NOTE ON THE TREATMENT OF GUNSHOT INJURIES OF PERIPHERAL NERVES.

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It has been our experience that peripheral nerves may be affected as the result of gunshot injuries in several ways.

1. Complete destruction or obliteration of a nerve for a considerable portion, even inches, of its course.
2. Complete division.
3. Partial division.
4. Involvement in scar tissue.
5. Involvement in callus following compound fracture.
6. Pressure by a mal-united fragment, following compound fracture.
7. Pressure by a lodged bullet.
8. Bruising.

When the case is first seen the particular variety of injury must, if possible, be diagnosed, as on this will depend the treatment. In making the diagnosis five separate examinations are necessary:—

1. EXAMINATION FOR PRESENCE OF DEFORMITY.

Very often we can tell at a glance which nerve is affected: thus wrist-drop indicates injury to the musculo-spiral nerve; claw-hand, injury to the ulnar; foot-drop, injury to the external popliteal; winged scapula, the nerve to the rhomboids; the mouth drawn to one side, injury to the opposite facial.

2. EXAMINATION OF THE PATIENT'S POWER OF VOLUNTARY MUSCULAR MOVEMENT.

A systematic examination is made of all the movements normally possible, the patient being asked, say, to flex, extend, adduct, abduct, etc., as the case may be; inability to perform any of these movements points to the muscles probably affected, and so to the injured nerve. In making the examination it must not be forgotten that apparent complete paralysis may be due simply to disuse; we discover whether this is so by testing the electrical reactions (see (5)).
Clinical and other Notes

(3) Examination of the Skin and of Cutaneous Sensation.

When the nerve to an area of skin has been divided, either anatomically or physiologically for some months, trophic changes are produced in the latter, such as shrinkage, glossy appearance, loss of hair, formation of ulcers, &c. The finding of such changes in any particular part at once tells us that the nerve to that part is affected. Then again, certain nerves supply definite areas of skin with sensation; if such an area is found to be anæsthetic, the nerve supplying it must be injured. The whole skin of the affected part must therefore be tested for sensitivity to light touch and pin-prick. When the area of loss of sensation does not follow the distribution of a nerve, but is of the type known as "glove-anæsthesia," we know we are dealing with a case of hysterical paralysis. When our examination has shown that a group of muscles supplied by a nerve is paralysed, and that the sensation of the area of skin supplied exclusively by it is normal, we deduce that the injury to the nerve is only partial; on the other hand, when the group of muscles act normally, and the skin only is affected, we know that the nerve trunk has escaped, and that only its cutaneous branch has been damaged.

(4) Radiographic Examination.

This will reveal the site of fracture, the presence of callus, or the abnormal projection of a fragment of bone. It will also locate a lodged bullet.

(5) Electrical Examination of the Muscles.

For this purpose we have used a Lewis Jones condenser furnished with an arbitrary scale of twelve values or strengths. If when the electrodes are applied, a muscle reacts to one of the first four values, it may be said to be normal electrically, and the nerve supplying it is healthy; if only to one of the second four it exhibits the reaction of incomplete degeneration, and the nerve supplying it is partially injured; if only to one of the last four, complete reaction of degeneration is present, and the nerve is so badly damaged that no impulses whatever pass along it.

If a muscle does not react at all, even to No. 12, it is probable that the muscle is irretrievably damaged, apart from whatever injury there may be to the nerve. In practice this instrument has two chief uses: (1) To diagnose which muscles, if any, are cut off from their nerves; and (2) to test by observations made with it at fixed intervals of time, say every two weeks, whether the lesion is recovering, remaining stationary, or progressing.

Treatment.

(1) Operative.—When by the methods just outlined, we discover that a nerve is injured at a certain point in its course, and is not recovering, it is our duty to perform an exploratory operation at the earliest possible moment, which, as a rule, will be as soon as the skin wound has soundly
healed. A long incision is made, with its centre over the suspected point, and the nerve dissected out and dealt with as each case may require, either by freshening the severed ends and suture; or by excision of a neuroma and suture; or by freeing from scar tissue or callus; or by chiselling away projecting bone; or by removing a bullet or piece of shell. Whatever is done to the nerve, it is finally wrapped round with Cargile membrane to prevent adhesion to the surrounding parts, and the skin wound closed with clips.

(2) Post-operative and Non-operative.—Whether an operation is performed or not, the subsequent treatment is the same. It consists in keeping the paralysed muscles constantly relaxed by suitable splints, or other means, and in maintaining their tone by daily massage and individual electrical stimulation, until such time as impulses are again able to pass along their nerve to them. This may be any time from a few weeks to a few years.

Prognosis.

This varies with each case. If there has been no actual anatomical division of nerve fibres, the outlook—provided any necessary operation has been performed—is very hopeful, and complete recovery in the course of from one to six months is to be expected.

But where nerve fibres have been divided, either at the time of injury, or at operation as in the excision of a neuroma, recovery cannot be expected for two or three years, and though partial recovery is common, complete recovery is rare.

In operating, therefore, a neuroma should only be excised where it undoubtedly involves the whole of the nerve; in all other cases the patient should be given the benefit of the doubt. If no recovery follows, the neuroma can always be resected later.

The distance the nerve lesion is from the periphery also affects the prognosis; the greater the distance the longer will be the period of recovery. Suppuration in the original wound is also said to make the prognosis worse, but it only does so indirectly by causing the formation of scar tissue.

The hysterical cases seem to follow no rule; one will get rapidly well under treatment, while another will remain quite unaffected.

The importance of after-treatment in these cases of nerve injury cannot be over-emphasized: if left alone and not kept under constant supervision, until recovery is at least nearly complete, the affected limbs will become in the majority of cases, useless appendages, contracted, shrunk and deformed.

Such treatment can only be carried out in an institution where the patients can attend daily, have their paralysed muscles stimulated, their instruments fitted and repaired, and careful records made of their progress.

It is to be hoped that a wise Government will realize this necessity,
and institute clinics throughout the country, where these and other crippled soldiers can slowly again be made useful members of the community.

The following fourteen cases, which we are enabled to publish through kind permission of Lieut.-Colonel Simson, R.A.M.C., Officer Commanding, Cambridge Hospital, comprise only those which have come to operation; in addition we have had under observation or treatment between twenty and thirty others.

<table>
<thead>
<tr>
<th>No.</th>
<th>Patient</th>
<th>Nerve affected</th>
<th>Condition found</th>
<th>Operation</th>
<th>Subsequent orthopedic operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lee-Cpl. W</td>
<td>Popliteals (R. int. and ext.)</td>
<td>Completely divided</td>
<td>Sutured, 23.10.14</td>
<td>Jones'.</td>
</tr>
<tr>
<td>2</td>
<td>Belgian, B</td>
<td>Upper trunk (R. brachial plexus)</td>
<td>Partially divided and involved in scar</td>
<td>Freed from scar, 3.11.14</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>Belgian, M</td>
<td>Musculo-spiral, R.</td>
<td>Involved in callus of fractured humerus</td>
<td>Freed, 16.11.14</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>Pte. W</td>
<td>Brachial plexus (R., lower cords)</td>
<td>Involved in scar</td>
<td>Freed, 3.12.14</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>Sergt. B</td>
<td>Ulnar, L.</td>
<td>Completely divided</td>
<td>Sutured, 17.12.14</td>
<td>—</td>
</tr>
<tr>
<td>8</td>
<td>Pte. B</td>
<td>Musculo-spiral, L.</td>
<td>Involved in scar, with neuroma</td>
<td>Freed, excision of neuroma and suture, 25.1.15</td>
<td>Modified Jones'.</td>
</tr>
<tr>
<td>9</td>
<td>Pte. M</td>
<td>Musculo-spiral, R.</td>
<td>Completely divided</td>
<td>Sutured, 27.1.15</td>
<td>Modified Jones'.</td>
</tr>
<tr>
<td>10</td>
<td>Belgian, P</td>
<td>Musculo-spiral, R.</td>
<td>Involved in callus of fractured humerus</td>
<td>Freed, 29.1.15</td>
<td>Modified Jones'.</td>
</tr>
<tr>
<td>11</td>
<td>Pte. M</td>
<td>Great sciatric, L.</td>
<td>Involved in scar</td>
<td>Freed, 5.2.15</td>
<td>Jones'.</td>
</tr>
<tr>
<td>12</td>
<td>Pte. P</td>
<td>Popliteal int., R. Popliteal ext. L</td>
<td>Involved in scar, with neuroma</td>
<td>Freed</td>
<td>—</td>
</tr>
<tr>
<td>13</td>
<td>Pte. W</td>
<td>Median, L.</td>
<td>Involved in scar</td>
<td>Freed, 26.2.15</td>
<td>—</td>
</tr>
<tr>
<td>14</td>
<td>Pte. W</td>
<td>Ulnar, L.</td>
<td>Normal</td>
<td>Simple exploration, 23.3.15</td>
<td>—</td>
</tr>
</tbody>
</table>

Besides the exploratory operation on the nerve, a secondary orthopaedic operation has in suitable cases (1, 8, 9, 10, 11) been performed on the affected limb, to prevent wrist-drop and foot-drop. In Cases 1 and 11 this has been Robert Jones’ skin removing operation: but in 8, 9, 10, the skin was merely pinched up into a fold, and kept so by a row of silkworm gut mattress sutures. As far as we are able to judge at present, this is a most satisfactory operation when performed at the wrist.
As regards the results of operative interference, we have to date only knowledge of recovery in three cases—5, 6, and 13. We hope in a later communication to be able to record the after-history of all these cases, with the results obtained. They are enumerated here to give an idea of the type of case met with, and of the operative treatment adopted.

Of these, Cases 1, 5, and 14 are of special interest.

In Case 1 a rifle bullet passed in and out behind the knee of each leg, injuring the left external popliteal nerve, and severing the right internal and external popliteals. The left external popliteal completely recovered in three weeks; it was therefore only "concussed," i.e., the passage of the bullet close to it caused a temporary loss of conductivity in it without producing any macroscopic lesion.

In Case 5 a bullet wound was received in the left buttock on September 14. Three hours later the man began to have great pain in sole of left foot, like toothache at first, and then "like a lot of mice biting it." On October 19, as there was no improvement, sciatic nerve was exposed, stretched, and injected with saline. (Lieutenant J. T.) This relieved the pain for ten days, after which it returned as bad as ever, the patient even threatening to commit suicide because of it. On December 11 the original gunshot wound was explored, and a hole found in the iliac bone; the finger introduced through this into the pelvis felt some shattered fragments of bone surrounding a distorted rifle bullet. The fragments and bullet were easily removed; when the patient regained consciousness after the anaesthetic all pain had gone, and he made an uninterrupted recovery.

In Case 14 the gunshot wound was received on November 7, 1914. When first seen in December, there was typical "claw hand," and loss of epicritic and protopathic sensation over one and a half fingers, suggesting damage to the left ulnar nerve. As examination showed that the injury was only partial, the case was treated by splint, and massage and movements. On March 3, 1915, as, except for the absence of deformity, he was no better, and he complained of pain in the scar whenever he used his hand, the nerve was explored, but was found to be normal. Though it is possible that the symptoms now complained of are simulated, in the absence of other evidence this must be regarded as a case of "concussion" in which the symptoms have been unusually prolonged.