THE TREATMENT OF GUNSHOT WOUNDS OF THE HEAD, BASED ON A SERIES OF NINETY-FIVE CASES.

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IN the consideration of cases of gunshot wounds of the head, one is struck with the extraordinary discrepancy which frequently occurs in the amount of damage done to the soft tissues as compared with that to the bony skull. In some a small wound is seen on the surface which on investigation is found to have caused most extensive fracture of the bony parts and injury to brain substance. In others an apparently severe superficial wound is found only to have caused a slight local depression of bone with no intracranial damage. Owing to the importance of correct treatment of these head injuries, a brief review of some of the points met with in a series of ninety-five head injuries treated in a stationary hospital with a mortality of 9 (10.6 per cent.), and the conclusions derived from them, may be of interest.

The cases occurred during the period from September, 1914, to July, 1915, and many of us I am sure will agree that during this period we have had to modify considerably our line of treatment in these cases as in other injuries. Preconceived ideas that severe injury inflicted on the skull or brain was bound to be accompanied by definite symptoms have been shown to be wrong. Frequently one sees men with severe damage to the skull and brain walking into hospital. This in itself should make one very careful in the examination of even apparently trivial injuries. It appears almost impossible to be able to diagnose the degree of severity of the injury without carefully watching the patient for some time. I am alluding here mainly to the cases which at first sight appear of very little importance. The percentage mortality in the very severe cranial injuries must of necessity be high, and although from the surgeon's point of view it may be interesting to point to some wretched individual whose life has been prolonged by surgical interference, yet in those that recover there is often some permanent damage left either in the shape of complete or partial paralysis or some interference with the mental perceptions, so that the individual spends the remainder of his life a care to his friends or a burden to the State. It is not for a moment meant that our efforts to save even the very worst of head injuries which come under our care should be lessened by even the smallest fraction; I only wish to put forward a plea for the most thorough examination of every case of head injury, no matter how apparently trivial it may be at first sight. These, to my mind, are the cases that from the wider State outlook are really the most important. It is surely better to make a permanent complete cure of these less obvious cranial injuries, which if overlooked might later on develop Jacksonian epilepsy, etc., than to save the life of some less fortunate creature who will at the best have some more or less permanent defects left.

In several cases of this series it was only after some time in hospital that the man showed any signs of cerebral trouble. In many cases which have shown no critical symptoms—such as localized paresis, headache, optic neuritis, convulsions, etc.—very extensive damage has been found on laying back a flap.

One case I should like to quote in this connexion:

Private W., wounded some three days previously, walked into hospital. He had a small healed scab over the left temporal bone, apparently a graze. He was kept in bed for ten days. He did not complain of anything till the tenth day and was going to be "marked out"; the temperature and pulse were normal: he complained of some slight headache. There were no eye symptoms.

On the twelfth day he had two fits not localized to any particular group of muscles. Operation was performed on the following day. A flap was turned back and a depressed fracture of the temporal bone found. On removing a circular area the dura was found non-pulsating and discoloured. When incised crucially about 1 drachm of disintegrated pulped brain welled out and was carefully wiped away. The wound was stitched and a drainage tube left in for forty-eight hours. Primary union occurred, and he had no further symptoms. He was discharged to England perfectly normal in every way.

It has now become the rule in this hospital that every case of head injury, no matter of what degree, is put to

bed, a purgative administered on the day of admission, and the entire scalp shaved. The history of the case is carefully gone into with special reference to the characters of the injury which point to the probability of a depressed fracture being present—for example, whether the blow was of sufficient intensity to stun the patient. When the entrance and exit wounds are separated by a bridge of scalp overlying a convexity of bone it is almost certain that a fracture has been produced. Practically all these injuries are inflicted by a local force and must therefore be examined with the mechanical possibilities in view rather than that the decision for treatment should be entirely dependent on a neurological examination.

In two instances where there were several wounds on the head, to one of which the patient directed attention, it was only when the scalp had been shaved that a second wound was found which was really the serious one. The difficulty in saying how much bony damage has been done by the appearance of the wound or by the use of the probe leads me to advocate a more thorough examination in almost every case. By this I mean excising the wound and making absolutely certain of the condition of the underlying structures.

This examination by excision should be done early, usually within a day or two of admission to hospital. If no damage to bone is found and a more extensive operation be not needed, the wound can be sutured and, provided that the technique has been good, primary aseptic union should be obtained. Having completed the excision of the wound, a fresh set of instruments must be employed for any further operative measures. If it is found necessary to trephine, the necessity of turning down a flap may be avoided. Sufficient room can usually be got through the original incision.

Indications for Trephining.

1. Although there may be no obvious depression to be seen, yet if the bone shows bruising or laceration of the periosteum, it is more than likely that some definite damage to the inner table will be found. In these cases a small trephine opening should be made and the inner table examined.

2. In cases in which such external signs are absent, but in which there has been loss of function, even if only temporary, persistent headache, giddiness, vomiting, or other signs of cerebral irritation, trephining should always be done. By so doing serious sequelae are avoided.

After having removed all depressed fragments and extradural blood clot, the condition of the dura mater should be carefully examined. In several cases in which it had been found to be discoloured, non-pulsating, and doughy, I have opened it by a crucial incision and a varying amount of disintegrated brain matter has been extruded, and was carefully wiped away. This brain matter is practically useless, and although some people consider that it may become absorbed in time, I think it is much better that it should be removed, otherwise it may act as a foreign body and give rise to after-symptoms. The risk of the brain becoming infected is considered by some to be sufficiently serious to bar the opening of non-lacerated dura, but if all due precautions are taken, infection should not occur, and certainly in those cases in which an opening was made there was no after-trouble.

One of the most difficult points to decide is the amount of bone that should be removed. Personally I am of opinion that when trephining has to be done, it is quite sufficient that an area of bone should be removed around the injured part until it is quite certain that all the depressed fragments have been removed. In cases in which the dura has been opened it is necessary to remove bone until an area of healthy dura at least $\frac{1}{2}$ in. to $\frac{3}{4}$ in. broad has been exposed all round the laceration.

Transport after Operation.

I feel rather strongly on the subject of the transport of cases after operation. Unless urgently indicated, it would seem better that serious head cases should not be moved for at least three weeks after operation; by this time all fear of danger arising from travelling should have disappeared.

Removal of Foreign Bodies.

The removal of foreign bodies from the brain opens up a very wide field of discussion. Experience in the cases

under review tends to impress on me the advisability of a digital exploration of the track in the brain being made at the primary operation in every instance in which the dura has been torn and the brain apparently pierced by a foreign body.

In some cases it was found that the brain had been pulped quite deeply along a "track" without penetration of a foreign body or piece of bone. A lesser degree of this was seen in those cases in which the brain was pulped without the dura having been open. I can only account for this occurring by its being due to the skull having been struck by a missile which in the first instance had a much greater "striking force" than that which caused the second; whether it be due to vibration set up in the particles of brain substance or not I cannot say.

These head wounds, like those of other parts of the body, almost invariably become septic if not dealt with at an early stage, and it is difficult to follow the arguments for leaving foreign bodies alone. If not removed they are almost certain to give rise to after-symptoms, cerebral abscess, hernia, epilepsy, etc. It frequently happens that the missile causing the injury does not lodge, but the fragments of the inner table may be deeply driven into the brain substance. These may often be found by digital examination with comparative ease. A finger passed along an already existing track, if due care be taken, is very unlikely to cause any additional brain damage. If these foreign bodies are left alone and secondary symptoms develop, the trouble and risk of brain injury are increased tenfold. The use of forceps or a probe for searching for foreign bodies is strongly to be deprecated. In a soft substance, such as brain matter, especially when operation has been delayed, one is only too likely to open up fresh tracks, and to lose that leading to the fragments.

The question arises as to the advisability of making a prolonged search for missiles seen by the *x* rays in the brain, but causing no symptoms. Here one has to be guided by many considerations. If at the time of operation no definite track can be found, and one has to fear damaging a portion of the motor area or some important centre in continuing the search, it would seem better not to risk doing more harm than good. I hope it is sufficiently clear that I consider it is always essential, where there is lacerated dura mater, that a digital examination should be made, and any driven-in particles, be they portions of bone or missile, should be carefully removed as early as possible.

As regards the technique employed in these cases, every case in which there is the least suspicion of fracture of the skull is given urotropine, grains 10 to 20, four-hourly. A purgative is administered. The scalp is shaved, washed with soap and water, then with ether, and painted with tincture of iodine. Instead of shaving, a depilatory paste may be used, consisting of barium sulphide 2 parts, starch 5 parts, and pulv. orr. rad. 1 part. A thin paste is made, smeared over the scalp, and after ten minutes the hair may be scraped off with the back of a scalpel. The hair should previously be cut short with a "horse clipper." The paste must be thoroughly removed, else a crop of pustules may result. This is a very simple method of removing the hair, and avoids any barbers' cuts. When the patient is on the table a fresh coat of tincture of iodine is applied and a circular area corresponding approximately to the proposed operation area thoroughly infiltrated with a 1 per cent. solution of novocain, to which is added adrenalin chloride. The patient is given a hypodermic injection of morphine, $\frac{1}{4}$ grain, and $\frac{1}{100}$ grain atropine an hour previously. By this means the amount of shock is reduced to a minimum and very little anaesthetic is required. The addition of the adrenalin renders the operation practically bloodless—in fact, several of these cases have been operated on with complete success and with no discomfort to the patient without any anaesthetic beyond the local injection of novocain. If the extent of damage is greater than was thought before exploring the wound, a general anaesthetic may have to be given owing to the injury present necessitating a much larger operation than was at first anticipated. Attached are a few brief notes on some of the more striking cases.

In conclusion, I should like to express my thanks to Colonel Gray, A.M.S., Consulting Surgeon, for all his valuable advice to me in the treatment of these injuries.

CASE I.

Sergeant A., completely unconscious on admission. A deeply furrowed wound of the parietal bone. Operated on, and many fragments of bone found to be driven into the brain. These were removed and injured bone chipped away. The patient regained partial consciousness the following evening, and answered questions slowly in monosyllables, but relapsed again and died in seventy-two hours.

CASE II.

Private K., bullet wound centre of forehead, exit parietal and occipital suture. Admitted with complete right hemiplegia. Operation: Flap turned back, exposing both entry and exit wounds; circular area of bone removed. A definite track found connecting the two wounds. On passing the finger along this track several pieces of loose bone were felt and removed along with blood clot. Wounds closed, and a drainage tube left in each. After-history: Slowly recovered muscle power when discharged to England. Has almost complete power of arm muscles, leg recovering well, but with a certain amount of spasm of the hamstrings.

CASE III.

Private B., admitted unconscious; right hemiplegia, incontinence of bladder and rectum. He was able to articulate, but was quite unintelligible. There was a small punctured wound over the left parietal, apparently caused by a rifle bullet. At the time, no *x* rays being available, it was impossible to attempt to localize the missile. A flap was turned down over the injured area and a circle of bone removed. The dura was found to have been penetrated. Several spicules of driven in bone were removed and a quantity of blood clot extruded. No prolonged search for the bullet was made. After-history: Slow convalescence, when discharged from hospital to England. The patient was able to speak quite rationally; full recovery of bladder and rectum, right arm almost normal, right leg only showing signs of partial recovery with well-marked spasm.

CASE IV.

Private U., admitted with severe injury to occipital region. Semiconscious and completely blind. Operation: Large flap turned down and entire occipital bone found comminuted and the dura mater severely lacerated. Many fragments driven in to the brain substance. Loose portions of bone removed. Torn dura cut away. Brain substances badly damaged and septic. Very little improvement after operation. Lumbar puncture done twice; cerebro-spinal fluid cloudy, and escaped under increased tension. Died fifth day.

CASE V.

Private E., admitted with a furrowed wound of the scalp slightly to the left of the course of the longitudinal sinus. Wound explored the day following admission. No apparent bony injury. Wound excised and edges brought together. Some days later the patient began to show signs of right hemiplegia. Wound quite healthy and healing rapidly. Sixth day: Hemiplegia practically complete. Second operation: Original wound laid open; trephined over the most convex portion of bone. On removing the disc of bone, and enlarging the opening an irregular shaped fragment about the size of a shilling was found detached from the inner table and lying over the motor area. This was removed, also some blood clot. The dura was slightly discoloured, but pulsated normally. Wound closed with silk-worm gut sutures, and a drain left in. The patient rapidly regained motor power. The use of his arm returned in the first week. When discharged to England, eighteen days later, he had almost full use of his limbs and was able to walk with assistance. The various points of interest in this case that strike one are: (1) The apparent absence of bony injury found at the first operation. (2) The slow onset of paresis. (3) The rapid recovery after removal of the cause of pressure.

CASE VI.

Sergeant U., gunshot wound right frontal bone. Injury must have been caused by a glancing blow, as the damage was confined to an area corresponding to the frontal sinus. Flap turned back, and depressed bone removed. Frontal sinus thoroughly opened up and blood clot cleared away; wound sutured and a drain left in for three days. Convalescence normal in every way.

CASE VII.

Sergeant A., gunshot wound right frontal bone. On admission unconscious and vomiting. Brain matter protruding from wound over right frontal bone. Flap turned back and the entire bone found detached and a fracture extending into the temporal. Dura torn and brain substance pulped. All loose fragments removed and bone chipped away clear of injured dura. After-history: Convalescence slow, but when discharged to England had completely healed, and cerebral condition was quite normal.

It is reported from America that an association to oppose the "twilight sleep" movement is being organized by a lady named Olson. She proposes to endeavour to excite the sympathetic interest of wealthy women in the campaign against that method of mitigating the pains of labour, and to raise money for the circulation of literature.