WAR WOUNDS AND AIR RAID CASUALTIES

The following is one of a series of lectures on the Treatment of War Wounds and Air Raid Casualties recently delivered at the British Postgraduate Medical School

WAR WOUNDS OF THE HEAD—II

BY

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The Skull

The treatment of injuries to the skull is a relatively easy problem: depressions should be raised and loose fragments removed rather than replaced because of the fear of infection; calvarial defects can be repaired without difficulty at a later date. A depressed fragment is best approached through a burr-hole sunk over the sound skull 1.5 cm. from the edge of the defect; the advantage of this manoeuvre is that normal dura mater can be defined with certainty, and from this start its torn edge can be identified and followed around the wound. Unnecessary

ject's neurological signs? If there are none, and if there is no foreign material jammed in the crack, it may be left alone. But if signs are present the bone must be burred through and possibly the dura opened.

Fractures of the base with the dura torn opening into the middle ear are serious because of the danger of meningitis developing. The external auditory meatus should be swabbed clean, never syringed, and a wisp of carbolic gauze packed in very lightly; the external ear and face should be cleaned and covered with a large sterile dressing. Pneumococcal infections may arise from co-incidental injury of the paranasal air sinuses. Fortunately these wounds are not common, for they are serious. It is better to remove sparingly the anterior wall of the frontal sinus if it is injured.

The Dura Mater

The question will often arise whether the dura should be opened. The reader should know now what the answer will be. If there are definite signs of intracranial damage, if the patient has localizing signs, if he has severe headache or is more stuporous than he should be, the dura should be incised. This should more certainly be done if the dura is dark blue in appearance, for this indicates blood beneath it. An incision will lead to its release and often to something more—the extrusion of pulped brain tissue. This should be washed and sucked away and then the dura closed again. Closure is important, for otherwise a superficial infection of no great virulence in itself may spread deeply. For this reason there is one important contraindication to incising the dura—namely, established sepsis in the wound. If a casualty has laid out for three or four days it will be safer not to open the dura if it is intact and to regard him as a case of potential cerebral abscess.

The Wound Track in the Brain

If good results are to be expected and no further damage done to the surrounding brain, the minutiae of the neurosurgical technique must be closely observed. The operation is planned, not to relieve, say, a hemiplegia, but to extirpate as early as possible the agents which caused it. All manipulations should be carried out very gently; the wound must not be packed with gauze. Suction is most useful when available. Cotton-wool should be used for swabbing rather than gauze, though the latter is quite permissible for scalp and bone. Heavy pressure or retraction on the brain not only causes further cerebral contusion but also sets up oedema. The meticulous avoidance of pressure and the careful sealing of vessels are two of the main differences between the technique of general surgery and neurosurgery. As the object in treating open injury to the brain is the prevention of infection by the removal of dead tissue, in-driven bone, and foreign bodies, the importance of careful radiological studies before the operation is started cannot be unduly stressed. The number of fragments removed should tally with the pre-operative count.

Theoretically, the edge of lacerated dura mater ought to be excised because it can be presumed to be infected.

FIG. 2.—Alternative methods of bone removal.

damage to the dura is often done with the nibbling forceps if the fractured edge is attacked directly. Depressed interlocked fragments are to be removed by a block resection, burr-holes being sunk at four points in sound skull around the depression and these connected by linear cuts made with a Gigli saw, de Vilbiss or Montenovesi forceps (Fig. 2). If double-acting bone-nibbling forceps of the Stille pattern are not available it is better to use block resection. The older kinds of rongeurs jar the patient uncomfortably and make him restless. Probably the chief advantage of block resection is that it is more apt to ensure a sufficiently wide removal of the bone around the injury. A margin of at least 2 cm. should be cut all round the dural laceration.

What should be done with a linear fracture? The answer depends on another question, What are the sub-

Experience, however, has shown that not only is this unnecessary, but it is inadvisable, because adhesions rapidly form between the swollen cortex and dura mater: these form a natural barrier against the spread of infection into the general meningeal spaces. We should see meningitis more often if the dura mater were so widely removed that access was easy from without to the leptomeningeal spaces.

If the wound has no particular depth a superficial toilet by syringing with hot saline and the extraction of bone fragments, aided by the patient's coughing or straining to cause the extrusion of debris, is all that is necessary. If there is a deep track further steps must be taken. The aim will be to clear the track of foreign bodies and devitalized brain without inflicting damage to the surrounding part. This object is best attained by catheter suction as introduced by Harvey Cushing in 1917; a No. 10 catheter or piece of drainage tube of similar size is attached to a glass syringe or rubber bulb (Fig. 3). There is little risk of sucking out normal brain tissue, but contused brain substance is easily lifted in this way, and bone fragments will be extracted as well. A gentle search with the catheter will reveal further fragments by touch. Such as cannot be removed by it must be gently taken out with forceps. Sometimes the catheter will pass along the wound track to enter the lateral ventricle so that cerebrospinal fluid will be withdrawn in the syringe. Ventricular penetration is always a serious matter, but bone fragments can be extracted from the lateral ventricle

FIG. 3.—Catheter suction of devitalized brain tissue, clot, and bone fragments.

and yet the patient may recover. It is much better to know that the wound reaches the ventricle than to be too timorous and leave infected foreign bodies behind.

Retained Missiles

Shell fragments proved radiographically to be an inch or so deep can be lifted out with forceps; those with crocodile jaws are best. Deeper metal pieces are dealt with by passing a sterile metal bar down to them and applying an electro-magnet. Only four to six volts are needed for the extraction of foreign bodies of the more usual dimensions. Missiles vary in weight from 4 or 5 grammes to 50 and more, but the smaller ones are the commoner. The larger the shell or bomb fragment the more likely is it to be superficial, for those of great weight penetrating deeply usually kill.

It is quite certain that an ill-equipped surgeon will inflict so much damage in attempting to grasp the fragment that he might turn a paresis into a permanent paralysis or excite a haemorrhage which he cannot still.

In past experience the missile itself has proved to be often so little infected that abscess has not formed around it (though it could do so) and it has developed a fibrous capsule within the brain. The infection is worst on the surface and least in the deeper reaches. If epilepsy develops later it will, in all likelihood, be due to the scarred track leading to the missile rather than to the latter itself. As a principle, missiles are better removed than left *in situ*; it is only with the very deeply situated ones that this is a course of doubtful wisdom; the presence or absence of an effective magnet is the factor on which the decision largely rests.

Injuries to Venous Dural Sinuses

Injuries to the large venous channels in the dura mater often prove fatal in the first hours owing to loss of large quantities of blood. In patients who survive, the repair of a lacerated sinus is always a hazardous manœuvre and of particular difficulty to those who are not practised in the surgery of the brain. Before starting the operation, muscle grafts should be taken from the temporalis if this is already exposed, or, alternatively, from the anterior compartment of the leg. Intracranial venous pressure must be lowered to its minimum by raising the head well above the level of the rest of the body, making sure that respiration is not impeded in the slightest degree and that the blood is perfectly oxygenated. If any one of those factors is acting adversely, the intracranial venous pressure rises, the sinuses distend with blood, and the bleeding becomes uncontrollably profuse. The surgeon will see to these things beforehand (including the obtaining of muscle as the first step) if a wound encroaches at any part on the surface marking of the sagittal or lateral sinuses. It is wiser then not to use the block removal method, since the elevation of the fractured area may cause an unpleasant haemorrhage. The bone over the laceration is better removed piecemeal by nibbling forceps until the tear is freely exposed in its whole length and on both its sides; it is useless attempting any kind of repair until this step has been accomplished. The type of repair will depend, of course, on the nature of the injury. If the continuity of the sinus is completely broken, each end must be encircled with fine silk thread and the ligature firmly tied. Longitudinal or incomplete transverse tears may be repaired by closing the opening with grafts of muscle, hammered into thin sheets. These Horsley muscle grafts are very efficacious, as they stick like postage stamps across the gap in the sinus, and of all the known methods they are the most easily applied and the most commonly used.

Wound Closure

A careful closure of the wound is essential if good results are to be expected: the aponeurosis should be pulled together with buried sutures of the finest silk and the skin edges opposed with great care. Catgut is a bad material for buried sutures in the scalp. It can be stated with some certainty that any wound that can be drawn together purely by buried sutures is not under too great a tension so far as the skin flaps are concerned. This is aided by dissecting them up widely by touches with the scalpel in the loose areolar layers between galea and pericranium.

It is safer to drain most wounds with narrow strips of rubber for three days. The rubber strips should be put in the extremities of the wounds and not in the centre or in positions where healing is likely to be delayed.

Raised dressings of spirit gauze built up at the periphery to take pressure off the wound are best; they should be replaced on the third day.

Epilepsy

Convulsive seizures of focal or generalized types may develop either within the first days of acute head injuries or late. The retained missile is of no particular importance in the production of these neural explosions; it is the cerebral injury that matters.

When epilepsy occurs in the early stages, as it may, the seizures are due to local haemorrhage or oedema, and may be controlled by intramuscular injections of luminal 3 grains or by large doses of bromide and chloral given orally or by rectal injection. Lumbar puncture should be done to see if meningitis is the cause; often it is not. The question of late epilepsy does not come within the scope of this discussion; suffice it to say that it can be expected in a very large proportion of cases when the dura has been perforated, and particularly when there is a cortical scar adherent to the skin. It may develop at any time after the injury, and I have known it to occur for the first time twenty years later.

Meningitis and Ventricular Infection

Although on theoretical grounds infection of the meninges might well spread widely from the site of a cortical wound and be a common cause of death, experience shows that it is relatively rare. The meningeal spaces become sealed off by oedema of the brain around the contused area and a defensive barrier arises, partly mechanical by obliteration of dead space, partly the result of sealing of blood clot (Fig. 4). When operative

FIG. 4.—Diagram of common route of infection in head wounds. The local injury is sealed off by adhesions. (A) Local meningitis. (B) Basal meningitis, by ventricular infection escaping through the foramina of Magendie and Luschka. Fig. 4 is reproduced from the *British Journal of Surgery* (1919, 7, No. 26), by kind permission of the editor and of the publishers.

cleansing of the wound is undertaken reasonably early this barrier is sufficiently effective to prevent major disaster. The presence of leucocytes and even polymorphonuclear cells in the cerebrospinal fluid is no indication that a fatal meningitis is established or even on the way. Pleocytosis of this kind will often subside without its ever having been possible to grow organisms from the fluid. Even when there is bacterial infection death does

not necessarily follow, though it of course signifies a grave condition. Experience taught me that the worst examples come from a deeply extending septic encephalitis that infects the ventricle. Once this has happened the cerebrospinal fluid circulation washes the organisms widely through the ventricular system and will carry them to the full extent of the leptomeningeal spaces. The majority of these patients die. The moral lies in the need for a most careful cleansing of the wound and the avoidance of any rough, and particularly any blind, procedures carried deeply into the cerebral tissues.

The treatment of meningitis consists in repeated lumbar punctures (two or more daily) or continuous lumbar drainage by keeping the needle *in situ* for two, three, or more hours, aided by chemotherapy. The last is the most important of all.

Cerebral Fungus

If a wound does not heal by first intention, and especially if the scalp has been closed under undue tension, the edges of the wound will part in the middle and a cerebral fungus develop. This should be carefully protected by a raised dressing built up some distance from the circumference of the wound. If the infection is limited and the injury very localized no great protrusion will occur. On the other hand, if there is a large defect in the skull and scalp the fungus may attain considerable size. It always indicates encephalitis, and its proper treatment is by means of antiseptic drugs by mouth and by repeated lumbar puncture. The old method of shaving off the fungus is to be condemned unconditionally. The ventricle herniates towards the fungus and may be opened by injudicious surgery. Lumbar puncture will always reduce a fungus; it may have to be repeated two or three times a day, or the needle may be left *in situ* for an hour or more. By the use of whichever of the modern antiseptic drugs or sera seem best adapted to deal with the infection, the encephalitis will subside in most of the subacute cases and in some of the worse ones. Possibly the importance of the sulphonamides in the treatment of these injuries has not been sufficiently impressed in these lines. Even though most war wounds are infected with organisms of more than one type, and with some not yet proved to be specially susceptible to the new drug, we have some grounds for hope. Sulphapyridine (M & B 693) should be especially useful in the cranio-facial injuries that did so badly in the last war because of pneumococcal infection, but it will be best if it or some allied compound is given immediately as a prophylactic to all wounds.

In the early stages the picture is that of an unhealed wound; but, if all goes well, granulations appear and cover the fungus, which will eventually epithelialize. Some months later a plastic operation may have to be considered.

Conclusion

Head injuries are most interesting wounds; the difficulty is that in war time they may have to be dealt with in such numbers. There is no special merit in very slow operating, nor is there any merit in great speed here, for it cannot be combined with the other requisites. Most of the operative steps outlined can be performed in little over half an hour, exclusive of the shaving of the head, the positioning of the patient, and local infiltration of novocain. It is a mistake to assume that the urgency of operation is so great that all surgical ideals should be discarded. There are now enough neurosurgical centres, and technique is so standardized that all likely to have

to deal with these war wounds can obtain an introductory training which would fit them to do so.

There is one last point, and that is the value of keeping the patient in the hospital where he has been operated upon for at least ten days afterwards. The results are better if this can be done, not only because travelling upsets the patient, but chiefly because some continuity in treatment is of the greatest importance. It is naturally extremely difficult for a fresh group of people to understand the exact nature of a lesion hidden beneath a newly sutured scalp.

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HEALTH ADMINISTRATION IN ZANZIBAR

The annual medical and sanitary report for 1938 of the Zanzibar Government deals with the island of Zanzibar and the adjacent island of Pemba. The population, a cosmopolitan one comprising Europeans, Indians, Arabs, and Africans, is estimated at 241,500. Birth and death rates for the year were approximately 14 and 21 per cent., while the rates of infantile and maternal mortality were estimated at 275 and 9.2 per thousand live births. With regard to climate, the mean temperature in Zanzibar town has been 80° F. over a long period of years, with an average daily range of some twelve degrees; the rainfall for 1938 was 73.8 inches. Pemba is very slightly cooler and somewhat wetter. Health administration is controlled by the Director of Medical Services, under whom are one senior medical officer, eight medical officers, and seven sub-assistant surgeons. There are also certain specialist appointments.

Ankylostomiasis and Malaria

With regard to diseases the report comments on the comparative frequency of duodenal ulcer, stating that no age, after the twentieth year, appears to be exempt from it. Some cases of advanced ankylostomiasis, which is widespread, showed, on hospital investigation, a hyperacidity highly suggestive of duodenal ulcer. The patients complained of pyloric pain, but x-ray examination revealed no positive evidence. With the improvement in the blood condition, which followed hookworm treatment, the hyperacidity decreased. As this occurred in every case, it seems probable that useful inferences may be drawn from a larger investigation. In the previous report it was estimated that roughly 98 per cent. of the population suffered from ankylostomiasis, 9 per cent. showing clinical signs of the disease. Arrangements have been made for the provision of large numbers of cement-covered pit latrines, and by the extension of this measure, together with intensive propaganda, it is hoped in time to diminish the high rate of infestation.

Anti-malarial work is beset by many difficulties. Until recently some 1,500 head of cattle were housed and permitted to graze in the town of Zanzibar. Their hoof-prints provided a large proportion of the anopheline breeding places. Myriads of anopheles bred in wells, which, of course, could not be oiled, while the "millions" fish put in to eat the larvae were themselves caught and eaten by small boys. The extension of the piped water supply has greatly diminished this danger. Although it has been possible to apply anti-malarial measures to swamps and marshes within half a mile of the town boundary, expense has prohibited control over a wider area, whence large numbers of anophelines are carried into the town by the prevailing strong wind during the rainy season. Culicine and stegomyia mosquitos present a still harder problem. Sewage in cess pits becomes so much diluted during the

rains as to allow the insects to breed, and numerous breeding places are available in holes in trees and domestic receptacles for water storage. The report notes that more larvae are found proportionately in the houses of the more prosperous Arabs and Indians than in the poorer quarters of the town.

Avitaminosis, manifesting itself in most cases as polyneuritis, especially of the lower extremities, is very common among people living in villages. Following the visit to Zanzibar of an expert on nutritional problems, measures are being devised with a view to the improvement of the dietary of the natives.

HOSPITAL CONGRESS AT TORONTO

Arrangements are now completed for the sixth biennial Congress of the International Hospital Association, to be held at Toronto on September 19 to 23, and given favourable world conditions this gathering should be the largest and most influential that has ever assembled in the history of hospitals. Delegates will arrive by various routes from all quarters of the globe, but naturally the larger number will come from the United States and Canada. All will be ready for the Pageant of Nations in Toronto on the evening of Tuesday, September 19. Forty study committees will be reporting, and on such diverse subjects as hospital construction, transport of patients, mechanical plant, spiritual care of the sick, the child in hospital, hospital libraries. An international language service in an ear-phone system is to be installed in the ballroom of the Royal York Hotel, the headquarters of the Congress, and the listener, by merely turning a switch, will be able to hear in one of the following five languages: English, French, German, Spanish, and Italian. The Congress of the I.H.A. will be followed by conventions of the American Protestant Hospital Association and the American Hospital Association. The party of delegates from Great Britain, Northern Ireland, and Eire travel in the C.P.R. liner *Duchess of Atholl*, leaving Liverpool on September 8, and will see hospitals in Quebec, Montreal, Ottawa, and Toronto. The return tour will be through the Eastern States of U.S.A., and again many other hospitals will be visited, and a final touch will be a tour of the "World's Fair" in New York. Further information may be had from Mr. W. McAdam Eccles, F.R.C.S., 104, Bryanston Court, London, W.1.

PROTECTION OF CIVILIANS IN WAR

An international medico-legal conference was held at Liège at the end of June to consider the subject of protection of the civil population in time of war. The discussions were presided over by two distinguished legal figures and the Professor of the Faculty of Medicine in Liège. The value of international conventions for the protection of the civil population was emphasized by Professor de la Pradelle of Paris, who based his claim on the history of the various movements which owed their origin to such conventions. Dr. Decharneux described in detail the medical organization of a mobilized country, emphasizing the necessity for co-operation between the health services of the army and those of the civilian authorities. He outlined the difficulties of national medical mobilization, and proposed a series of solutions which required urgently to be considered by the responsible authorities. These were concerned with the organization of the medical profession throughout the land, the employment of women medical practitioners, the organization of laboratories and of campaigns against epidemics, and the need for international agreement on the safeguarding of medical and public health services in occupied territories. It was also urged that civilian medical practitioners should receive instruction in military medicine and pathology. Dr. Moureau considered that the co-operation of the health services of the army, of the Government's public health services, and of such bodies as the Red Cross Society should be sought to secure co-ordination of the blood transfusion services. The Belgian Government called a conference shortly after the medico-legal one had finished its programme, and a commission was appointed to consider the practical details of such co-ordination.