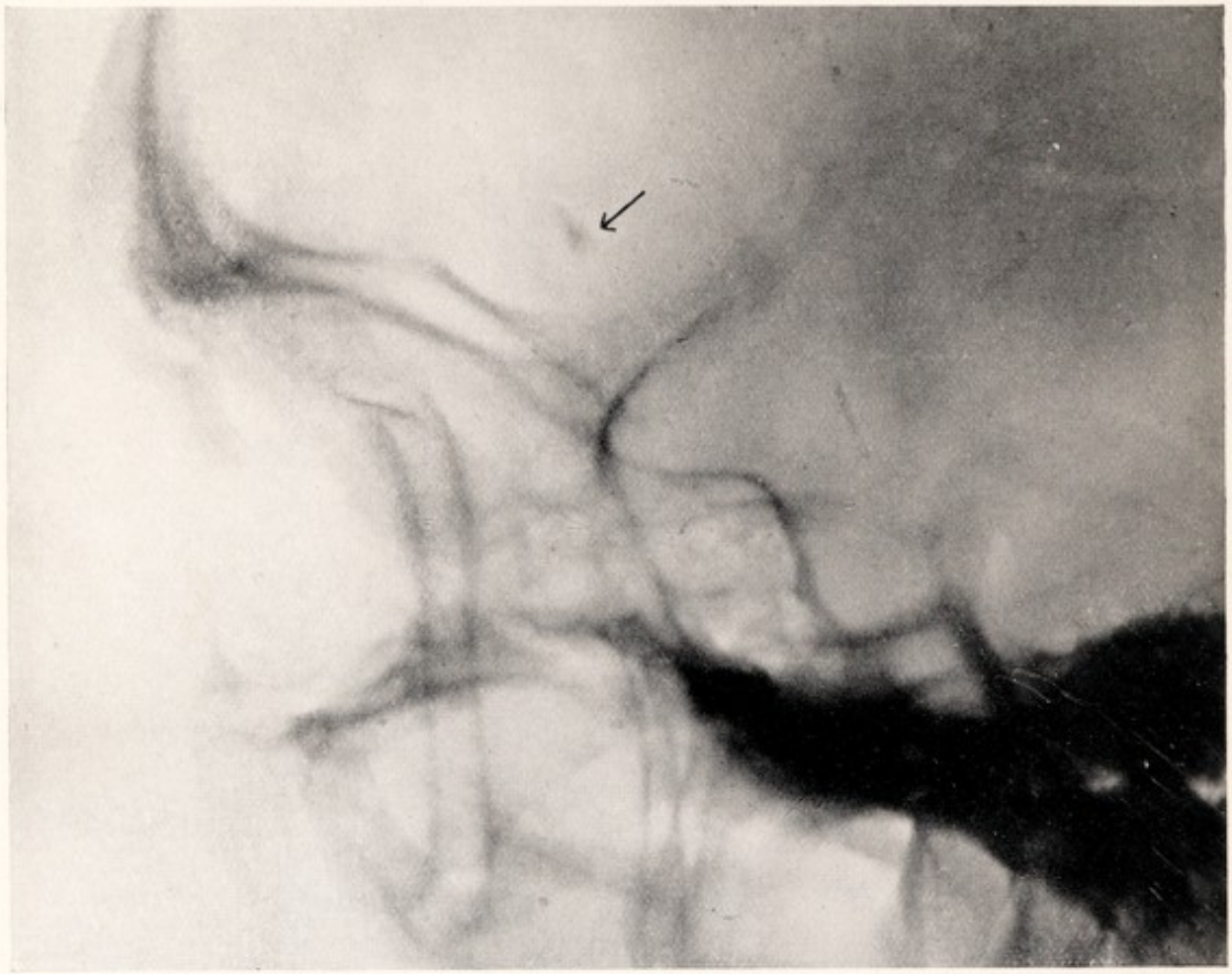


FIG. 24.—Case II. Pre-operative X-ray showing the telltale minute area of calcification (arrow) which stereoscopically lay directly above the left olfactory groove. Note the downward displacement of the posterior clinoid processes of the slightly enlarged sella. (Nat. size.)

of smell, an optic atrophy with practical blindness and a minute patch of calcification just above the left olfactory groove, whereas his primary complaint had been the loss of vision on the right. The importance in a case of this kind, of a precise clinical history with the symptoms in their exact chronological order, cannot be over-emphasized. If we may presume to reconstruct the history in the light of the operative findings, he had had for months or years, unobserved, a relative anosmia primarily affecting the right side. This had

been followed in course of time by a right-sided primary optic atrophy due to direct pressure on the optic nerve near the foramen. The lesion had finally enlarged sufficiently to produce complete bilateral anosmia, to affect the other optic nerve by an increase of intracranial pressure, and to cause indefinite frontal-lobe symptoms.

In retrospect the diagnosis is easy enough. In reality it was far from being so. It was extremely difficult in the first place to tell whether the optic atrophy was actually primary or, in view of the haziness of the disc outlines, whether it represented a slowly advancing atrophy due to a low grade of papilloedema. What is more, the symptoms had originally appeared on the right side and yet the small shadow detected by the X-ray, suggesting calcification in a tumour and presumably therefore in its oldest portion or stalk, lay to the left of the median line.

Curiously enough, in accordance with the surgical tradition that unusual cases appear in pairs, there entered the hospital two days after John T.'s admission another patient, a woman who ultimately proved to have an exactly similar and symmetrically placed olfactory-groove meningioma. In her case the condition was less advanced, and yet it was known that she had unaccountably lost her sense of smell at least five years previously. She too was found to have a minute patch of calcification which lay just above the olfactory groove on one side of the mid line, but in her case there was unmistakably a low grade of papilloedema which had not advanced to atrophy and had not as yet affected vision.

The fact that surgical intervention in these two patients was postponed for nearly three weeks after their hospital admission shows how uncertain we were as to the propriety of undertaking a procedure, desperate at best and which if unsuccessful would certainly have made their status much worse than before. It was even difficult to tell from which side the lesion should be approached, for though in the case of John T. the symptoms suggested that the growth was primarily right-sided, yet the patch of calcification, as stated, lay to the left of the mid line.

A tumour of the sort which was visualized in these two patients, however it might be approached, offered by ordinary methods of procedure a surgically hopeless problem. However, on the bare possibility that the anterior pole of the lesion could be brought into view sufficiently well to be attacked with the electric loop, and in the hope that it would prove to be not only a meningioma, but one of sufficiently firm consistency for its shell to be finally withdrawn after excavating its central portion, I screwed up my courage to operate upon the first of these patients.

February 10, 1927. **Operation. Piecemeal total removal, aided by electro-surgical methods, of 60-gram, more or less symmetrically placed meningioma, though evidently arising from the right olfactory groove. Seven-hour operation. Transfusion. Recovery.**

Under novocain-anaesthesia the usual low frontal osteoplastic flap was reflected without incident, disclosing a tense dura. On elevating this from the roof of the orbit and carrying the separation down part way to the sphenoidal ridge the lower anterior margin of a dense tumour could be palpated. What is more, the posterior part of the orbital roof and the adjacent sphenoidal ridge were found to be defective owing to the pressure absorption. Because of the discomforts occasioned by elevation of the tense frontal dura to this depth it was necessary to administer ether-anaesthesia.

An incision was finally made through the tense dura well down under the frontal lobe, and the margin of a meningioma was disclosed. I had but a faint conception at this stage of the procedure of what a task we had before us, but with a dehydrating current I first made a cross-cut in the exposed margin of the tumour and then began to scoop out loopfuls of tissue from the body of the growth.

To make a long story short, it was finally possible so far to excavate the chief mass of the tumour lying to the left of the falx that the outer shell of the growth could be drawn forward and freed from its dense zone of attachment along the deepened and widened olfactory groove overlying the ethmoidal plate. Only in this area was any troublesome bleeding encountered, and it was easily controlled by using a dessicating current which charred the dura and, at the same time, it is to be hoped, destroyed any remaining nests of tumour cells which remained adherent to it.

In drawing forward the large posterior portion of the growth it peeled away from the cerebral tissues, leaving clearly exposed the elongated and flattened right optic nerve and the adjacent portion of

the chiasm as well as the cup-shaped depression in the dura overlying the sella, showing that there were no attachments of the lesion in this situation. The left optic nerve was not seen.

By the removal of this chief mass of the growth from the right side, fortunately with but a minimum of contusion to the frontal lobe, a

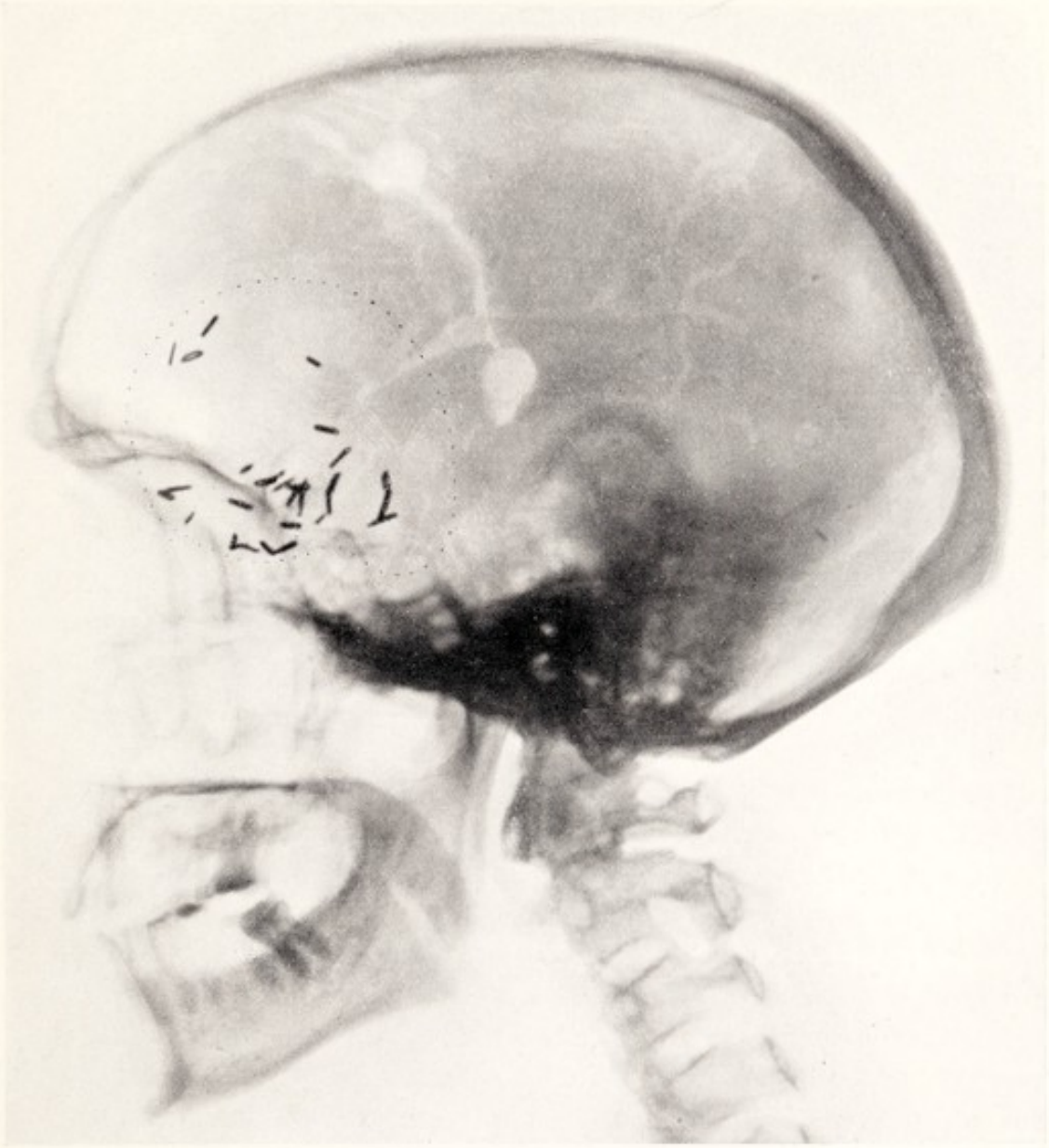


FIG. 25.—Case II. Post-operative X-ray in which the approximate size of the tumour (dotted line) is indicated by situation of silver clips placed on vascular attachments and bleeding points in the cortical nest from which it was dislodged.

large cavity was left, which made comparatively easy the subsequent manipulations necessary for the removal of that portion of the tumour lying to the left of the mid line. This completely blocked the crescentic opening under the falx and hid from view the mesial surface of the left frontal lobe. In order to dislodge this remaining portion it was necessary transversely to incise the falx at the upper part of the field and

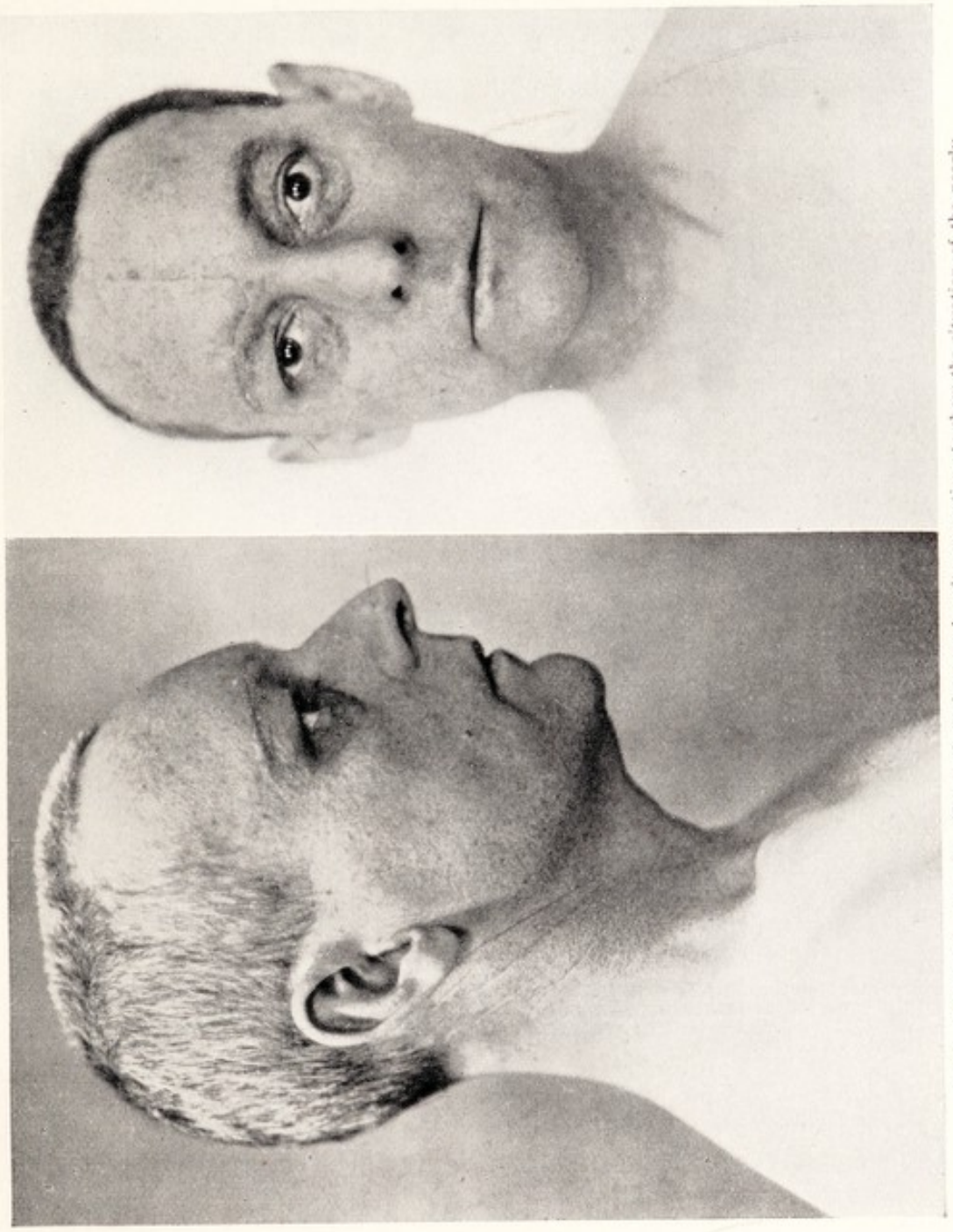
also to detach it from the crista galli which was removed. It was then possible to tilt out this last remaining portion of the tumour intact (cf. Fig. 28), leaving a concave pocket in the hemisphere.

After painstaking hæmostasis by aid of the coagulating current and by the placement of silver clips (cf. Fig. 25) on a few points which tended to bleed, the huge cavity was filled with Ringer's solution, the boneflap was replaced and the scalp was closed in the usual layers without drainage.

Second comment. As can be appreciated, this was not a procedure to be done hurriedly, nor could it possibly have been carried through in a single session by any other method I can conceive of. Indeed, it could not have been done in the multiple sessions resorted to in the case previously described. As matters stood, from the time when the scalp was novocainized to the final closure and dressing, seven hours were consumed. The patient's condition had remained excellent in spite of the extensive manipulations and some loss of blood till after the removal of the anaesthetic during the last hour, when the pressures began to fall and the pulse to rise. Consequently, while the wound was being closed he was given a transfusion of 500 cc. of blood from a donor, with immediate improvement in his condition.

Postoperative notes. The convalescence was without incident. He was sitting up on the fourth day. The wound healed with a nigh invisible scar (Figs. 26 and 27). Almost immediately after the operation he was conscious of better vision in the left eye, and this progressively improved so that by the time of his discharge a fairly dependable field could be plotted. In spite of a persisting central scotoma he regained sufficient sight to permit him to recognize people and easily to get about alone. There also was an almost immediate postoperative improvement in his somewhat obscure mental symptoms.

Pathological note. The tumour fragments which were removed, weighed, all told, 60·5 grams, and taking into account the dessication produced by the coagulating and dehydrating currents, we may estimate that the growth may have been about an 80-gram meningioma. In the accompanying photograph (Fig. 28), the chief mass to the left represents the final fragment removed from under the falx out of its cup in the left hemisphere. Its surface shows the finely nodular, often mulberry-like, character of the surface of most of these basilar



FIGS. 26 and 27.—Case II. The patient three weeks after operation, to show the situation of the nearly invisible frontal scar.

meningiomas. The assembled bits of tissue to the right represent the more or less charred fragments scooped out by the electric loop, some of which are characteristically coiled and worm-like.

To the surgeons who may be accustomed to speed up their operations this may appear to have been an unnecessarily prolonged and formidable procedure. All said and done, it is

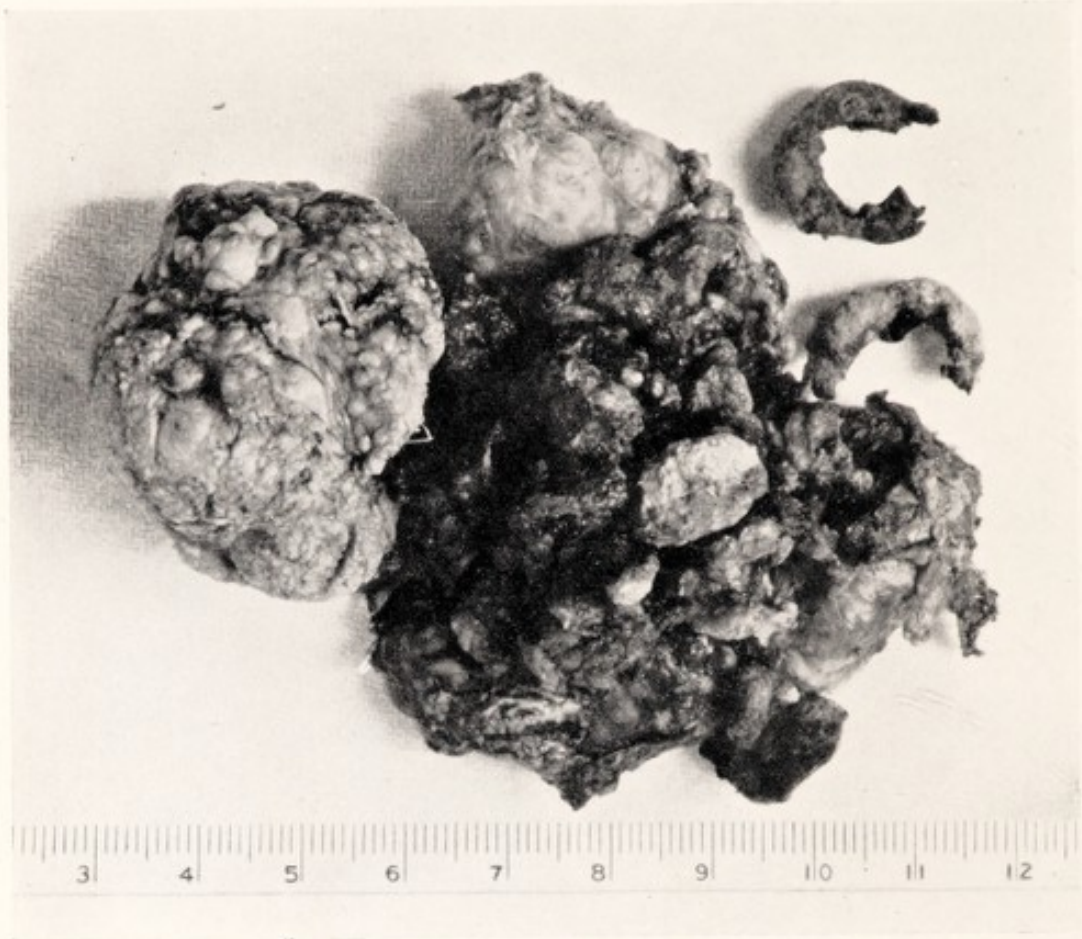


Fig. 28.—Case II. To show (on the right) the mound of tissue-fragments excavated from the centre of the tumour, together with the main mural mass subsequently dislodged. The large intact nodule (on the left) represents the mass which lay to the left of the mid line. (Nat. size.) Weight 60·5 grams.

the final result that counts, and having been brought up to believe that convalescence is shortened by attention to the technical details while the patient is on the operating-table, I have no dread of a long session. However, though an operation so difficult as this will always be time-consuming, experience may serve to shorten it. In the other patient I have mentioned as having entered the hospital coincidentally, the procedure was easier and the operation was completed in five hours without the necessity of a transfusion. The growth

proved to be smaller and the fragments of charred tissue weighed only 35·5 grams. However, in still a third case, a much larger olfactory-groove meningioma has more recently been successfully attacked by the same methods, and full nine hours were expended, an exhausting business for the surgeon and his staff, no less than for the patient.

But the point to be emphasized is that these operations were all carried through at a single session with preservation of the boneflap instead of in multiple sessions as in the case done by the old methods reported for the purpose of contrast. Enough has been said to indicate that we now have at our command a device which makes it possible to extirpate tumours hitherto so inaccessible that their attempted removal would have been regarded as foolhardy in the extreme.

There is unquestionably much for us to learn about the various currents suitable for dehydration, coagulation and incision when dealing with intracranial tumours other than the meningiomas. A discussion of the subject, in these its broader aspects, would lead me from the main purpose of this address, which is to describe that special type of meningioma which arises from the olfactory groove. For these tumours are, to-day, not only capable of clinical recognition owing to their peculiar syndrome, but are capable of removal in a single session by this novel method of electro-surgical excavation.

Surgery, from the days when Peter Lowe very probably thought the art had reached its highest development, to the time of Macewen, has progressed so rapidly that one generation would hardly recognize in the work done by the next anything more than traces of its own methods. Where do our chief obligations, as surgeons, lie ? Without Humphry Davy and the discovery of the principle of inhalation anaesthesia, without Helmholtz and the ophthalmoscope, without Roentgen and the X-ray, without Faraday and the alternating current, without Pasteur and studies of fermentation, without Kelvin and thermodynamics, without a host of others and their discoveries, such a procedure as I have described would, in

the yesterday of surgery, hardly have been dreamed of ; and who can possibly foretell what the morrow may bring forth through the application of disclosures in science which may transform over night this art of ours in ways unanticipated.

The surgeon is not likely to be one to make the underlying contribution, but his practical mind leads him to experiment with it and put it to use, and the result may be revolutionizing. Such was the outcome of Lister's labours while connected with this University ; and Macewen who succeeded him found surgery so broadened in scope because of its greater safety that specialization has come to signalize our guild, he himself being properly regarded as one of the forerunners of the newest of special fields, that relating to the surgery of the nervous system.

In this field of neuro-surgery a technique utterly different from that which is usually employed by the general surgeon is essential for success, and one promising addition to this technique which is unquestionably capable of enormous development I have ventured to describe at this time. And it gives me special satisfaction to realize how delighted those masters of technique, Theodore Kocher and W. S. Halsted, who laid such stress on the importance of painstaking haemostasis in surgical work, would have been to have seen some of this new surgery, which is as bloodless compared to the surgical methods they perfected as theirs was bloodless compared to that of their contemporaries and predecessors.

Electro-surgery at least permits us to-day to remove certain brain tumours from situations and under circumstances which a year ago—indeed six months ago—I would not have thought possible. In illustration of this I have described a single operation, upon one patient, and have contrasted it with the trials and tribulations of a series of operations conducted only three years ago on another patient for a similar lesion. The electro-physical principles involved are highly technical and are hardly as yet in more than an experimental stage. It will take a combination of physicist and surgeon and electrical technician working together to perfect the apparatus and to develop its future possibilities for surgery in general.

Could such a triumvirate, for example, as Kelvin, whose undergraduate publication, you may recall, was on *The Uniform Motion of Heat in Homogeneous Solid Bodies, and its Connection with the Mathematical Theory of Electricity*— could a Kelvin, I say, in combination with a Macewen and a re-born James Watt as their technical assistant, be resurrected to put their fertile minds and dextrous hands to the problems involved, a second revolution in surgical technique, no less startling and significant than that we owe to Lister, might well enough take place.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