TREATMENT OF ACQUIRED DEFECTS OF THE SKULL

BY

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If one may judge by the paucity of literature on the subject, the treatment of defects in the vault of the skull does not seem to have been of interest to British surgeons. A search through the *Index Medicus* has resulted in finding references to only two papers, both of which appeared in the *British Journal of Surgery* (vols. 3 and 4). Yet these holes in the skull may be associated with symptoms of much concern to the patient, arising from brain complications—the result of the injury. In their slighter forms they show as headaches, giddiness, mental depression, inability to concentrate, and want of confidence, any or all of these being no doubt influenced by the constantly obvious hole through which the pulsating brain can in many instances be observed, while some of the patients who before their injury never had any trace of nervous disease may become subject to epileptiform seizures.

Operation for the repair of these defects affords an opportunity whereby the patient may be really greatly benefited, so that these injuries offer an interesting field in surgery. Too many patients suffered from war wounds that terminated in this way, and it is remarkable that so few reports of operation for the condition have been published and that none can be found recording the late results of any operative treatment.

In civilian practice open fractures of the skull are probably the most frequent cause; very much more rarely a hole is left after a portion of a bone, the seat of a neoplasm, has been removed. In early life concussion of skull bones with or without a fracture may in rare instances be followed by more or less extensive absorption of bone, and it occasionally leads to the development of a "traumatic cephalhydrocele" (*Edin. Hosp. Reports*, 3, 562).

When dealing with closed fractures of the skull that require operation it is probably the custom of most surgeons to replace any bone that is removed—for example, trephine disks, loose fragments in depressed fractures, etc.—as suggested and practised by Sir William Macewen. In the majority of cases the reimplanted bone forms osseous union frequently only by interrupted bridges, but strong enough to give good protection to the brain; but it is unusual for reimplantation of bones to be followed by fibrous union.

With open fractures it is often a matter of greater difficulty. Many of the patients who sustain these injuries in civilian life have the entire wound thoroughly ingrained with extraneous dirt: not only the surface of the scalp wound but the bone surface and even the brain itself may be thus contaminated, as well as by sebaceous material, hairs, etc., from an unclean scalp. Cases of this type offer as good a test of one's ability to make a wound aseptic as can be found in the whole field of surgery, but when thoroughly dealt with it is surprising how well they get on and how often healing by primary union takes place. In these cases it is the experience of the operator which counts: that alone will allow him to decide whether the bone may be reimplanted or not, though the most experienced will occasionally find that there has been a failure to prevent sepsis and that the bone fragments must be removed. It must also be

remembered that in many cases fractures of the vault are continued down to the base and involve the accessory sinuses connected with the nasal cavities, from which infection can spread.

Of 115 cases of fracture of the skull under my care that required operation bone was removed temporarily and reimplanted in forty-seven. Sixteen of these had closed and thirty-one had open fractures. Of the sixteen with closed fractures three died—two from laceration, etc., of the brain, and one from septicaemia following a suppurating parotitis which developed seventeen days after operation. The others made good recovery.

Of the thirty-one patients with open fractures, many of whom had wounds thoroughly ingrained with extraneous dirt, six died of cerebral complications within forty-eight hours. The others of this group recovered; in four of them, however, the reimplanted bones had to be removed, three of these because of sepsis; in the fourth patient, who had a deep gutter fracture of frontal bone, a trephine disk was required to enable bone to be elevated: the two tables of these fragments were completely separated along the diploe. Neither the frontal (air) sinus nor the longitudinal (venous) sinus had been injured. The trephine disk and the outer table of the fragments were reimplanted; and while the latter united well the disk remained movable. Nine months later the patient returned complaining of pain in the skin of the forehead on pressure over the site of fracture; this was due to a spicule of bone. An incision was made and the trephine disk found to be quite avascular and loose. The reimplanted fragments of the outer table were firmly united and fixed; and the dura mater in the trephine opening had a good layer of new bone covering it in continuity with the margin of the opening.

In the case of gunshot wounds of the skull, and particularly in those sustained in the war, sepsis of a severe degree occurred in all of them, resulting in a prolonged convalescence; and all wounds of this type that healed did so with more or less extensive adhesions between brain and scalp. In many instances no real scalp existed at the wound, the cerebral cicatrix being covered merely by a thin layer of epithelium, intimately adherent to it, and of course immobile upon the brain below.

It is not good that a man should have his brain anchored to his scalp, and perhaps this is more important in wounds at the Rolandic and frontal areas. These are the cases associated particularly with cerebral symptoms, which may be another reason for operative treatment in addition to that of filling up the opening in the skull.

There are various methods by which these openings may be closed. They are either autoplasmic or heteroplasmic. Of the autoplasmic methods the König-Müller operation does not appear to have been adopted in this country to any extent. It has never appealed to me, and I have never seen any patient who had been treated by it.

In some situations where there is a large gap to be filled in it may be impossible to cut an intact bone-flap, and in most cases, owing to the convexity of the skull, the best that can be done is to produce a tessellated layer of bone scales. The method is not adapted for cosmetic purposes on the forehead. The extent of wound produced by the formation of the two flaps required is no great advantage. The use of bone, or cartilage, transplanted from a distance has its advocates. It means an additional wound, and a rough, irregular, freshly cut surface in the case of bone that might lead to the development of irregular spicules, causing irritation either of the brain or of the scalp (see above).

The ideal operation, in my opinion, is the one that gets a patient well as quickly and as easily and with as little traumatism as possible, and so in every instance of a gap in the skull, both in civil and in military practice, I have employed celluloid for the purpose of filling the gap.

Celluloid has one, and only one, disadvantage—it is a foreign substance. The qualities which recommend it are many. In the first place, unlike almost all the heteroplastic materials that have been employed from time to time, it is not absorbable; then it is easily obtained in plates large enough to fill any of these openings, is easily worked, and can be moulded within certain limits. It can be “splinted” for extra strength or to maintain a definite and desired shape with a second layer, or by strips, of the same material, which, with a proper solvent, become permanently incorporated as a single mass; it is easily sterilizable; it presents an entirely smooth surface to a damaged cortex beneath and a freshened surface of scalp or scar tissue above it, the advantage of this being that the outside covering remains freely mobile upon the plate. Celluloid is, moreover, strong and resilient and capable of resisting quite a considerable degree of violence (see below). As far as I am concerned my experience in its use is entirely satisfactory, and, what is more, the patients I have seen recently, twenty and more years after their operation, are thoroughly satisfied also.

In the *British Medical Journal* of February 3, 1906, I reported notes of six patients for whom celluloid was employed for gaps of various sizes, the largest being 9×5 cm. Since that date I have only used celluloid for five other patients in civilian practice.

After the war began in 1914 eighteen men were admitted under my care at the 4th Scottish General Hospital suffering from gunshot wounds of the skull and brain. Two of these men came with large granulating cerebral herniae, the others with their wounds completely cicatrized, leaving more or less dense and extensive adhesions between brain and scalp.

Concerning these eighteen men, all of whom had a celluloid plate inserted, eight have been lost sight of (five of them were the subjects of general epilepsy—the result of the brain injury—the fits coming without warning); and it is unfortunate that the later history of these patients is lost. The remaining ten I have seen personally during this current year, twenty or twenty-one years after their operation. Six of these were suffering from traumatic epilepsy following on their injury when they came under observation. Three of them have not been improved so far as the epilepsy is concerned, the fits continue and they have been unable to work since their discharge from hospital. In one of these patients the wound was frontal, in one parietal, and in one right parieto-occipital with visual aura (flashes of light) preceding the convulsions. The fourth patient (with left occipital wound) of this group had many generalized fits with visual aura (flashes of light, “revolving like a wheel”). He has been free from any major seizure since his operation and has been employed continuously since his discharge; but states that at times he still sees the flashing light, which is followed by a “queer feeling” coming over him (*petit mal*). When this happens he is obliged to cease work for about five minutes, but does not lose consciousness. At the end of this time he goes back to a moulding machine in an engineering shop, and is able to take up his work where it was left off. He is employed on full wages, so these interruptions cannot be very serious.

Of two remaining patients, one, with a frontal wound, had many general convulsions before and several during the early days following his operation; the other, with a wound over the left Rolandic area, was the subject of Jacksonian epilepsy, the fits beginning in the right index finger and usually involving both limbs of the right side. These two patients have been entirely free from fits since they were discharged from hospital; they are employed full time on full wages in responsible positions, sums of money passing through their hands.

Four men happily escaped the calamity of having epileptic manifestations added to the misfortune of being wounded. Three of them have been well in every way since their discharge from hospital and have been employed full time on full wages ever since. One (frontal) works in a large explosives factory; one (parietal) is a railway platelayer; one (frontal with a large part of the vertical right frontal bone and the whole of its horizontal plate removed) is in charge of a pumping engine at the waterworks of a large town. The fourth man of this group went seven years without any fits after his skull was plated, but at the end of that period developed an abscess, and seems to have had one or two fits. The abscess was evacuated, and the plate, a large one, was removed; the wound healed again quickly. Two years after this event he called upon me and said that he was very well and had had no more fits, but was not working. He produced the plate, which was absolutely intact after its seven years in his head and did not show the least sign of erosion at any point. A letter received from him in the spring of this year stated that he was well but still unemployed.

In these ten men the “plates” were found to be sound, fitting well, and of good resistance, and with the cutaneous scars freely movable upon them. All the men expressed satisfaction with the plates and said they had a feeling of confidence in themselves in consequence of having them.

The technique adopted in all these cases has been the same as described in my first paper. For an operation in which a heteroplastic substance is to be used the essential factor is to obtain asepsis. One may say that where sepsis has occurred after the primary wound, and especially where healing has been by extensive epithelialization of granulations, the longer a patient can be kept between the time of the last granulation being covered and the secondary operation the better. All the war cases dealt with had been highly septic, and the plating operation was always deferred till at least six weeks after complete covering had been obtained: better still to wait two, or even three months, although while the war was in progress it was not easy to keep the patients so long in hospital. These remarks apply equally to the use of completely detached bone or of cartilage. It is possible that infection can be better resisted by the bone scales obtained in the König-Müller flap, for they are still in vascular continuity with the soft tissues of the flap.

As has been stated, the cicatrix of the scalp was very often of the thinnest description, and the effort was always made to keep this intact by incising through the normal scalp and dissecting the superficial scar as carefully as possible off the cerebral scar. In spite of this thinness and the apparently poor blood supply, necrosis of the scar did not occur in any case. The brain scar, often very dense and at other times cystic, was excised, and a layer of thin celluloid (actually a portion of a photographic cartilage-film), large enough to extend completely beyond the cut surface of the brain, was employed by slipping

it below the opening in the dura mater, all round, and then filling the bone defect with celluloid, one-sixteenth of an inch thick, laid upon a shelf made by chiselling completely round the bone margin. The layer of thin celluloid was used with the idea of having a perfectly smooth surface which might exert a slight pressure upon the brain wound and prevent broad and extensive adhesions from forming between it and the dura mater; I believe that it was definitely useful. The scalp incision was always close-sutured with deep and superficial stitches and without drainage. In several of the patients fluid—blood, serum, or cerebrospinal fluid—collected beneath the flap, at times causing considerable tension; this fluid was removed by aspiration through the substance of the flap, repeated as often as necessary until the flap came to lie permanently on the surface of the plate. I am of the opinion that the removal of fluid from the cavity of an aseptic surgical wound through the cut edges of the wound is a surgical error, for it constantly leads to sepsis. The fluid should be aspirated through the otherwise intact skin.

The chief purpose of these notes is to indicate that celluloid is a thoroughly satisfactory material for the object in hand, provided that asepsis can be maintained.

Its durability is proved by the fact that in nine patients examined this current year the plates which were inserted in 1916–17 are to all intents as good as on the day of operation and are all fitting accurately.

Of the six patients reported in 1906 the after-history of only two of them is known. One of these, a man with a large plate in his right temporal fossa, lived for thirty years, and died, from senile gangrene, with the plate *in situ*. The other, a female, was the first patient for whom I used celluloid. This was in 1897, to fill a gap that had been produced by the removal of a tumour of the left frontal bone, the diagnosis of which lay between sarcoma and gumma, and which had not reacted to a course of anti-specific treatment of those days, being still the cause of intense pain. It was removed ten years before Wassermann's test or Ehrlich's treatment had been elaborated, but when the test was ultimately made and a positive reaction obtained the treatment was given with an entirely satisfactory result. This patient is still alive and well with the plate *in situ*, just forty years after it was inserted. At that time it had been moulded into a dome shape that corresponded fairly accurately with the natural convexity of the left frontal bone. Several years later the patient received a severe blow upon the plate, with the result that it was considerably flattened, but it possibly saved a brain contusion.

As further evidence of the resisting power of celluloid, another patient, also with a frontal plate, while working as a gardener was struck with the flat surface of a spade sufficiently heavily to produce a scalp wound over his plate, but without further injury. And one of the epileptic patients with a frontal plate who was recently seen volunteered the statement that during his fits he had often had his forehead bruised, and felt sure the plate had given definite protection. These facts regarding its resistance to external violence and its durability indicate that celluloid is an excellent substitute for transplanted bone, which is only superior to it in that it can become an integral part of the skull.

The total number of men doctors in Germany has risen from 52,342 in 1935 to 55,259, or 5.6 per cent. The number of women doctors during the same period has risen from 3,644 to 4,339, or 19.1 per cent.

SOME UNUSUAL CASES OF GLAUCOMA SECONDARY TO INJURY*

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The occurrence of glaucoma as a complication of ocular injuries, both non-perforating and perforating, is familiar to all of us, and I think I may say that in most cases a satisfactory explanation for its development can be given. The cases which I am about to describe, however, seem to me to be worthy of report, because not only do they not belong to any of the commoner types, but I am not aware that similar cases are to be found in the ophthalmological literature. Unfortunately the mechanical explanation of the rise of tension in each of these is, so far as I am concerned, so obscure that I am unable even to make any reasonable suggestions, but I can at least inform you fully as to how three of the four cases reacted to treatment.

Case I

My first case is one in which the glaucoma was the result of a non-perforating injury. A man, 21 years of age, when playing Association football received a blow on his left eye—he thinks that the loose end of the lace of the football struck him. The eye was very painful at the time, but the pain disappeared in the course of a day or two, and the sight seemed to be unaffected. Some time after the accident—he cannot say definitely when—he had a sudden attack of misty vision, associated with neuralgic pain and haloes. Similar attacks occurred at intervals, especially in the evening, and these became gradually more frequent and severe. I first saw him two months after the accident—he was then having a particularly severe and prolonged attack, the eye having been painful and the sight misty for two days. The left cornea was slightly hazy, the pupil semi-dilated and sluggish; the tension was raised and arterial pulsation in the retinal arteries was present; there was no cupping of the disk; the vision with a -1D sphere was 6/9 partly. After instillation of 1 per cent. eserine the tension became normal in half an hour. Apart from the increased tension no abnormality of any kind could be found; the anterior chamber was of normal depth and the lens in place and undamaged. After the fall of tension to normal, vision was 6/5 with a +1D sphere. The field of vision was full. The patient was delighted with the effect of the eserine, and I prescribed 1/4 per cent. eserine drops twice daily. This kept the tension normal for a time, but if the eserine drops were left off the attacks began again. The patient came to see me several times just as one was beginning, and on each occasion the eye became temporarily myopic just before and during the attack. After about two months, as the attacks recurred directly the eserine was discontinued, I decided to operate; several of my colleagues saw the patient, and agreed that this was the right thing to do. As the only abnormality discoverable was a suggestion of increased flare in the aqueous, I thought it best to begin with a paracentesis. The result of this procedure was that the attacks ceased for a fortnight, but after that they recurred again as badly as ever. I then trephined the eye. Two days afterwards, when I was dressing the eye, the patient closed the other one and said that everything looked distorted. On examining the fundus I saw an enormous papilloedema, of about 6 dioptres measurement, and numerous large retinal haemorrhages surrounding the disk. The papilloedema subsided in about three weeks, the haemorrhages ultimately disappeared, and two months after the operation central vision was 6/4 unaided. The visual field, however, showed a general peripheral constriction, especially marked on the temporal side. The constriction of field was accounted for by a reduction in size of the peripheral retinal arteries.

* Read in the Section of Ophthalmology at the Annual Meeting of the British Medical Association, Belfast, 1937.