Remarks

ON

CASES OF NERVE CONCUSSION DUE TO BULLET AND SHELL WOUNDS.

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THE following notes of nerve injuries of this description are from cases which have been under my care at the 4th London General Hospital, and I beg to acknowledge the permission of the Commanding Officer to publish them, and to express my thanks to Lieutenants C. E. H. Milner and D. E. D. Davis for their reports of the cases.

The block of conduction of nerve impulses may be either anatomical or physiological. If it is the former, it is due either to severance of the nerve, to destructive pressure on it, or to crushing. By physiological blocking is meant such a condition of the nerve as arises from a lesion the effects of which are only temporary. It may be that the nerve is deflected out of its course and slightly stretched, or is pressed upon by effusion of blood, or receives a blow transmitted to it through a portion of muscle, or is itself jammed against a bone for a short time. Whatever the cause, it results in such a temporary disintegration or temporary disturbance of that portion of the neuron which renders it incapable of allowing impulses to pass through upwards or downwards. The point, however, to be remembered is that it is a state of affairs in which recovery of power usually ensues.

CASE I.—Concussion of the Posterior Tibial Nerve : Recovery in Four Weeks.

S. R., private, was wounded at the Marne, and was admitted to the 4th London General Hospital on September 20th, 1914. A bullet had passed through the right calf from side to side, just about the middle of the leg and posterior to the bones. The track of the bullet was exactly transverse to the line of the posterior tibial vessels and nerve. There were no evidences of injury to the former, and the bleeding had not been severe. On admission, it was noted that he could not flex the right toe, and this remained in hyper-extension. There was no loss of sensation in any part of the toe or on the sole of the foot, neither was there any complaint of pain in the course of the nerve. The toe was placed in a fully flexed position on a splint, and on October 1st it was noted that when the toe was held straight passively there was just a flicker of movement in the direction of flexion. Gradually this range of movement increased, and on October 25th, that is about five or six weeks after the injury, full movement had returned.

CASE II.—Concussion of the Musculo-spiral Nerve : Recovery in Four Weeks.

A. B., private, wounded by a fragment of shell on September 16th, 1914, was admitted September 27th. A piece of high velocity shell had passed through the soft parts of the outer part of the left arm, at a spot exactly corresponding to the musculo-spiral groove. He could extend the middle finger of the left hand only; the other fingers were in flexion, without any capacity for extension. It was, however, ascertained that the inability to extend the last two phalanges of the index finger was owing to a severance, some years previously, of the extensor tendon, which had failed to unite. The digits, therefore, which had lost the power of extension owing to the shell wound, were the thumb, the ring and little fingers. There was also some loss of complete supination, to the extent of 15 degrees. On October 2nd electrical tests were carried out; there was no evidence of reaction of degeneration, and a good prognosis was given. Sensation in the affected fingers was described as "woolly." On November 3rd, the little finger had recovered, but he could not yet supinate fully. From the time of admission he had been put up in a bent malleable iron splint, so that the wrist and the affected fingers were hyper-extended (Fig. 1). On November 20th all power had returned. There was full supination, and he was able to extend all the digits, except the last two phalanges of the index finger, which, owing to an injury long previous to the shell wound, prevented full extension.

CASE III.—Concussion of the Great Sciatic Nerve : Recovery of Movement in Eleven Weeks.

W. H., private, was wounded in three places by a shell on September 14th, 1914, and was admitted on September 27th. One piece of shell smashed the lower end of the right humerus and the upper end of the ulna, and the ulnar nerve was involved there. Another piece passed along the other side of the thigh inflicting merely a skin wound, and a third entered the posterior surface of the thigh $2\frac{1}{2}$ in. below and behind the great trochanter and came out at the lower end of Hunter's canal. There was apparently complete paralysis of the great sciatic nerve and its branches below the middle of the thigh. The limb lay flaccid in bed, and there was distinct foot-drop. On the fourteenth day after admission, the muscles were tested electrically; no reaction of degeneration was present. I was fortunate in having the opportunity of a consultation with my colleague Major Mott, and he expressed the opinion that this was a case of nerve concussion and not of gross lesion. It was observed at this time that there was great tenderness on digital pressure along the course of the posterior tibial nerve. It is to be noted that in many of these cases pain of this description is a very prominent feature. Major Mott advised that he should have very light massage and hot air treatment. On November 1st it was seen that there was a beginning of recovery of movement in the toes and that sensation was commencing to return in the affected area. He continued to complain a great deal of burning and darting pain during this period. On November 27th, however, the movements of the toes and foot were complete, the foot-drop had disappeared, and localization of touch and pain was perfect. On December 8th there was complete recovery of all the movements below the site of the lesion, and sensation had returned. He still, however, felt much tenderness when pressure was made along the course of the posterior tibial nerve in the calf.

CASE IV.—Concussion of the Facial Nerve : Recovery in Three Weeks.

A. W. R., private, was wounded at the Aisne by a fragment of shell, which caused laceration of the soft part of the vertical ramus of the lower jaw, exactly in the course of the facial nerve. The wound was one-third of an inch deep. In this case the only sign of paresis was a difficulty in closing the left eyelid firmly. This, however, passed off in three weeks, and he made a complete recovery.

CASE V.—Bullet Wound in the Upper Arm, exactly over the Musculo-spiral Groove.

W. C., private, was wounded at the Aisne on September 21st, 1914, and admitted on October 1st. There was no paralysis of the musculo-spiral nerve, although the bullet had passed through the outer part of the upper arm exactly over the musculo-spiral groove. An x-ray examination showed that the humerus had escaped entirely, and there was absolutely no sign of paralysis of the nerve. His arm was thick, and there were plenty of soft tissues over the bone, so that this may explain the absence of nerve symptoms.

CASE VI.—Wound below the Mastoid Process : Late Effects from the Sympathetic Nerve.

J. J., a Belgian, was wounded on October 21st, 1914, at Dixmude and admitted on October 29th. There was a bullet wound just below the right mastoid process. He told us that the bullet had passed into the tonsil and had lodged there, but on the third day he had vomited, and as he put it, he had brought up his tonsil with the bullet in it; this was confirmed by the existence of a large, ragged wound occupying the site of the right tonsil. He was only able to swallow fluids, but articulation was quite clear. From the direction which the bullet had taken, an injury might have occurred to any one of the following nerves: the facial, glosso-pharyngeal, vagus, hypoglossal, spinal accessory, and sympathetic. Yet at the time of admission there was no evidence of injury to any one of these nerves. The difficulty in swallowing, which disappeared entirely before he left the hospital, could fairly be ascribed to the large faucial wound; and the probability is that none of the nerves supplying the pharynx were involved, as his articulation was perfect from the first. However, on November 3rd, it was evident that the right sympathetic nerve was slightly affected, for that pupil was smaller than the left, although it reacted to light. This condition continued until November 12th, when he left, and we could not trace him further.

CASE VII.—*Injury of the Posterior Cord of the Brachial Plexus.*

G. R., private, was wounded by a bullet on September 22nd, 1914, and was sent to the Auxiliary Hospital No. 173 in the Champs Elysées, Paris. The wound was situated just below the clavicle and had healed completely. He brought with him an excellent report from Miss Grace Judd, M.B., B.S., which I quote verbatim:

There was some general wasting in the right arm, most prominent on the under surface of the forearm, but in the biceps and about the shoulder the wasting was moderate. Complete paralysis of the following muscles was present: The extensor communis digitorum, the extensor carpi radialis longior, the three extensores pollicis, the supinator longus and brevis, and the triceps. Partial loss of power existed in the flexor carpi radialis, the deltoid, biceps and brachialis anticus, teres minor, latissimus dorsi, and supraspinatus. The muscles which had escaped were the adductor pollicis, flexor brevis minimi digiti, flexor carpi ulnaris, the pronators, pectorales, trapezius, rhomboids, and the serratus muscles. As to sensation, subjective numbness was felt particularly on the internal surface of the arm and the dorsal surface of the forearm. Pain was present in the arm, especially at night, and the loss of sensation of touch was co-extensive with the muscular distribution of the affected nerves. So, too, was the loss of sensation of pain and temperature. The appreciation of vibration was completely lost in the centre of the most anaesthetic area.

The limb was flexed at the elbow, placed in a sling, and the wrist and fingers were hyperextended and put on a malleable iron splint, which was applied to the anterior surface of the forearm and hand. Improvement continued slowly, and on November 27th he could extend fully the second and third phalanges, but the first only half way. On December 16th there was further improvement in the extension of the first phalanges, and sensation to touch and pain in the affected areas had completely recovered. A radiogram showed that there were four small pieces of shell in the sub-clavicular region. By an electrical examination of the muscles made on November 27th it was found that the triceps, deltoid, supinator longus, and extensors of the wrist and fingers did not react to faradism, whereas the pectoralis major, latissimus dorsi, serratus magnus, trapezius, levator anguli scapuli, biceps, finger and wrist flexors, and the muscles of the thenar eminence reacted fully. There was no reaction of the extensors of the wrist and fingers. It may be observed, by way of parenthesis, that in nerve-grafting cases which I have undertaken, partial recovery of motor power has taken place before any reaction to galvanism and faradism, and this recovery of movement has preceded the re-appearance of electrical reactions by two or three months. In this case the reactions were those of degeneration, but of a temporary nature in some muscles. On December 25th there was observed further improvement in extending the fingers.

CASE VIII.—*Compound Fracture of the Left Elbow: Injury to Musculo-spiral Nerve: Drop Wrist: Slight Recovery of Movement Three Months Afterwards.*

Lance-Corporal J. was wounded at the Aisne and sent to Paris. He was admitted to the 4th London General Hospital on October 31st, 1914. There was a compound fracture of the left elbow due to a shell wound, drop wrist, complete loss of extension of the fingers, and of sensation on the back of the forearm, hand, and fingers. The limb was put into a sling, and a bent malleable iron splint applied, so as to keep the parts in extension. On November 27th there was found a flicker of extension movement in the last phalanges, but no superficial sensation of touch on the extensor surface of the forearm, the hand, or the fingers. He felt the prick of a pin, and could localize it on the back of the forearm and on the first phalanx of the ring finger. On December 15th the last phalanges could be extended about half way. Reaction of degeneration was present in the muscles supplied by the musculo-spiral nerve.

It is a little difficult to gather what is the general acceptance of the vague term "concussion of nerve." Perhaps the following definition may prove acceptable: It is damage done to a nerve trunk without actual destruction of the axis cylinders; and the damage may consist of an effusion of blood between the fibres, following compression of the nerve against a bone by the rapid passage of a foreign body in the immediate neighbourhood of the nerve. In other cases the actual lesion may not amount to haemorrhage, but to a temporary anaemia, or its opposite,

hyperaemia of the nerve; and we require specimens for microscopical examination before we can be quite precise. It is also possible to conceive that in certain large nerve trunks, such, for instance, as either of the popliteal nerves, where the motor fibres can be split up for a very long distance from the sensory, either a motor or a sensory bundle may be injured, so that in one case motor paralysis alone may exist and in another sensory symptoms be present.

When a patient suffering from a projectile wound is admitted, presenting nerve symptoms, the condition of the wound should be noted, whether suppurating, healing, or healed. If the first, and if the case presents symptoms of nerve concussion, we should bear in mind the probability of the strangling effect of scar tissue upon the nerve and the possibility of paralysis of long duration. When, however, the wound is healing or has healed, then that possibility is much less. In all the cases which have been quoted here the state of the wound was most satisfactory; in fact, several had healed almost by primary union. And, if I may say so, these facts reflect the greatest credit upon the completeness of the organization "at the front" for the immediate treatment of the wounded and the skilful arrangements made by the Army Medical Staff for the subsequent care and dressing of the patients.

In all cases a stereoscopic skiagram is taken, on admission, for fragments of shell, or a bullet may, if allowed to remain, compress the nerve trunk, or may produce exudation and subsequent organization into scar tissue. In these events, whenever possible, the fragments should be removed after accurate localization, especially if this shows them to be in the immediate neighbourhood of a nerve trunk, and an opportunity may then be taken of examining into the condition of the latter. If a bone has been splintered or fractured, the probability of fragment pressure is greater and should be adequately dealt with. The sooner all sources of pressure and irritation are removed the sooner will the contused nerves recover. Generally, these cases come to us some days after the injury, either with partial paralysis or anaesthesia, or both, and it is important to determine whether we are dealing with a physiological or an anatomical block—meaning by physiological, interruption of the conductivity of the nerve due to temporary abeyance of its functions, and by anatomical a gross lesion, such as partial or complete division or absolute compression by a bullet or fragment of bone.

Briefly, I may indicate the following points, which are helpful. A partial and irregular paralysis or paresis of muscles supplied by one nerve trunk, such as occurred in the patient described in Case II, some of whose fingers were incapable of extension, is indicative of physiological blocking, such as arises from a small haemorrhage amongst the fibres or around the nerve, or bruising. The electrical reaction of muscles and loss of the sensations of superficial and deep touch, pain and temperature should be inquired into; and from about the tenth day onwards the muscles should be periodically tested for the signs of reaction of degeneration (R.D.). This should be done by an expert, because many fallacies may arise. Total loss of electrical conductivity is conclusive of complete block, whilst the diminution of reaction to the electrical test is of small importance, unless the polar reactions are reversed. The continued presence of R.D. is symptomatic of serious and organic injury to a nerve trunk, but in some cases of concussion R.D. disappears and the muscles respond normally. Persistence of R.D. constitutes, in my opinion, a legitimate cause for exploration of the nerve. Nevertheless, there may be voluntary movements of the affected muscles long before there is reaction to faradism. In differentiating between concussion and gross injury the matter of pain is of great importance. If it be constant in the distribution of the nerve below the lesion, and if there be great tenderness of the nerve trunks, then the probabilities are that we are dealing with a concussion which has been followed by a traumatic neuritis. Pain is often extremely obstinate to treatment in these cases, and is felt long after recovery of movement and the establishment of normal tactile sensation. An absence of trophic lesions of the skin is indicative of absence of gross lesions of the nerve of a destructive nature.

My friend, Major Mott, tells me that he finds light massage and hot air very helpful in such painful cases, and my

experience in other forms of traumatic neuritis has been that the static current of high voltage is very useful. Drugs do not appear to be very successful, but a combination of codeia, dimethyl-amido-antipyrin (so called in the Japanese *Pharmacopoeia*, also known by the name of the German brand, pyramidon) and caffeine may be tried.

One word as to the significance of early recovery of movement. If within a few days after the wound there is ever so slight a flicker in the parts which have been paralysed, then we shall not be far wrong in concluding that we are dealing with concussion, and not with serious injury, likely to be very prolonged in its effects.

Reference may now be made more particularly to the treatment of these cases. If there is an open wound it should be treated antiseptically and thoroughly drained; the essential point is not to be in haste to operate merely because a nerve or nerves appear to be injured, but to wait until it is evident that R.D. is persistent, and that the usual measures such as massage and electrical stimuli have had no effect. An important principle which must be insisted upon here is that, in dealing with parietic or paralytic muscles, they must be always kept relaxed, and this can be done by suitable splinting. The best splint is a malleable iron splint well padded and bent so as to fix the limb, with the affected muscles relaxed; thus, if we are dealing with drop wrist or paralysis of the extensors of the fingers, the splint should be bent at one end so that the hand and fingers lie on it in hyper-extension (Fig. 1), and this position should never be relaxed, even when the splint is taken off for massage and electrical applications. Similarly, in foot-drop the splint

Fig. 1.—Three figures showing the method of securing hyper-extension of a dropped wrist. a, Malleable iron splint; b, dropped wrist.

should be so applied to the posterior surface of the leg and foot that the leg is in dorsiflexion (Figs. 2 and 3). This is, in my opinion, one of the greatest aids to recovery.

As to the time taken, this depends essentially upon the degree of nerve disturbance; thus, it varied from twenty-one days in Case iv to nearly three months in Case iii, and it may be longer. The variations in sensation should be carefully watched and a significant sign is recovery of sensation from above downwards, just as if a stocking were being peeled off down the leg. So long as we are satisfied that recovery of movement and sensation are proceeding, however gradually, we should hold our hands and not operate.

Naturally, there are cases in which it is difficult to be sure at first of the nature of the nerve injury, whether it is concussion, bruising or pressure, or complete destruction of the nerve fibres. Here again, in the absence of a patent cause such as a bullet-laceration of a nerve, it

Fig. 2.—Showing the use and the application of the malleable iron splint for foot-drop. a, Malleable iron splint, before bending; b, dropped foot; c, the splint bent to a right angle and bandaged to the foot, now at right angles; later, the splint may be bent acutely so that the foot is dorsiflexed.

Fig. 3.—A second method of using a malleable iron splint for foot-drop. a, Malleable iron splint; b, dropped foot; c, splint bent and applied to the dorsum of the foot, so that it is held at a right angle.

is most important to wait. When all progress has ceased, we are then sure of the degree of residual paralysis and can plan and carry out suitable operation. Many so-called successful operations on nerves have been fallacious, because sufficient time has not elapsed to allow the degree of residual paralysis, after every form of palliative treatment has been tried, to become evident.

A few words in conclusion as to the treatment of gross lesions. Whenever we have cause to suspect from an x-ray examination that such exists, then the nerve should be explored. When, however, we have waited for the residual paralysis to declare itself, we can operate with a view of removing the pressure of scar tissue or we can decide upon a secondary suture, nerve transference, or nerve anastomosis. These all have their appropriate place in the treatment of nerve lesion from bullet and shell wounds, when the indications are quite clear. The subject of nerve injuries arising from projectiles is an interesting and fascinating one, and some of the extraordinary possibilities which cases present may be inferred from the accounts given of those which have recently come under my notice.

THE Cambridge University Press will shortly publish *An Introduction to the Study of Colour Vision*, by Dr. J. Herbert Parsons, of University College Hospital.

MESSRS. CASSELL AND CO., LTD., announce a fifth edition of Luff and Candy's *Manual of Chemistry*, revised and enlarged by Mr. Candy. Much of the additional matter relates to the theory of ionization and some of its consequences. The section on volumetric analysis has now been extended to include the volumetric aqueous solutions of the new *British Pharmacopoeia*.

ACCORDING to the *New York Medical Journal*, the annual report of the Surgeon-General of the United States Army, which has just been issued, states that during the past year fifty-two army surgeons have published contributions on medical topics, including three books, two prize essays, and one hundred and ten separate articles, some of which have been republished in book form. Among them are a series of articles on the medical aspects of the Civil War, a report of a trip to China, a review of the medical work in Porto Rico by the United States Government, and a number of articles giving the results of original research carried out by the members of the corps.