REMARKS ON THE CLOSURE OF GAPS IN THE SKULL, WITH NOTES OF CASES.

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It sometimes happens that after an operation at which the skull is opened, for one reason or another, a gap is left in the bone.

At the present day most surgeons in opening the skull, if they do not employ Wagner's osteoplastic flap method, probably follow the principle, long ago advocated by Sir William Macewen, of preserving the bone removed, so that, at the completion of the operation, it may be replaced in the opening from which it came. This ought always to be the practice wherever it is feasible; even where the surface of the bone is much ingrained by dirt the internal table can be split off from the external, and replaced often without sepsis occurring, and in cases where the dura mater and brain have receded from the interior of the skull owing to compression, so that the bone, if laid directly upon the dura, would be far below the level of the cranium, it may still be possible to obtain a satisfactory bony closure of the defect by suturing the fragments of bone to the under surface of the scalp, and so hold them in position until the brain expands again to meet them.

But the bone cannot in every case be replaced; be it that the intracranial structures—brain or vessels—are so badly lacerated or diseased that it is essential that an opening shall exist in the skull; or, perhaps, a portion of the skull has to be removed with a neoplasm growing from it: or, again, reimplanted bone necroses and comes away; in any case, it will sometimes happen that a gap remains in the wall of the skull.

It has sometimes occurred in such cases that new bone has been reproduced by the dura mater and the gap completely filled in in consequence, and probably this is more likely to occur in young patients. Goetz¹ has recorded a case where a defect in the skull, measuring 8.5×5.5 cm., was completely covered in by bone regenerated in this way, but it is rare for this to happen. In many cases the bone-reproducing powers of the dura are destroyed, and in others the dura has been removed from the area exposed, so that there is no chance of bone being developed, therefore attempts have been made to close the skull opening by various methods; and it is desirable that this should be done, more particularly in cases where there has been injury to the dura and brain beneath—in all cases, in fact, where it is possible for adhesions to form between the brain, or dura, and the scalp—on account of the liability of such conditions to lead to secondary nervous lesions.

METHODS.

The more important of the methods which have been adopted are as follows:

1. The implantation of decalcified bone, as suggested and employed by Senn.
2. The use of calcined bone (Barth).
3. The use of bone which has been sterilized by boiling (Westermann).
4. The implantation of bone removed from another site in the same patient—for example, the surface of the tibia (Seydel).
5. The implantation of bone from another species of animal.
6. The implantation of metal plates—for example, aluminium (Booth).
7. The use of celluloid plates (Fraenkel).
8. With the object of preventing adhesions forming between the dura, or brain, and the margin of the opening in the bone, gold leaf has been employed by Beach; indiarubber tissue by Abbe and egg membrane by Freeman.
9. The osteoplastic method of König and Müller which consists in making a skin and bone flap (the latter being a thin layer of bone, cut with a chisel) from the skull in the neighbourhood of the existing gap and turning this flap over to cover the defect. For this purpose it is necessary that the bone from which the flap is cut should be of a fair thickness and even then, in the process of cutting the flap, it is certain, from the shape of the skull, to be broken into fragments, any or all of which may necrose and so defeat the object of the operation.

It is said that in the course of time the under-surface of the

bone-flap in this method becomes smoothed off and that adhesions do not form, at any rate between the under-surface of the cut bone and the dura mater; but where there is a defect in or laceration of the dura as well it is very probable that adhesions would form between the brain and the under-surface of the transposed flap.

This method of König² and Müller³ is probably only suitable in cases where the gap to be covered in is situated under the hairy scalp. It is hardly applicable to the frontal region, as there it would either entail an excessive scarring or necessitate a flap the skin over which was growing hair.

My personal experience of this class of case has been derived from the treatment of six patients in whom I attempted to fill the existing gaps in the skull with celluloid plates. In the first patient whom I had to treat the frontal region was the one concerned, and for cosmetic reasons I avoided the König-Müller method. The result of the implantation of the celluloid plate was so satisfactory that I continued the method in the succeeding cases, although my predilection had formerly been rather towards the König-Müller operation.

Case 1. Tumour (Gumma?) of Frontal Bone: Excised and Gap Filled by Implantation of a Celluloid Plate.

Mrs. C., aged 29, admitted to the Glasgow Royal Infirmary, October 16th, 1897, on account of intense pain associated with a tumour of left frontal bone. Married eleven years, six full-time labours, the last four months ago; no miscarriages;

Case No. 1.

children all alive and well, save one, who died, aged 1 year, of some intestinal condition. Her health has always been good. Five months ago she received a blow over the site now occupied by the tumour. Six weeks ago she began to experience a sensation as if "something were growing" from the frontal bone, and "often asked her husband if he could see anything" there. The swelling became obvious three weeks ago, but for the last six weeks at least there has been more or less constant pain with acute exacerbations at times. The patient had been under the care of Drs. Craig and Glen, who sent her to me. They had seen the tumour develop, and had considered the question of syphilis, and, although no signs of this disease were present and no history of it to be obtained, had treated the patient with large doses of iodide of potash; the tumour, however, enlarged steadily, and the pain was not in any way relieved—became worse, in fact—and the idea of sarcoma came to be entertained rather.

A spare woman, with a small projection from about the centre of the frontal bone at the level of the frontal eminences, the skin still slightly movable over it. The swelling is elastic, and the pressure on it causes pain. Measured over its convexity, the swelling is 2.5 cm. both vertically and transversely. No history pointing to disease of the frontal sinuses.

The patient came into hospital for the purpose of having the tumour removed, as latterly the pain had been intolerable, so on October 19th it—along with a portion of healthy bone around—was removed. It had perforated both layers of the bone, and a deep red vascular tissue projected from each surface; the dura mater beneath was unduly vascular, and looked as if it might have been adherent, and a piece of it rather larger than the tumour was therefore removed also.

On October 23rd a celluloid plate measuring 5.5 cm. ($2\frac{1}{4}$ in.) by 4.5 cm. ($1\frac{3}{4}$ in.) was fitted to the gap in the bone, after being moulded as well as possible to correspond with the natural curve of the frontal bone. The wound healed aseptically. Her pain ceased immediately after operation. The tumour was unfortunately mislaid, and so never was examined histologically, but several months later she developed some skin lesions which were certainly syphilitic.

She was last seen in October, 1905, the celluloid plate fits almost as accurately as at first, but in consequence of a blow

received over it three years after it was placed in position it is flatter than it was (see figure from photograph taken just after this); had it not been there this blow might easily have injured the underlying brain.

Case 2. Compound Fracture of the Skull.

W. H., miner, admitted August 21st, 1899, with extensive compound depressed fracture of left temporal bone, the result of the explosion of a dynamite cartridge. The wound was thoroughly ingrained with dirt of all kinds, the dura lacerated and ingruined, and the brain beneath showed a large lacerated wound from which, at a distance of $1\frac{1}{2}$ in. from the surface, I removed a fragment of stone the size of an ordinary bean, after which a free gush of cerebro-spinal fluid came away, and it was my impression that the left lateral ventricle had been opened. For four days after this he was unable to express his wishes or to name simple objects shown to him.

For ten days following his admission there was a very free flow of cerebro-spinal fluid from the wound. After this time it ceased and the wound slowly healed. He went out with the brain obviously adherent to the scar in the scalp.

He was readmitted February, 1900, and on March 9th, an omega-shaped flap of the scalp was dissected down from off the brain and a celluloid plate fitted and the flap sutured back into position. Large quantities of cerebro-spinal fluid began to come away from the posterior angle of the wound, requiring constant dressing, and did not cease until May 22nd, after which it remained dry and the sinus quickly closed. He went home, June 4th, very well in every way, and remained well until the middle of August, 1900, when the wound broke down and he returned a day or two later with the wound septic. The plate was accordingly removed and the wound healed again quickly, of course with adhesion of brain and scalp. Further operation has been declined.

The length of time during which cerebro-spinal fluid came away (70 days) is remarkable: it came from a minute opening at the posterior margin of the flap and remained clear all the time. The amount discharged was very great and was a source of great inconvenience from the continual change of dressing which it necessitated.

Case 3. Fracture of Skull; Rupture of Middle Meningeal Artery.

A. F., aged 28, admitted December 14th, 1900, with symptoms pointing to a haemorrhage from meningeal artery after a fall. He was trephined over the anterior branch of right artery at once and a large extradural blood clot removed. The clot was so extensive that a second opening had to be made over the posterior part of the parietal bone to evacuate it completely; the trunk of the meningeal artery was torn at its foramen, and as packing the cavity did not completely arrest the haemorrhage, on December 16th the right external carotid was tied. On December 20th a celluloid plate was placed in each of the openings in the skull and the wounds sutured. The following day some puriform discharge began to come from the right nostril, and on dressing the wounds on December 24th pus was found at the lower angle of the anterior wound, so the plate there was removed. The posterior wound was quite normal. The anterior wound was lightly packed and healed well, and the posterior wound gave no trouble at all, the plate there healing in firmly. He has not been seen since July, 1902. At that time he was well, and declined to have any further operation on the anterior wound, where there is a large defect, no bone having been produced by the dura.

Case 4. Epilepsy following on a Head Injury.

W. P., aged 14. Admitted March 4th, 1902. The patient had been struck on the right frontal bone by a stone nine years ago, and two weeks later had his first fit. He was trephined elsewhere over the site of the injury, and a piece of the bone removed, but since then the fits have been very frequent. There is a scar 2.5 cm. above the right eyebrow, and at this point there is a defect in the bone, and the brain is obviously adherent to the skin here.

On April 18th the skin was dissected back from the brain, and three days later a celluloid disc 4 cm. by 4.5 cm. fitted in the gap. Wound healed aseptically. The epilepsy has not been affected in any way by this freeing of the brain.

He was seen in October, 1905. The plate remains firmly fixed in the gap, and lies flush with the outer surface of the adjacent bone, and it is not easy to detect where one ends and the other begins.

Case 5. Compound Depressed Fracture of Right Parietal and Squamous Bones with Wound of Dura and Brain.

W. M., admitted May 5th, 1902, with an extensive compound depressed fracture just above the right auricle, the result of a machinery accident. The wound was very dirty and the bone comminuted, the dura mater much torn, and there was an extensive laceration of the brain beneath. The fragments of bone were removed, and on May 13th a celluloid plate 9.5 by 5 cm. fitted into the gap which had been left. Uninterrupted healing. He was seen October 2nd, 1905, well in every way, the plate lying close in the gap and its margins scarcely to be made out.

Case 6. Fracture of Skull. Haemorrhage from Middle Meningeal Artery.

J. C., aged 26 years, admitted June 6th, 1903. Fell 15 ft. on to his head. A large extradural blood clot was removed from left side of skull; the actual wound of the meningeal artery was not found. Arterial blood welled up continuously from the base of skull, and the cavity was packed. This oozing continued whenever packing was removed, for five days, and then ceased. On June 15th celluloid plate fitted in and scalp sutured, but the wound had become infected, and plate had to be removed on the 23rd. After this recovery was uninterrupted. He declines further operative treatment. No bone has been produced by the dura mater.

Cases 1 and 5 were brought before the Glasgow Medico-Chirurgical Society on March 17th, 1905.

The result of these cases is that of the 6 patients so treated 3 were successful and 2 failed, the plate requiring to be removed owing to sepsis; while in the case of the remaining patient who had two plates 1 healed in well and the other had to be removed, the sepsis in this case having extended from the nasal cavity. This patient has been lost sight of, but of the other 3 in whom the plate healed in, 1 patient has, up to the time of writing, worn the plate for eight years, and the other 2 have worn theirs for more than three and a half years.

In 4 of the patients there was an extensive wound of the dura mater, and for reasons already indicated I am inclined to look upon this as probably being a contra-indication to the employment of the König-Müller method.

Whether one reimplants bone at the time of the primary operation or employs as a secondary means of closing a gap the König-Müller flap or a plate, asepsis is essential for success; and it is to be remembered that, although reimplanted bone heals in aseptically, it does not follow that the fragments will unite with each other or with the surrounding bone; possibly this means that in these cases non-viable bone has been reimplanted. I see from time to time a patient whom I trephined in April, 1904, on account of a compound depressed fracture about the frontal eminence, and in whom the bone fragments were reimplanted; but they have not united, and though no trouble has arisen from them and they feel quite loose, they possibly are as much "foreign" bodies as a celluloid plate would have been, and certainly they do not afford as good protection to the brain as a plate would do.

It is, however, unusual in my experience for bone fragments to heal in without uniting and becoming firm. Out of 48 cases of immediate operation on account of injury I reimplanted the bone in 23, and in 20 of these it healed in, and became firm in all of them except the 1 case just referred to; in the other 3 patients the bone had to be removed owing to infection. In the remaining 25 cases the bone was not reimplanted for various reasons: of these, 20 died from the severity of their injury, of the other 5 who recovered 4 were treated by the insertion of a celluloid plate (Cases 2, 3, 5, and 6 described above).

Of the other procedures which have been recommended and employed, the use of gold leaf, indiarubber tissue, etc., can at the best only act as a preventive to the formation of adhesions, and even in this respect they are, according to Weer and Woolsey,⁴ not sufficiently resistant to the action of the tissues, but become disintegrated in the course of time so that adhesions ultimately form.

The transplantation of a piece of bone from the patient's tibia, for example, or from an animal, has not any special recommendation, and I think that the use of calcined bone, or decalcified bone or bone sterilized by boiling has decided disadvantages, and for this reason, that if we cannot employ living bone, the material selected as a substitute ought in the first place to be non-porous, so that it will not permit penetration of its substance by granulation tissue which might ultimately lead to its disintegration, and thereby possibly allow the dura or brain to form adhesions, which is precisely what we should endeavour to prevent.

Grekow,⁵ however, has urged the use of calcined bone because it is absorbable, believing that in the course of time the dura will develop new bone. But it is difficult to see why the dura would be more likely to develop the new bone after the absorption of implanted calcined bone than it would be without it; most surgeons seem to be of the opinion that because the dura so constantly fails to develop bone it is advisable to try some other method of filling the gap. The brittleness of calcined bone, and con-

sequent liability to be fractured, is possibly another objection to its use. It further appears to me that any substitute material employed in addition to being non-porous ought to be tough, resilient, smooth, non-absorbable and capable of being moulded, and celluloid possesses all these qualities. The material which I have made use of has been about $\frac{1}{16}$ in. in thickness; when warmed it can be moulded to some extent, not so perfectly as aluminium or silver perhaps, but its elasticity and resilience are much greater, and probably therefore it is capable of offering more satisfactory resistance to external violence, blows, etc.; in the case of Mrs. C. (Case 1), for instance, the plate certainly served a useful purpose in protecting her brain from injury from a blow which fell directly upon it.

REFERENCES.

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AURAL CASES IN GENERAL PRACTICE.*

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MR. PRESIDENT AND GENTLEMEN,—Let me try to repay your courtesy in asking me here, by submitting to you some general rules, which I seem to myself to have learned from a good lot of throat and ear work, and to have found useful. You must forgive me if I speak in a vague and haphazard way, and range over many subjects; but what I have to say mostly concerns the examination of these cases.

The examination of throat and ear cases comes under three headings: First, the history of the case; next, the physical signs of the case; next, the testing of the patient's hearing. These are our three methods of going into the case: The history, all that we are told; the physical signs, all that we see and touch; and the testing of the hearing, all that we can deduce.

The last of these three methods, I venture to say, is of very little importance. What, after all, is the value in practice of the ordinary testing of the hearing with a watch or a tuning-fork? A man may fail to hear the ticking of a watch, yet he may hear fairly well the voice of a friend; or he may hear a watch easily, yet may fail wholly to enjoy a concert or a play, or to catch and appreciate the general talk round the family table. Hearing is an intellectual process, active, not passive; we bring our will and our attention to bear on it, we contribute experience, and insight, and the power of guessing the missing word. All his life a man has been listening to voices and music, and the noises of the town and the harmonies of the country; and he may still catch, by force of habit or of will, these familiar sounds, even though his ears are dull to a sound so unfamiliar and unprofitable as the ticking of a watch. There is more in the act of hearing than a mere stimulation of the auditory nerve; there is habit and memory and will, and these faculties help us to apprehend and piece together those sounds which we want to hear; but nobody wants to hear a watch ticking, or has listened to watches ticking all his life.

Now take the ordinary tests with a tuning-fork, are they of much practical use? They always seem to me most vague in the very cases where we ought to find them most definite. It is claimed for them that they can distinguish affections of the middle ear from affections of the internal ear; and that is just where they so often fail, and no wonder, seeing how often these two structures are involved together in the same set of troubles. I confess that I have given up the tuning-fork, believing that it is worth next to nothing for diagnosis, and worth nothing for treatment; besides, it requires from the patient a higher power of observation than is common among out-patients.

We come now to a method of examination which is of far greater importance: I mean the careful study of the history of the case. Let the patient tell his own story his own way, full length, without prompting, just as it strikes him; and you will be sure to learn something. Next to abdominal cases, there are no cases where it pays

better to get a deliberate account of all that the patient has to tell. Take, as instances of the value of a full history of the case, the influence, in the production or perpetuation of aural troubles, of rheumatism, syphilis, drink, worry, over-work, and unhealthy occupation. Or take the gravity of the fact that there is, as the patient says, "deafness in the family." Or consider how many patients forget that they had earaches in childhood, which yet laid the foundation of their present deafness. Or, which is the best of all instances of the importance of the patient's own words, take what aural patients say of those subjective sounds which we call tinnitus. One patient will merely say that he has a sort of buzzing or humming in one ear. We may be able to cure that patient: he may have nothing worse than a plug of wax in his ear, or a slight catarrh blocking his Eustachian tube. Another will say that he hears a thumping sound, which goes in time with his pulse. We are less likely to cure him. Another will describe in vivid, exact, and picturesque words a complex, articulate, elaborate set of sounds: he will compare them to this or that sound in Nature; will dramatize and act what he hears. He will say, "I hear a lot of birds singing in the trees," or, "I hear a regular tune, just like music, and I could almost sing the tune"; or, "I hear church bells ringing in my head, some near and some far off, as if they were in different villages." We shall hardly cure that patient. Such a heterogeneous and fantastical tinnitus represents a perversion of the very centres of hearing and of understanding; it is inaccessible; it is almost of the nature of a hallucination, or of an epileptic aura; it has captured not only the perception of the patient but also his imagination; and we shall not easily dislodge it from that stronghold.

Next come the physical signs of the case, and all that we can learn from the evidence of our senses. In hospital practice I always advise students to try to see, in every case, everything—the membrana tympani of each ear, the front view of the inside of the nose, the back view of the inside of the nose, the mouth, the back of the throat, and the larynx. All this should be done as a matter of routine. The patient is not unwilling to be thus carefully studied; and it is the one and only way in which the student can learn this part of his work. For he learns how to distinguish real disease from mere defects or abnormalities of structure or of function, which do not amount to disease and do not require treatment; he learns not to mistake a turbinated bone for a polypus, or a group of papillae circumvallatae for a new growth, or the redness down the handle of the malleus, just after the ear has been syringed, for an acute inflammation of the middle ear. Moreover, by this methodical examination of everything in every case one makes, now and again, a discovery. For instance, a patient had complained only of earache, and had been treated only for that; but the cause of the earache was found, by more thorough examination, to be cancer of the tongue. Another patient had an incessant, hacking, noisy cough, and had been treated for his cough, and in vain; then, by more thorough examination, both ears were found plugged with wax, and the removal of the wax practically cured the cough; it was a reflex cough, such as we often provoke by putting a speculum into the ear. To look at every structure, in every case—tympanic membranes, anterior and posterior nares, mouth and pharynx, and vocal cords—that is the one way to learn throat and ear work, and to escape a good many errors of judgement.

And here let me submit to you a lesson which I seem to myself to have learned very late from my throat and ear cases. I say we should examine everything, including the mouth, and in the mouth I include the teeth. Not only for this reason, that a stump in the upper jaw may cause suppuration in the antrum, and the cutting of a back tooth may be attended by earache and even by inflammation of the middle ear, but for this reason, that caries of the teeth seems to me to have a great deal to do with setting up or keeping up an unhealthy condition of the upper air passages. Dr. William Hunter has taught us to recognize the remote effects of oral sepsis in chronic gastritis, and, finally, in pernicious anaemia; but it has also a less remote effect. Patients come to us with a history of repeated attacks of tonsillitis, or with weak throats and swollen uvulae, or with what we call rather vaguely post-nasal catarrh and chronic hyper-

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