basal lesions, and in only 2 of the 8 cases was the sixth nerve affected, although it is, of course, known that this nerve is much the most liable to suffer from a pathological increase of intracranial pressure.

Fits were observed in ten of the patients; in two both sides of the body were involved, but they were limited to one side in the others. From the descriptions we received, as well as from our personal observations, the unilateral seizures apparently commenced in the face or hand when there was extensive palsy of the convulsed side, or in the lower limb when the paralysis was limited to its distal segments; that is, the excitation started either in motor centres which were only partially damaged, or in their immediate proximity.

Other complications are relatively rare. Meningitis occurred in some in which the dura mater had been lacerated and the brain damaged directly; and in one a general pyaemia, from which, however, the patient recovered, developed secondarily to a septic wound of the sinus. It is surprising that we have encountered only this one case of general infection considering how commonly pyaemia occurs in connexion with septic bone related to the lateral sinus. A secondary hemiplegia occurred in two cases; in one after an operation in which the longitudinal sinus bled freely and had been plugged with gauze, and in a second thirteen days after the infliction of the wound and ten days after an area of depressed bone compressing the sinus had been removed.

The general symptoms of intracranial pressure have been as a rule pronounced. Most of the patients have suffered considerably from headache, and in some it has been particularly severe. In five cases there was also definite optic neuritis with considerable swelling of the discs, and not merely such congestion and blurring of their edges as is seen in a large proportion of all gunshot wounds of the head. In four of these cases at least we could exclude meningitis and secondary cerebral abscesses, and must consequently attribute the ophthalmoscopic changes to the oedema and swelling of the brain.

TREATMENT.

The treatment of injuries of the longitudinal sinus presents considerable difficulties. When there is a defect in the skull to one side of the middle line, and the brain is lacerated by indriven fragments of bone, the wound should be dealt with as if it lay in other regions of the head, but special care is necessary to avoid and control the serious haemorrhage that is apt to occur from the sinus or its lacunae.

If the symptoms are due, however, only to compression of the sinus or its lacunae the immediate removal of the compressing bone would at first sight appear to be the rational treatment; but experience has shown that the results of surgical interference have been extremely unsatisfactory. Among 39 cases we observed which were operated upon either by ourselves or others, 15 deaths occurred in the base hospitals, while only one among the 37 unoperated upon cases died before transference to England. These figures have not, of course, an absolute value, as it was naturally the most serious cases which were on the whole selected for operation, and in 7 of the fatal ones there was, in addition, some direct injury of the brain. They are, however, sufficient to emphasize the danger of operation.

On the other hand, it must be remembered that the uncomplicated cases show a remarkable tendency to improve, probably owing to the free venous anastomosis permitting a re-establishment of the circulation.

If operation is necessary, it is advisable to remove bone all round the depressed portion, and only then elevate this; for if haemorrhage occurs the surgeon is then in a more favourable position to control it. As a rule, some bleeding from either the sinus or its lacunae occurs when the fragments of bone are removed, but it can generally be arrested by placing a piece of pericranial tissue or muscle on the laceration, keeping it in position for a short time by moderate pressure, and then carefully replacing the scalp flap over it. The method is certainly preferable to arresting the haemorrhage by a gauze plug, as it is not so liable to produce further thrombosis. When the sinus is completely divided or much lacerated a plug may be, however, necessary.

When there are serious symptoms of intracranial pressure a subtemporal decompression may be necessary;

it was performed in a few of our patients. It is, of course, a safer operation than a large opening in the neighbourhood of the wound, as the latter exposes the patient to the risk of intracranial infection from the septic scalp.

We have, however, found lumbar puncture, repeated frequently if necessary, sufficient to relieve the pressure symptoms in several cases.

It might naturally be expected that an injury which damages the sinus, or the lacunae and their tributary veins, might be complicated by the occurrence of a subdural haemorrhage, especially as the somewhat similar injuries in the newly born which produce cerebral diplegia have been shown by Harvey Cushing¹ to be frequently associated with such haemorrhage; and one would on these grounds be tempted to perform a subtemporal decompression in cases which show evidence of a high degree of intracranial pressure, especially when prolonged or increasing. Both operative experience and *post-mortem* examinations, however, have made it clear that such haemorrhage is rare. When it does occur it takes the form of a thin film of blood spreading over the cortex down to the base of the brain—a condition in which surgical interference is unnecessary and undesirable. In only one case in our series was there a haemorrhage of such magnitude as to need operative relief, and in this case the progress of the symptoms gave definite information before the operation was undertaken.

REFERENCE.

¹ *Amer. Journ. of the Med. Sciences*, October, 1905.

THE TREATMENT OF GUNSHOT WOUNDS OF THE HEAD, WITH SPECIAL REFERENCE TO APPARENTLY MINOR INJURIES.

BY

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The number of patients who arrive at the base hospitals with gunshot wounds of the scalp is large. As their injuries are apparently superficial and their symptoms few or none, they frequently come down as "sitting" cases, and on arrival there is a tendency to overlook the fact that among them there is a fairly high percentage of cases with definite injury to the skull or to the skull and brain.

The following analysis of the lesions found at operation in 140 cases demonstrates that any scalp wound should be viewed with grave suspicion and the necessary measures to determine the presence or absence of a fracture of the skull taken.

Scalp wounds only	82
Fracture of outer table only	19
Fracture of inner table only	1
Fracture of both tables, dura uninjured	18
Fracture of both tables, dura lacerated	1
Fracture with laceration of dura and brain..	19
	140

Excluding scalp wounds only, the percentage of head injuries = 41.5; excluding scalp wounds and fractures of outer table only, 27.8.

A careful examination of the patient should be made, and any disturbance of cerebral function or lesion of cranial nerves observed. The optic discs should be examined. The anamnesis is important. If unconsciousness is caused at the time of injury by the force transmitted by the bullet or piece of shell which is concentrated on a very small area of the skull, the chances are considerable that at least fracture, and possibly injury of the brain, has been caused. The latter is more probable if the unconsciousness has been deep or prolonged. Transient local paralysis, or the occurrence of local spasm or epilepsy does not necessarily indicate gross trauma of the brain, but in such cases at least depressed fracture or localized haemorrhage may have occurred. Persistent headache should be viewed with suspicion.

Owing to the difference in velocity of the missile, and therefore to the difference in the momentum imparted to the tissues displaced when the skull is struck, an injury to the skull or brain is usually far less severe when caused by a non-penetrating shrapnel bullet or piece of shell than when caused by a non-penetrating rifle bullet which strikes the skull tangentially. The injury is the same in kind in both cases.

1. There may be propulsion of fragments of bone into the brain substance.

2. Though no fragments of bone are forced into the brain, yet the dura may be lacerated by the displaced bone, which may spring back again, and the momentum imparted to the superficial pulped area of brain substance may force that inwards, or the commotion above may be transmitted onwards, so that a track indistinguishable from that caused by the passage of a foreign body is formed. The pieces of bone removed at the operation should therefore be carefully examined to see that none are missing; and if this examination is impossible or unsatisfactory, the track should be explored by the finger.

3. Even though the dura is not lacerated, this pulping of the brain may be quite marked. The disintegrated brain substance is of no use; it acts as a foreign body, causing further destructive changes in the brain substance around and should be allowed to escape through a small crucial incision in the dura. On the other hand, cerebral symptoms may be due to concussion or other cerebral injury which cannot be relieved by operation. At the same time a severe lesion may be present in the absence of severe symptoms, as the following cases show.

CASE I.

Sergeant-Major B. Admitted four days after injury with a small circular wound $\frac{1}{2}$ in. in diameter above inner end of left eyebrow. The wound was covered with a dry scab. The patient complained of a slight frontal headache, otherwise nothing abnormal was discovered. A skiagram showed a shrapnel ball just inside the skull. At operation the wound was excised and a flap turned down. The ball was lying between the skull and dura and a piece of bone, consisting of outer table the size of the ball with a larger piece of inner table, was removed from a depth of 2 in. in the frontal lobe. The brain was drained for a few days through the original wound and three months later the patient returned to the front.

CASE II.

Private G. R. Admitted five days after injury with a similar wound in the same situation. A piece of shell had been removed at a clearing station. There were no symptoms, not even headache. On picking off the scab, the serous fluid in the wound pulsed. At operation several pieces of bone were found in the frontal lobe at a depth of $1\frac{1}{2}$ in.

CASE III.

Private W. C. Admitted to a general hospital with a small wound of forehead. Slight headache for the first two days. Remained in hospital for eight days and then discharged to base, where he stayed a week. At the end of the week a swelling appeared under the wound which up to then had been painless and covered with a small dry scab.

On admission to No. 5 General Hospital, a small circular wound, $\frac{1}{2}$ in. in diameter and 1 in. above the outer end of right eyebrow, was discovered. The tissues around were swollen and oedematous, the swelling extending down the right cheek. The scab was removed, and an ounce or so of pus evacuated. Under treatment with hypertonic salt solution, the swelling and oedema rapidly disappeared. A skiagram showed several small fragments of bone in the brain, but no obvious hiatus or fracture.

Operation.—The wound was excised and enlarged. A small hole in the bone was discovered. After trephining, a lacerated track in the brain was found filled with deliquescent brain matter and pus. Several fragments of bone were removed from a depth of 2 in. A tube was inserted into the brain and the inner part of the wound sutured.

A culture from the brain abscess yielded *Staphylococcus aureus*.

He was sent to England with a clean granulating area at the outer end of the wound. The sutured portion united by first intention. Throughout his stay in hospital he had no headache or other cerebral symptoms.

EXAMINATION.

A skiagram should be taken, preferably at right angles to the wound. Too much reliance should not be placed on the results, as in several instances a depressed fracture has been found, which was not shown in the plate, and in two cases, where the plates apparently showed depressed fractures of the inner table, no such lesion was found. At the same time much valuable information is usually gained, especially as to the presence and situation of metallic foreign bodies.

The wound should on no account be probed, as in this way superficial infection is carried into the depths of the wound. If the wound is very septic and the scalp around is oedematous, it is preferable, if there is no urgent indication for operation, to apply hypertonic saline treatment for

a day or two before operating. Urotropine, 20 grains, three times a day, should be given to all head cases from the time of admission. The scalp should be completely shaved and painted with iodine.

OPERATION.

The first step of the operation should be excision of the scalp wound. Unless the edges are undermined, a narrow margin suffices. The scalp is steadied with the fingers and two incisions surrounding the wound are made passing down to and including the pericranium, the island of tissue so isolated is then picked up with forceps, stripped off the bone from one end to the other and removed. The instruments used are then rejected. By this procedure in most cases the whole of the infected tissues are removed and an uninfected wound remains to be dealt with.

This incision should always be the first step and should not be postponed to a later stage in the operation. The wound should never be enlarged by incision through its septic edges without preliminary excision, as by this procedure primary union is rendered very improbable. The bone is now examined by the eye and finger, the pericranium being further stripped up if necessary and if no bony injury is found, the wound is sutured without drainage. If a fracture is discovered, it is necessary to obtain more room, and, as pointed out by Colonel H. M. W. Gray, this in the majority of cases is best done by enlarging the wound and not by turning down a scalp flap, unless when the lesion is extensive or multiple. In ordinary head operations the value of a flap is evident, but in these cases a wound is already present directly over the lesion in the brain, and its extension does not add to the disabilities already present. In actual practice it is found that sufficient room is readily obtained.

If there is bony injury it is dealt with on the same lines, a $\frac{1}{2}$ in. trephine crown being raised and the possibly infected bone cut away with craniectomy forceps, all loose fragments of bone being removed.

If the dura is uninjured the wound is then closed without drainage and mastic wound varnish and gauze applied. For twenty-four hours a firm compress of gauze is bandaged on.

When a laceration of the brain is found, the track is very gently explored by the index finger and any fragments of bone or metal removed if readily accessible, a drain is placed into the brain, and the wound sutured as before.

Results.

Of the 118 cases in which primary suture without drainage was practised, 114 healed by primary union. Of the remaining 4, 3 which came early in the series showed slight superficial sepsis for a few days, and 1, where a too early attempt to suture a wound caused by opening an abscess in the scalp was made, broke down altogether. In a number of these cases two or more wounds were excised, so that the percentage of primary union is really higher than is shown by the figures. The size of the wound sometimes renders suture difficult, but by freeing the scalp for some distance around the wound by lifting the cranial aponeurosis with an elevator approximation of the edges was obtained in all but the two following cases. These results should correct the opinion which has sprung up in some quarters that it is difficult and undesirable to obtain primary union in excised scalp wounds.

CASE IV.

Corporal D. was admitted in an irritable condition. No paralysis, no changes in optic discs. A very foul lacerated wound, 6 in. by 3 in., was present in the occipito-parietal region. After three days' treatment with hypertonic saline the wound was excised and a fissured fracture 4 in. long with no depression was found. On trephining comminution of the inner table for an inch on either side of the fissure was discovered, the fragments lying loose in blood clot. The fragments were removed and the wound sutured, deep tension sutures passing through rubber tube being used. For an inch in the centre of the wound the edges were $\frac{1}{2}$ in. apart. The wound healed by first intention, and at the end of a week the edges of the central part were freshened and the wound completely closed.

CASE V.

Sergeant H. Large septic lacerated wound left temporal region. Wound excised and enlarged. Depressed gutter fracture. Trephined, bone removed with craniectomy forceps. Dura bruised, but tension and pulse normal. Wound sutured

after making another incision parallel to the first, and 3 in. away. This wound was left open. Both wounds remained aseptic, and the second was closed seventeen days later without difficulty.

Although it is inadvisable to open the dura in the presence of a septic wound, yet where the septic tissues have been excised by a surgeon who can rely on his technique the results of allowing exit to the pulped brain tissue are excellent. In over 30 cases treated in the Rouen area the dura has been opened with no deaths, while in 3 cases where this was not done cerebral abscess followed by death has occurred. The following case illustrates this point.

CASE VI.

Private R. E. B. Admitted nine days after injury, having been transferred from another hospital. A small circular wound in left parietal region with pus exuding; complete paralysis of intrinsic and extrinsic muscles of right hand. Movements of wrist, elbow, and shoulder unimpaired. The paralysis followed immediately on the wound, which rendered the patient unconscious for a few minutes. The septic wound was excised with a $\frac{1}{2}$ in. margin, and the septic tissues with a shrapnel ball embedded removed. A flap was formed and a small orifice in the bone discovered. Trephined, and depressed fragments of inner table removed. The dura was intact, but a small area of softening could be felt. The dura was opened by a $\frac{1}{2}$ in. crucial incision, and about a teaspoonful of liquid brain was extruded. A drain was inserted through one end of the original wound and the rest sutured. After a fortnight power was completely regained in the extrinsic muscles, and at the end of three weeks some return of power was noticed in the interossei and in the opponens pollicis. A month later the patient reported still further improvement.

Advantages of Removing Depressed Fragments.

Since we know that depressed fragments of bone, even though the dura be uninjured, may give rise to symptoms after an interval of time which may be longer or shorter, and that though the spicules of bone which are driven into the brain may be aseptic at first and yet give rise to cerebral abscess through infection tracking down from the surface, it seems reasonable to perform an operation which has little risk, and to perform it early in the expectation of avoiding these serious sequelae.

The following cases illustrate the benefit of removing depressed fragments.

CASE VII.

Bandsman C. W. Admitted with a small healing wound covered by a dry scab in the posterior parietal region. No symptoms. At the end of ten days generalized fits. A skiagram showed a depressed fracture. Operation showed a depression of the inner table 2 in. in diameter. Dura uninjured; primary union; no further fits.

CASE VIII.

Sergeant A. W. W. Admitted with two small nearly healed wounds, left temporal fossa. No symptoms. Was very energetic in helping with work of the ward for four days when he had a general epileptic fit, followed during the night by others. Wounds excised and sutured. A large flap was then turned down. An area of bone $1\frac{1}{2}$ in. by $1\frac{1}{2}$ in. was then found to be depressed. The temporal muscle was still attached to the depressed area, so that examination through the original wounds by finger or probe would not have revealed the depression. Trephined, depressed area removed. Much splintering of inner table; spicule of bone had penetrated the dura mater, and clear cerebro-spinal fluid was flowing from a $\frac{1}{2}$ -in. slit in it. An attempt was made to suture, but the fluid came through the stitched holes. Bleeding from a dural vessel stopped by a piece of muscle, and from bone with bone-wax; flap sutured. Next day a collection of fluid released by inserting probe. No further collection; no more fits.

CASE IX.

Lance-Corporal A. M. Admitted with gutter wound in occipital region above inion. Complained of defective vision since being wounded. On examination, found to be suffering from transverse hemianopia, the lower halves of both fields of vision being absent. A skiagram showed a depressed fracture. Wound excised; flap turned down; depressed gutter fracture; trephined. Depressed inner table $2\frac{1}{2}$ in. in diameter found pressing on both occipital lobes; dura not injured. Bleeding from superior longitudinal sinus controlled by piece of muscle. Flap and wound sutured. Vision became normal two days later.

The same methods have been applied in the treatment of the most severe injuries, including several involving the frontal sinus. In 64 cases there have been 5 deaths, a percentage of 7.8. In three of these cases pieces of shell casing had traversed both hemispheres of the brain; in one a gas-containing abscess was present in the brain on admission; and in the last the patient was admitted with spreading meningitis commencing, and though

improvement occurred after drainage, lumbar puncture, and contralateral subtemporal decompression, he ultimately died. The following cases are examples of these more severe injuries.

CASE X.

Private C. A. K. Admitted with two septic wounds of forehead, 5 in. apart, caused by the entry and exit of a rifle bullet. The patient, while not unconscious, was very drowsy, and, when roused, extremely irritable. No paralyses were observed. A skiagram showed fractures of the skull. The two wounds were excised and united across the forehead and extended laterally. Much comminution of bone at both points was found, with laceration of both frontal lobes. Bone was removed until a margin of $\frac{1}{2}$ in. of healthy dura was left. The track through brain and falx was explored with finger. No fragments were found. The wound was sutured with a rubber drain into each end of track in brain. Patient returned to England with wound soundly healed, mentally normal.

CASE XI.

Sergeant H. Admitted with tiny entry wound of rifle bullet in left cheek. Large ragged septic wound of exit over right eye, with cerebral matter protruding. Right eyeball lacerated and collapsed. Very irritable and suffered from delusions. No paralyses. The right eye was excised by Colonel Lister's method. The wound of right eyebrow was excised. Fragments of orbital roof and about $1\frac{1}{2}$ in. of vertical plate of frontal bone, including the frontal sinus, removed. Frontal lobe much lacerated, the finger entering $3\frac{1}{2}$ in. Liquefied brain matter came away in quantity. Wound sutured with rubber drain into brain. Wound of entry also excised and sutured. For three or four days delusions remained. Patient continually dragging dressings off unless constantly watched. Brain matter ceased to come away about the fifth day. Gradually mental changes improved, and patient returned to England at the end of a month with wounds soundly healed and apparently normal mentally.

CASE XII.

Private J. J. Admitted with two septic wounds due to a rifle bullet traversing the frontal region. Entry wound over left eyebrow, exit through upper eyelid on right. Brain matter protruding from both wounds. Severe wounds of both feet and below one knee were also present. Patient was deeply unconscious with incontinence of urine and absent reflexes in lower limbs. The globe of the right eye was destroyed and the fundus of left eye obliterated by blood in the vitreous. Right eye excised. Wounds excised and enlarged. Both orbital plates, nasal processes of frontal bone and ethmoid, were comminuted. The fragments were removed and several deeply-placed pieces removed from brain. The wound of entry was sutured and drainage effected through wound of exit, which was partly sutured. The patient eventually recovered completely, returning to England apparently normal mentally. Vision began to return in the left eye after four or five days, and finally became $\frac{2}{3}$.

Another case practically identical in its details with the last one as regards the cranial injuries had the same result; the wound of entry in this case was over the left malar bone and exit through the right eyebrow.

CONCLUSIONS.

To sum up, the methods adopted in this hospital are:

1. Careful preliminary examination.
2. Early operation on every scalp wound, however slight.
3. Complete excision of septic tissues at the commencement of the operation.
4. Removal of all accessible foreign bodies from the brain.
5. Primary suture of wounds.

In conclusion, I wish to thank Colonel H. M. W. Gray for much help and many kindnesses both in my work and in the preparation of this paper, and my colleagues in the hospital for their cordial co-operation in the clinical work, many of the cases having been operated on by them.

THE returns of vital statistics relating to non-native officials in West Africa during 1914 (Cd. 7871) are affected by the war, since of 53 deaths in all 18 were of persons killed in action, while 3 more were directly connected with military operations. Excluding all these, the rate of mortality per 1,000 is 11.6, as compared with 11.8 in 1913 and 20.6 in 1903. The invaliding-rate is also satisfactorily low. Five of the deaths were due to blackwater fever, 2 to yellow fever, and 2 to malaria. The population at risk is, of course, too small to permit of very reliable deductions being drawn, but the facts are consistent with the belief that the conditions of life on the west coast are being steadily improved.