SOCIETY TRANSACTIONS

physician in charge as pseudoparesis, which seemed to be due to the fatigue and exhaustion of the front line. In general, they were somewhat similar to paresis with ideas of grandeur and considerable mental deterioration, but without positive laboratory or physical signs.

Although the work of the psychiatrists may have been very good, many men came to France with mental defects.

When I was in England, in 1915, I saw more wounds of the brain than I did the whole time I was over on my second trip. The reason for this was undoubtedly the use of the steel helmet. Most head injuries did very well. The wounds of the spinal cord were fully as discouraging as those seen in 1915. This was probably due to the high velocity of the bullets used in modern warfare. Many of the patients died. About 30 per cent. of the wounded extremities showed some paralysis and the great difficulty in treating injuries of the peripheral nerves was due to the great distance from home and the lack of beds. As a result, many of these had to be left for secondary operations after they got home with less chance for recovery.

CHICAGO NEUROLOGICAL SOCIETY

Special Meeting, May 27, 1919, Held at U. S. Army General Hospital 28, on Invitation of the Commanding Officer, Col. William N. Bispham

NERVE REGENERATION AND NERVE SUTURE. Presented by Lieut.-Col. Dean D. Lewis.

Colonel Lewis said that within two hours after section of a mixed nerve, evidence of the first step in regeneration could be detected. This first step is the formation of delicate protoplasmic bands which probably originate from the nuclei of the neurilemma. These bands spring from both proximal and distal stump but those from the former are more important, being four times as active as the latter. The protoplasmic bands bridge the gap between the ends, when these are not too far apart, and serve as conduits for the neurofibrils which grow out from the proximal stump. These are produced in great number, many times the number needed for a normal nerve, each axis cylinder sending out a host of them in quest of the distal stump.

When a gap has to be bridged by a transplant, an autogenous transplant is best. The neurofibrils do not penetrate a heterogenous transplant but grow down along its surface. Theoretically, the best transplant would be an auto-transplant with Wallerian degeneration; that is, a nerve about nine to twelve days after division, but experimentally such a bridge has not been found to be superior to a piece of normal nerve.

A so-called neuroma forms on the proximal stump in about nineteen days and is made up principally of spirals of neurofibrils which turn back and wind about the axis cylinders, and of ovoid pads which form on the end of the neurofibrils. Experimentally, it has been found that injection of the nerve with alcohol prevents the formation of a neuroma.

Colonel Lewis advocated neurolysis instead of nerve suture unless there is undoubted anatomic block in the nerve. In many cases the nerve is injured by the projectile but not divided, and a frequent type of lesion is that in which the nerve is embedded in a dense cicatrix of surrounding tissue which causes physiologic but not anatomic block. These are cases for neurolysis.
Colonel Lewis operated on two patients before the society. The first was one of high explosive wound reaching from the greater trochanter to the gluteal fold with paralysis and wasting of all muscles below the knee, some trophic disturbance, no pain. The nerve was found in the midst of scar tissue and obviously had been injured, as at one point it showed a hard fusiform enlargement or nodule. The nerve was freed from enveloping cicatricial tissue and then at the point of the indurated enlargement the hard and thickened sheath was trimmed off with scissors. After removal of considerable tough tissue the nerve where injured was reduced almost to normal size and consistence. In the opinion of the operator this was a much better procedure than to excise the inch or two of indurated nerve and suture the ends. The nerve was then embedded in or surrounded by muscles and the wound closed. The prognosis was considered to be good.

The next case was one of extensive shell wound at the upper third of the forearm involving both ulnar and median nerve. The former had largely recovered, but there had been no motor or sensory improvement in the distribution of the median nerve. This was exposed at the upper part of the wound and traced downward until a definite proximal stump was reached. The operator then looked for the distal stump which finally was located about 2 inches lower. As there were extensive scars from elbow to wrist, it was borne in on the spectator that for such surgical procedures the operator must not only know the anatomy, but must be intimately familiar with all tissues in the region and must be a surgeon of great skill and tenderness. In this case the ends could not be approximated so the cutaneous branch of the radial was dissected out, a piece excised and used as a transplant, being sutured to the trimmed proximal and distal stumps of the divided median. Transplant and stumps were enveloped in muscles and the wound closed. For tubulization of sutured nerves, fat, fascia, cartilage membrane, calf's artery, etc., have been used, but Colonel Lewis believes that all hemorrhage having been controlled, muscles make the best envelope. Colonel Lewis said that the advisability of operating on nerves in the forearm, especially in its lower part, was questionable because the disability caused by the lesion is not great and the postoperative pain is apt to be prolonged and severe. Stiles of Edinburgh and some other surgeons do not operate on such cases. Replying to a question, Colonel Lewis said that he was not an advocate of stripping vessels or nerves of their sympathetic network for the relief of causalgia. He thought the injection of 50 per cent. alcohol into the nerve a better procedure. It relieved the pain, and by the time the effects of the injection wore off the causalgia would have recovered.

Colonel Lewis then presented some patients, although none of them had been operated on long enough to permit one to say anything about the outcome, except those in which neurolysis had been performed. He had on the service some cases in which primary suture was performed in July and August of last year, and there was distinct return of motor power with almost complete return of function.

Two cases that he presented had shown very distinct evidences of return of motor power after neurolysis. One case was one of constriction by a fine cicatricial band, following a high explosive wound of the left arm associated with fracture of the humerus. There had been complete physiologic interruption for six months. The cicatricial band was divided and a muscle neurolysis of the nerve performed. The dissection used to expose the nerve
was made along the intermuscular septum, as few muscle fibers as possible being divided in order to avoid hemorrhage. Within ten days after this operation was performed there were distinct evidences of return of motion in the radial extensors of the wrist. The improvement continued and had been rapid.

In the second case, a machine gun bullet perforated the right arm high up. The bullet had evidently passed along the musculospiral nerve. Physiologic interruption of the nerve had existed for over six months. The nerve was exposed on the inner side of the arm high up before it enters the musculospiral groove. The epineurium was found thickened in two places, and the nerve was imbedded in scar tissue. The nerve was dissected out of this and placed in a new bed. Within twelve days after this operation there was a return of motion in some of the extensor muscles.

Neurolysis is of distinct benefit in such cases for it undoubtedly hastens return of function and prevents the disabilities which arise from continued inactivity of paralyzed muscle groups.

In performing neurolysis, muscles which are comparatively healthy should be used to make the new bed. The dissection, therefore, should be made along intermuscular septums so that the hemorrhage will be reduced to a minimum. When dissected free, the nerve involved is placed in the new muscle bed. This type of operation is to be preferred to the use of free fat, cargile membrane or of a calf's artery hardened in formalin. It is the most satisfactory type of operation for this purpose.

When the nerve has been divided, an end to end suture should be performed. While some doubt has been thrown on Stoffel's work dealing with the internal topography of peripheral nerves, there is no doubt that nonaxial rotation of the nerve is to be desired and that an accurate end to end approximation of corresponding funiculi should be attempted. Epineural sutures of fine catgut or silk are used for this purpose. These epineural stitches pass a little deeper than the epineurium and obliterate any space that might exist between the ends of the nerves. When long defects exist, an attempt to secure end to end anastomosis by posture or displacement of the nerve segments is attempted. He had secured an end to end suture of the sciatic, when the defects measured 7.5 cm. by mobilizing the segments of the nerve and flexing the knee joint.

Defects in the ulnar above the elbow joint may be bridged by dissecting the ulnar nerve out of the groove behind the epicondyle, and displacing it anteriorly, and by flexing the forearm. In all cases where possible, an end to end suture should be made.

If the defect cannot be overcome, nerve grafting should be resorted to, using the autocable graft advised by Huber or calf's fetal sciatic nerve, preserved in 80 per cent. alcohol, as suggested by Nageotte.

These last methods give only a small percentage of successes. Tubulization is uncertain and should be used only in those cases where no other methods can be applied. Resection of a bone, such as the humerus, to overcome a defect in the musculospiral should not be employed. Lateral implantation of a nerve into a neighboring nerve, using the sensory part of the nerve to carry the fibers downward, may be used in cases where the defect cannot be overcome by the ordinary methods. This procedure is practically autotransplantation.
METHODS OF EXAMINATION AND SUPPLEMENTARY MUSCLE MOVEMENTS IN PERIPHERAL NERVE LESIONS. Presented by Major Lewis J. Pollock.

The examination of the motor functions of the patients suffering with lesions of the peripheral nerves was conducted by means of a spring scales and the results noted on a chart showing the imprint of a hand or a foot, in terms of pounds or ounces of pull. This method enabled him definitely to determine the extent of movement of each segment about a joint and called his attention to certain seeming discrepancies which he demonstrated (Fig. 1).

![Fig. 1.—Testing the pronator with spring scales method.](image1)

Record of contractures and range of motion was obtained by molding a lead tape about the segments of joints and tracing the outline on paper (Fig. 3).

Imprints of hands and feet were taken and revealed certain characteristic pictures. In many cases the degree of atrophy was shown more clearly by this method than by photographs (Fig. 4).

Tone was measured by ascertaining the millimeters of mercury necessary to insert a blunt plunger a certain distance into a muscle mass. It was found that only for a short time after a peripheral nerve lesion was incurred, was this method practicable. After fibrosis occurred the resistance to pressure occurred as the result of factors other than tone and the method had to be discarded. In the former instance the difference between normal and paralyzed muscles would be as between 180 and 140 mm. of mercury (Fig. 2). Atrophy
was measured by the water displacement method. Contrary to accepted theories, the degree of atrophy did not bear a constant relation to the severity of the lesion. Many cases that were recovering or had recovered showed a great amount of atrophy, whereas cases of complete anatomic division of nerves showed but little. For example, a recovered sciatic nerve lesion showed 500 gm. of loss, whereas a case of a completely severed sciatic nerve with no regeneration showed but 100 gm. of loss. The degree of atrophy is dependent more on the amount of massage, electricity and passive movements the extremity has had than on the severity of the lesions.

The method of sensory examination differs from that ordinarily employed only in the employment of a wisp of cotton saturated with ether to test extreme degrees of cold. This method is more accurate, simple and convenient than the employment of test tubes.

Fig. 3.—Method of recording range of motion.

Major Pollock called attention to the large and constant overlaps of the peripheral nerves for prick pain and showed cases of combined ulnar and median nerve lesions in which the anatomic area of the sensory portion of the median nerve, with the exception of the distal phalanges, was overlapped by the musculospiral and musculocutaneous nerves. This overlap should not be interpreted as a sign of recovery, and return of sense of prick pain in the area of possible overlap would have to be ruled out in studying regeneration.¹

Major Pollock showed about thirty patients to illustrate various "supplementary movements." (Abstract appears as original paper in this issue.)

¹. An original paper on this subject will appear in a future number of the ARCHIVES OF NEUROLOGY AND PSYCHIATRY.
Fig. 4.—Imprints of (a) sciatic lesion; (b) normal foot; (c) lower brachial flexus; (d) partial median; (e) ulnar; (f) ulnar; (g) ulnar and median; (h) median; (i) ulnar and median.
CRANIOPLASTY. Presented by Major Dallas B. Phemister.

Major Phemister performed an operation to illustrate one method of repair of a large cranial defect. On Oct. 5, 1918, the patient had been struck on the head by a bit of high explosive shell which had carried with it a fragment of the soldier's helmet three-quarters inch into the brain in the left parietal region. The patient was not rendered unconscious and had no aphasia, but the right leg and arm were paralyzed. The arm had recovered to a considerable extent, but the leg was still quite paretic. In the last five months the patient had had six jacksonian fits.

The slightly oval cranial defect was about 1½ inches in diameter, and as defects of this size do not grow less, it had been decided to fill it with a bone transplant. The outer table was removed all around the edge of the defect, leaving the inner table. Thus was prepared a narrow shelf or ledge on which would rest the edges of the transplant. This was cut from the outer table of the parietal region of proper size and shape to fit the defect, care being taken to preserve the pericranium. In chiseling this transplant from the inner table it was cracked into several fragments, but the pericranium held them together and the whole was fitted into the defect and secured by suture. Such transplants grow fast to the surrounding bone, retain their vitality, supply adequate protection and, what is not indifferent to the patient, constitute a marked cosmetic improvement.