Clinical and other Notes

Since the writing of the above, opportunity presented itself for investigating the canvas growths in tents and marquees pitched in and around Genoa and Bordighera, Italy. The Stemphylium and Macrosporium were again found in all infected portions of the canvas, while the associated organisms resembled those found in Malta. Of these latter the A. tenuis was the most prevalent. Treatment was again applied.

REFERENCES.

A NOTE ON NERVE SURGERY AND ITS RESULTS.

By Captain J. S. KELLETT SMITH.
Royal Army Medical Corps.
Medical Officer-in-charge Electrotherapy and Massage, Summerdown Camp, Eastbourne.

AND

Captain A. L. HOME.
Royal Army Medical Corps.
Surgeon to Central Military Hospital, Eastbourne.

DURING last year 6,636 patients were treated at the Electrotherapy and Massage Department of Summerdown Camp, Eastbourne. The busiest period followed the admissions in May of the casualties sustained in the March "push." The list in that month rose to 1,726, and for twelve weeks afterwards the number of daily treatments averaged over 600. This volume of work was only rendered possible by the enthusiastic spirit shown by Miss C. M. Young (Head Masseuse) and her thirty-nine assistants of the A.P.M.C. No praise is too great for them, and we wish to place on record our appreciation of their fine example at this time.

Neither could the numbers have been dealt with without the system, adopted from the foundation of the Department by Colonel J. S. Bostock, of including all kinds of treatment in each ward. It was thus possible for a masseuse to supervise efficiently as many as five cases at the same time; for example, one man might be in a radiant heat bath, a second having electrolysis, a third interrupted and reversed Faradism, a fourth stimulating his own muscles by a low-tension portable coil, and the fifth receiving actual massage. This system besides being economical in time and cost, also makes for the happiness of patients, who find interest in the company of their fellows and avoid the monotony of a solitary treatment hour.

The number of cases of serious injury to peripheral nerves is shown in the following table. It may be remarked that all instances of minor contusions are omitted, only those being counted in which distinct changes due to nerve block were evident, and in which treatment of muscles was indicated. We have also omitted a few cases of facial, sp. accessory, scapular, and long thoracic paralysis.
Clinical and other Notes

<table>
<thead>
<tr>
<th>Nerve</th>
<th>After operation</th>
<th>Not requiring operation</th>
<th>Found to require and sent for operation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachial plexus</td>
<td>4</td>
<td>19</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Circumflex</td>
<td>14</td>
<td>16</td>
<td>12</td>
<td>42</td>
</tr>
<tr>
<td>Musculo-spiral</td>
<td>1</td>
<td>19</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Posterior interosseus</td>
<td>30</td>
<td>46</td>
<td>29</td>
<td>95</td>
</tr>
<tr>
<td>Median</td>
<td>32</td>
<td>44</td>
<td>66</td>
<td>142</td>
</tr>
<tr>
<td>Ulnar</td>
<td>10</td>
<td>7</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Median plus ulnar</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Anterior crural</td>
<td>12</td>
<td>14</td>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>Sciatic</td>
<td>4</td>
<td>8</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Internal popliteal</td>
<td>8</td>
<td>46</td>
<td>11</td>
<td>66</td>
</tr>
<tr>
<td>Posterior tibial</td>
<td>106</td>
<td>236</td>
<td>154</td>
<td>496</td>
</tr>
</tbody>
</table>

These figures differ from those usually accepted as applying to the relative liability of individual nerves to injury, the explanation being that, as a convalescent hospital we received only selected patients who were beyond a bedridden stage and able to attend to themselves as regards ordinary functions of life. One fact however stands out—namely, the preponderance of ulnar over median injury in wounds of the forearm.

But although our selection of cases was thus modified to some degree, it will be readily understood that by this time we had got far away from the original purpose of a convalescent camp. The number of main nerve injuries discovered here and sent out for operation is significant of the class of injury sent to us. We were no longer bound down to a narrow time limit; we received nerve cases, for instance, immediately after operation and treated them until they reached the safety line. It has been an extraordinary experience. Before the war one rarely had the opportunity of following the progress of a nerve repair; in Summerdown a casual census one day showed no less than 175 cases of nerve injury either waiting operation or in various stages of recovery.

Chief interest centres in those cases in which the diagnosis of the injury to the nerve was made with us, and in which operation was carried out by Captain Home at the Central Military Hospital. We not only had the satisfaction of confirming the diagnosis, but we were also enabled to see the after effects of treatment. Details of these cases are furnished by Captain Home as follows:

From the end of 1916 to May, 1919, sixty-nine cases of nerve operation have been undertaken at the Central Military Hospital, Eastbourne, but records of the seven earliest cases are incomplete. The remaining sixty-two operations were done in the period from October 11, 1917, to April 23, 1919, and properly come within the scope of Captain Kellett Smith's survey, as having in every case but one been the subjects of massage in his department before operation. The sole exception is that of a repatriated prisoner from Germany who had been demobilized, and who on presenting himself to have his A.F.Z.22 completed was discovered to have ulnar nerve paresis after gun-shot wound of forearm. His operation revealed complete division of the nerve. Resection of bulbs and suture were performed, and he has now come under treatment of the massage department during his regeneration period.
To deal therefore with the remaining sixty-one cases of nerve operation—they concern fifty-nine individuals, as in two cases the individual had two operations at different dates.

The injuries were as follows:

<table>
<thead>
<tr>
<th>Nerve Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar</td>
<td>31</td>
</tr>
<tr>
<td>Median</td>
<td>15</td>
</tr>
<tr>
<td>Musculo-spiral</td>
<td>1</td>
</tr>
<tr>
<td>Posterior Interosseous</td>
<td>4</td>
</tr>
<tr>
<td>Sciatic</td>
<td>3</td>
</tr>
<tr>
<td>Median and ulnar</td>
<td>4</td>
</tr>
<tr>
<td>Median, sciatic and musculo-spiral</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total (65 nerves)</strong></td>
<td>69</td>
</tr>
</tbody>
</table>

As one ulnar nerve was divided in two places, i.e., both main trunk and dorsal branch, this makes a total of sixty-six nerves injured. As regards these sixty-six nerves, it was found that the injuries were:

<table>
<thead>
<tr>
<th>Nerve Status</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nerve strangled</td>
<td>15</td>
</tr>
<tr>
<td>&quot; partly divided</td>
<td>10</td>
</tr>
<tr>
<td>&quot; completely divided</td>
<td>41</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>66</td>
</tr>
</tbody>
</table>

The interesting facts that so far emerge are therefore not only the extraordinary frequency of ulnar nerve injury as compared with other nerves, but also the much greater frequency of complete division.

Of these fifty-nine cases, sixteen have been operated upon so recently that it is too early to give any account of their progress.

Of the remaining forty-three cases the results may be tabulated as follows:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite evidence of restoration of nerve function</td>
<td>40</td>
</tr>
<tr>
<td>Transferred to other hospitals</td>
<td>2</td>
</tr>
<tr>
<td>Invalided from Service to receive massage elsewhere</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>43</td>
</tr>
</tbody>
</table>

Of the cases transferred one will be referred to later as a case of nerve bridging. The other case was admitted for operation on account of intense pain—exploration of the ulnar nerve revealed that the nerve was fibrosed for about an inch where it had been wounded. Resection of the fibrosed portion was performed, followed by suture, and first intention healing was secured. The patient was then returned to the convalescent hospital during my absence on leave. His pain recurred almost as badly as ever and he was accordingly transferred to a hospital at Woolwich. The excised portion of the nerve was subjected to microscopic examination and proved to be dense fibrous tissue containing only a few degenerate nerve fibrils.

These operations were all performed under my own eyes. In fourteen cases my colleague, Captain G. G. Wray operated, with my assistance, in one case Major W. C. Long, I.M.S., and in one case Captain G. O. Wells-Cole; in the remaining forty-five cases I was the operator, with the assistance of one or the other of these colleagues.

In every case the diagnosis made by Captain Kellett Smith was confirmed by the operation findings, and the operative procedure adopted has been justified by the results obtained, with the exceptions noted above.

An important factor in the success has, I think, been that union of the operation wound by first intention has been the almost uniform result.
In only two cases has there been any suppuration and in those it has been superficial and confined to the site of the original wound.

Although the foregoing figures lend themselves to many kinds of analyses, it is obvious that in the present notes only a few general deductions can be advanced.

(1) THE MATTER OF DIAGNOSIS (CAPTAIN KELLETT SMITH).

At first very elaborate tests were carried out in all suspected cases, but the rush of work led us to seek safe short cuts as soon as these declared themselves. As a rule there was no difficulty in deciding whether a nerve required surgical investigation or not; the clinical picture as a whole was generally enough to determine this, although confirmatory electrical tests were always applied; but the borderline cases, in which the trophic condition of skin and muscle was more or less good despite paresthesia and paralysis to voluntary control, or those again in which there might even be some residual reaction to Faradism, came into a different category.

Here we learnt to depend very greatly as regards tests upon one electrical reaction, viz.: a peculiarly sluggish relaxation of the muscle after stimulation with the galvanic current. This sign is best elicited for demonstration in cases of ulnar mischief, when the first dorsal interosseus may be used for the purpose. It served as a good friend in strengthening our decision on many occasions. On its evidence we submitted nerves for operation when opinion in other quarters was adverse, and the results always gave us ample justification.

The sluggishness of the galvanic response is, of course, generally accepted as an important part of R.D. Tinel sums up the position quite tersely. Talking of the galvanic hypo-excitability at the motor-point with polar inversion and slow contraction, he says, “Of these three elements, it is slow contraction that seems to be of the greatest importance. Without great hypo-excitability and without polar inversion, slow contraction seems sufficient to characterize the R.D.”

We do not know what Tinel means to cover by the word contraction, but we beg to suggest that the type of the relaxation phase may reveal more than the actual contraction phase and that there is in addition a type of relaxation, difficult to describe, as always when words are applied to movement, which is characteristic of serious nerve block—a relaxation which looks to be something more than mere “passive effect of extension and elastic rebound”—a relaxation in which the muscle bundles seem to relax in independent time, slowly and deliberately, sometimes producing by this independence an almost wave-like effect curiously reminiscent, in this and in their pace, of the behaviour of un-striped muscle. This particular reaction was especially found in muscles kept functional by massage and stimulation over long periods, whilst the tissues were settling down into a fit state for surgical investigation of the governing nerve.

(2) SURGICAL TECHNIQUE (CAPTAIN HOME).

In exploring an injured nerve it is important to expose and isolate the nerve freely above and below the lesion, then tracing the nerve from both ends through the scar area, dividing the adhesions at the expense of surrounding parts rather
than of the nerve. When the nerve has thus been fully traced, it will be evident
whether its continuity has been preserved. Sometimes the two ends are found
to terminate abruptly as bulbs, separated by some interval of scar tissue and out
of alignment. Sometimes the bulbs are connected by a band of scar tissue in
line of the original nerve. Sometimes again there is merely a fusiform thickening
of the nerve which may on close inspection be found only to involve a portion of
its thickness. In such a case the previously ascertained clinical facts will have
prepared the operator to find only partial injury to the nerve.

Lastly, it may be found that when the adhesions have been divided the nerve
trunk shows evidence that it has merely been constricted and compressed without
itself being scarred.

The decision as to whether to resect the fibrosed portion must depend upon
the operator, but he may be guided by the comparison of the hardness and general
appearance of the affected portion with that of the trunk above and will usually
be able to form a satisfactory opinion.

If resection be decided upon, the method I find serviceable is as follows:
With a previously unused knife I make successive incomplete transverse sections
of the suspected portions at each end until I come upon definite nerve bundles.
Then I pass two catgut sutures at opposing sides of one end of the nerve from
periphery to cut surface lengthwise, taking a fair grip of the nerve in the stitch.
Each stitch is then passed from cut surface to periphery at the other end of the
nerve, on its appropriate side, thus as far as possible preserving the anatomical
relations of the component fibres when the cut ends are approximated. In order
to pass these stitches it is more convenient to be able to steady the nerve with
forceps, and this can be done by gripping the portion to be resected in the forceps.
When the stitches are in position, the transverse section can be completed and the
nerve ends brought together; but it is I think best not to tie the sutures until
two more stitches have been inserted again on opposite edges of the nerve, but
this time transversely to its length and about half an inch on either side of the
line of junction. Then, if the nerve ends can be approximated without undue
tension, these four stitches can be tied and the junction inspected; a few more
catgut stitches mainly in the nerve sheath may now suffice to make the union
sound and neat. The transversely placed stitches will be found to reinforce the
longitudinal and not to cut out so easily. But it is of great importance that there
should not be any tension. And to avoid this it may be advisable to prolong
the incision upwards and downwards and expose the nerve more freely above and
below by blunt dissection for several inches. Then in most cases the nerve will
come well together, especially if the neighbouring joint or joints be flexed. The
nerve union thus effected is wiped with sterile paraffin and the wound then closed
with silkworm gut sutures, attempt being made to secure very accurate coaptation
of the skin edges. In a few cases I used Cargile's membrane, but I have found
the paraffin method easier and cheaper and quite as efficacious.

At first I poured a little paraffin into the wound, but I found that in one or
two cases the wound slightly opened to allow of the escape of a little greasy fluid,
which was evidently ejected as a foreign body.

These operations have all been upon limbs and it has therefore been possible
to secure end to end apposition in all but one case by full flexion of wrist or elbow
or knee.
Clinical and other Notes

The one case is of interest. Here the ulnar nerve was completely divided in the forearm and one inch missing. After bulb resection, with full wrist flexion and freeing the nerve as much as possible, we only succeeded in getting the nerve ends within 1/4-inch of one another and so had to be content with a catgut bridge, which, for want of a better material, we wrapped in eggshell membrane procured from a hard-boiled egg. First intention healing followed, but as previously noted, the patient was shortly transferred to a hospital in the North and no further report has been obtained.

In two later cases in which similar difficulty has been encountered the desired end has been achieved in the following way:

In the first case, having failed to get end to end apposition, I proceeded to expose the (ulnar) nerve thoroughly at the elbow with the intention of transplanting it in front of the elbow and so obtaining end to end apposition when the elbow was flexed; but I found that the free exposure had released the nerve so much that the ends met easily (with full wrist flexion), so that I did not transplant.

With that experience, in the second case as soon as I found that end to end apposition could not be secured, I fully exposed the nerve at the elbow and again the fuller freedom obtained allowed the ends to meet when the wrist was flexed.

In the case of the median nerve in the forearm the procedure has been simpler; provided that the nerve was well freed above and below, full flexion of wrist and elbow allowed of end to end apposition even after loss of nearly two inches of nerve, e.g., where the nerve had been divided and the ends were widely separated and bulbous, necessitating free resection before suture.

In some cases my colleague, Captain Wray, resected the nerves obliquely, considering that in this way he obtained more exact coaptation. But I have not done this and from my results see no reason to do so. The proceeding is, to my mind, inclined to be more costly in nerve and more tedious in performance without compensating advantage.

In one case of injury to and partial division of the sciatic, it was noted that the external popliteal fibres alone were involved. On exposure at the seat of injury the nerve was found to be fibrosed about half way through, having evidently been partially divided, and healed by scarring. The nerve trunk was therefore freed more fully above and below, and it was then possible to separate it to external and internal popliteal elements, which were traced up to the point of scarring, when it was found that the external popliteal alone had suffered and that the internal was practically intact. The scar tissue was therefore resected (about one inch) from the external popliteal, which was sutured end to end, the internal popliteal being looped to allow this. The result proved to be highly satisfactory, sensation and voluntary movement returning before the patient left camp some months later on transfer to a hospital nearer his own home in the North.

In the strangulated nerve cases, it has been found that the nerve when freed from the encasing scar, beyond showing evidence of compression, has been of normal appearance and consistency. For this reason no resection has been done
and the results have justified this abstention. In one recent case (median nerve),
partial return of sensation to the affected fingers occurred seventy-two hours after
operation; and this improvement has since been maintained and increased.

None of these operations have been undertaken under three months after the
original wound has been healed and this, I think, is very important with regard
to the possibility of an aseptic operation result.

As regards length of time between wound and operation; I may note that in
the case of a partially divided sciatic with resulting foot-drop the wound was
sustained on November 27, 1917, but on account of prolonged suppuration
(necrosis of femur) the operation was not performed until November 27, 1918,
when partial resection was done. Yet the report on May 1, 1919, was to the
effect that sensation was improving and that voluntary movements of the foot
were returning, though as yet feebly; that is to say that there were definite signs
of restoration of nerve function though massage was considered still necessary
for a further lengthy period.

(3) Results (Captain Kellett Smith).

Does a nerve after division ever completely recover, or, to put it in a different
way, does a muscle ever regain its former condition when its nerve has once
undergone severance?

Our opinion is in the negative. And when we say this it must be understood
that we talk of muscles alone, acting freely and without check caused by any
concomitant results of trophic changes in joints and tendon sheaths. These,
however small, are often responsible for continued weakness of movement,
and ought not to count in weighing the integrity of the muscle-nerve combination
per se.

A muscle group may recover, and very often does recover, to such an extent
that its action differs hardly appreciably from that of its fellow. A musculo-spiral
wrist, for example, may serve so well that very astute examination may be neces-
sary to detect any weakness whatever; but when the test of a forced grip is
applied it is often found that the patient helps the necessary dorsiflexion of the
wrist by pressing against the resistance of the object gripped.

So with an ulnar hand. It may recover to the point that little handicap is
perceived in ordinary use, but the finer movements remain slightly awkward—the
stiff collar stud is difficult to button, writing is less facile, in playing an instrument
the fingers lag a bit.

It is interesting to speculate upon the reason of this residual disability.
Possibly degeneration of some of the motor end-plates may have an influence,
but the most feasible explanation seems to lie in the effect of nerve injury upon
the cells of the anterior cornu. It is known that when a nerve fibre is divided,
although the part central to the lesion remains sound, as a rule the nerve cell is
profoundly affected. To quote from Starling's "Physiology," second edition,
p. 321: "In some cases this change may go on to complete atrophy of the cell,
and consequent degeneration of the whole of its axon. Generally, however, the
cell gradually recovers, so that six months after the lesion no difference will be
observable between the cells on the two sides of the cord." It is reasonable from
this to suppose that we may find in the failure of some of the cells to recover an
explanation of continued motor weakness, and incidentally we have set before us
Clinical and other Notes

a time limit to recovery even under the most favourable circumstances. Moreover the division of a mixed nerve is a different thing to the experimental division of a motor root from which the foregoing deductions are made, and Warrington, in a series of experiments conducted at Liverpool, showed that similar degenerative changes may be produced in the anterior horn-cells by dividing the posterior roots, thus cutting off those impulses by which their activity is normally excited. In the division of a mixed nerve, therefore, we have a double reason for degeneration of the motor cells.

We have noticed a fact which is explicable on this theory. Division of a peripheral nerve whose motor cells are still able to receive associated sensory impulses may be expected to be followed by a more perfect recovery than if the reception of such impulses is impossible. For example, the motor cells of a divided ulnar may still receive a sensory stimulus from the median area in the hand, and vice versa; but if both median and ulnar nerves are destroyed, then the total sum of recovery in each distribution is less than it would have been had either nerve alone been injured.

The patient appreciates the difference after successful operation before the surgeon can demonstrate it, "the fingers feel warmer," "the hand is different somehow, more life in it," "it feels more like my own again," are frequent expressions.

The first obvious signs of recovery are improved trophic condition—the skin approaches normal in appearance, the characteristic blush fades—and a return of protopathic sensation in the anaesthetic area.

The patient takes interest in this latter point and is generally ready to demonstrate the moving boundary of "deadness." Another interesting remark when some measure of voluntary power has been regained, is, "I don't have to think so hard now when holding something in the hand." This argues perhaps not so much a re-training in the higher neuron as a re-establishment of a lower neuron arc.

Our conclusions then are, briefly, that when all circumstances are favourable the best result is short of perfection, but gives what may justly be called an excellent recovery; that the outlook when two associated mixed nerves are injured is not so good; and that, descending through the range to those cases presenting complications known to be adverse to nerve recovery, operation is still fully justifiable, inasmuch as it will probably give a limb of good nutrition adequate to primary functions.

As regards time we cannot be dogmatic even when circumstances appear equal; we have had the surprise of seeing a divided sciatic transmitting voluntary impulses producing full, although feeble movement, to a leg seven months after union; we have seen power restored to a tibialis anticus after three years.

A sentence in the instructions issued by the Ministry of Pensions is very wise, and covers more ground than is apparent at first sight—"Nerves take a long time to regenerate, even when the two ends of a severed trunk have been united by suture, hence the man will require a considerable temporary pension over a period probably of two years."

(For permission to publish these notes we are indebted to Lieutenant-Colonel F. Ashe, R.A.M.C., O.C. Military Hospital, Eastbourne, and Lieutenant-Colonel C. Martin Row, R.A.M.C., O.C. Military Convalescent Hospital, Eastbourne.)