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SUTURE OF MUSCULO-SPIRAL (SPLITTING NEUROPLASTY) AFTER EXTENSIVE DESTRUCTION OF THE NERVE; UNUSUAL ORDER OF REGENERATION, LIGHT TOUCH APPEARING BEFORE THE OTHER FORMS OF SENSIBILITY. PRELIMI- NARY NOTE

By R. H. M. Dawbarn, M.D., and Joseph Byrne, M.D.

Dr. Dawbarn's Report.—This patient *æt.* 34, a cloth-cleaner, married, with two healthy children, no history of venereal disease, seven and one half months ago fractured his right humerus in the middle of the shaft. Either then, or from subsequent unfortunate manipulation, the musculo-spiral nerve was divided, where it lies in its groove in the humerus. The radiograph showed very poor apposition of the fragments, and other means failing, Lane plating was performed. The scar of the incision can be seen. It was hoped that the nerve might have only been bruised, not wholly divided, and time was given hoping for an improvement in the inability to use the muscles supplied by the posterior interosseous or arch of the musculo-spiral. After five months, at about two and a half months ago, reoperation was performed; the musculo-spiral exposed in its relationship above the external condyle, and traced backward to its groove, where it was found severed, and above the point replaced by scar-tissue for at least two inches. Dividing the ends until normal nerve-tissue was reached, increased the gap to about three inches. This interval was bridged by plastic neurotomy. The nerve was split at a low point of its distal portion, and the long graft thus made was swung backward into the gap, and its sheath sutured to that of the divided proximal end with finest linen thread. Primary union was obtained. No other nerve was injured so far as could be judged during this operation. Dr. Byrne reports already some little degree of returning sensibility, and the outlook in time seems favorable. Meanwhile an apparatus is worn to avoid a tendency to overflexion of the hand by the unopposed activity of the group of muscles and the patient is being treated by electricity and massage.

Dr. Byrne's Report.—The full neurological report of this case forms a part of a series of cases under observation, and is reserved until the study is completed.

After the plating operation the patient had pain if the arm were moved or the site of injury touched. This pain radiated down the arm to the back of the hand and thumb. Since the nerve was sutured patient

has suffered from slight occasional "jabs" of pain referred to the site of operation. He was first seen by Dr. Byrne April 15, 1915, that is 146 days post operative (plating) and 17 days after nerve suture. Examination showed atrophy of the long extensors with dropped wrist, some atrophy and fibrillation of the first dorsal interosseus. The scar of the skin wound half an inch long lies over the space. No pain was felt unless arm is jarred or site of wound touched. There was loss for all forms of sensibility over the radial portion of the back of the hand and wrist and extending over the radial area on the thenar eminence and dorsum of thumb. On the back of the hand the ulnar limit for light touch and heat at 152° F. roughly corresponded to the extensor tendon of the ring finger. The ulnar boundary for prick loss at 2 was $\frac{1}{4}$ inch less than that for light touch loss whilst the boundary for prick at 12 and for ice corresponded roughly with the tendon of the middle finger. The area of loss for all forms of sensibility included the radial area on the thenar eminence, but that for prick loss at 12 was represented by a space one inch wide by $2\frac{1}{4}$ inches long lying between the metacarpal bones of the index and middle finger, extending up to the level of the web of the thumb and index finger where it tapered off like a night cap, inclining over into the middle of the first interosseus space.

Light touch was preserved in four different small areas on the dorsum of the hand. One of these, *A*, chart April 15, was $\frac{3}{4}$ inch in diameter and located over second interosseus space and metacarpal of middle finger at the level of the web of the first interosseus space. Similar smaller patches $\frac{1}{4}$ inch or less were found as follows: *B*, on same level as *A*, but separated from the latter by $\frac{1}{2}$ inch and resting over metacarpal of index finger; *C*, slightly to ulnar side of thumb metacarpal and slightly distal to middle of shaft of that bone; *D*, one inch proximal to *C* and $\frac{1}{4}$ to $\frac{1}{2}$ inch ulnar to it. The interrupted line in the chart enclosing *A* and *B* indicates that by increasing the stimulus from .0055 to .0095 the areas became fused. The small area *E* showed sensibility for prick at 2 preserved well within the general area of loss for prick at 2. In the study, April 19, similar small islands, *A*, *B*, *C*, were found in all of which sensibility for cold, ice, was preserved. The location of these areas does not correspond with any of the similar areas of preserved sensibility for light touch. The indentation at *B* seen in boundary for cold loss on dorsum of hand, gives a clue to the meaning of these islands of preserved sensibility. Later observations render it almost certain that at a slightly earlier period there existed an island of preserved sensibility for cold at *B*, which was not discovered at the examination, April 15, because inexact methods were employed.

The chart, April 24, shows significant indentations in the bounds for touch, prick and ice. The ulnar boundary for light touch loss has fused with the radial boundary of island *A* of chart for April 15, and the upper wrist boundary shows an indentation that has taken up island *B* of chart for April 16. The area of prick loss at 2 has narrowed also, showing an indentation which evidently corresponds to island *E* for April 15. Most significant of all in chart of April 24 is the marked indentation of the boundary for ice loss at the site of the tabatier. Here the indentation manifestly fuses with island *A*, April 19. At this date islands for light touch began to make their appearance on the thenar eminence followed by usual alterations in the boundaries for touch loss. Finally chart, May 29, shows the following significant conditions. I. An area *B*, $1\frac{1}{4}$ inches wide by $2\frac{1}{4}$ inches long, on dorsum of hand

corresponding to space between metacarpal bones of index and middle fingers at the level of the web of the first interosseus space in which light touch is preserved after shaving, but all other forms of sensibility are lost. On this area the pulling of a hair caused only a sensation of touch and the compass tests, though not quite satisfactory, have shown so far little if any defect. II. An area, *B*, where light touch is absent and sensation for prick and ice preserved. III. Small areas, *E* and *F*, in which sensibility for all degrees of heat and cold is lost but prick preserved. IV. Areas *G* and *H* where sensibility for prick is preserved and that for all degrees of heat and cold lost. V. Area *A*, $\frac{1}{4}$ by $\frac{7}{8}$ inch, at root of thumb on palmar aspect, where sensibility for prick and for all degrees of heat is lost and that for touch and all degrees of cold preserved. A similar smaller area is found at *B* on the thenar eminence. VI. Between *B* and *A* on the thenar eminence is another area, *C*, where sensibility for prick is present whilst that for light touch and for all degrees of heat and cold is absent.

Conclusions are: I. that division of the musculospiral nerve in the upper arm gives an area of loss for all forms of sensibility, epicritic and protopathic, over an area that roughly extends over the dorsum of the thumb, the thenar eminence, in part, and the radial half of the dorsum of the hand and lower wrist. Head and Sherrin (*Brain*, 1905, 28, 116) deny this, insisting that in order to get other than epicritic loss in the dorsum of the hand following section of the radial nerve at the wrist, section of one of the branches of the external cutaneous is necessary. Our conclusion here does not fairly controvert the statement of these authors as the circumstances responsible for lesion of the musculo-spiral in our case might well have caused lesion of the external cutaneous or of one of its branches. There was no evidence of loss of sensibility on the forearm beyond slightly impaired sensibility on a very small area for the weak faradic current and this was doubtful. There was no loss for light touch, after shaving; compasses were perfect and there was no evidence of a line of change for a dragged pin point. II. Pain referred to the arm and hand disappeared when the nerve was sutured. This observation has an important bearing in the light of the author's theory (*N. Y. M. J.*, May 1, 1915) of the mechanism of neuralgic and all forms of paroxysmal pain caused by injury or disease of the nerves. The prime cause of all such pains is interference with normal conduction along the nerve paths. This results in a storing of potential in the cells of the sensory root ganglia with consequent overflow centrally spontaneous or otherwise, causing the paroxysms of pain. When the ganglion cells become exhausted of their stored potential the pain disappears until a reaccumulation of potential occurs. The anesthetic and manipulations incidental to the operation, suturing the nerves, thoroughly exhausts the sensory neurone bodies of their stored potential. This, and not the restoration of anatomical continuity, causes the immediate disappearance of the paroxysms after operation, and under such circumstances it takes some time, usually days or weeks, before the potential has time to reaccumulate in the ganglion cells. Meanwhile protopathic sensibility has returned to some extent and this, which is itself in the main caused by storing of potential in the ganglion cells, prevents that continued storing of potential which ultimately manifests itself in pain paroxysms. Paroxysmal pains of neural origin always result from defects in conduction, especially in the pain and temperature paths, as demonstrated. This holds for all the true neuralgias and this hypothesis explains the results,

good and bad, obtained by diathermy, nerve sections, electricity, etc., as well as the spontaneous cures. III. The dissociation areas observed prove clearly that in the peripheral system separate and distinct sets of fibers conduct impulses for (a) light touch with possibly a separate set for compasses; (b) prick and (c) for each of the various forms of heat and cold, although Dr. Byrne has only seen one or two instances in which epicritic sensibility for cold was apparently preserved where sensibility for ice was lost. IV. The irregular mode of regeneration with the appearance of island areas of returned sensibility with consequent indentations in the boundary of lost sensibility makes us ask the question: how much of this is due to the procedure employed at operation and how much to the peculiarities, overlapping, of the nerve supply of the region.

Head, after experimental section of the radial nerve at the wrist and both branches of the external cutaneous, in his own arm, found an area of dissociated sensibility similar to areas *A*, *B*, *C* and *B* in our chart, April 15. His area was in the region of the tabatier, and on the dorsal aspect of the wrist. The question arises, was the external cutaneous injured in their case at the time of plating the bone, and if so, were the areas of disassociation existent from the time of operation, and not the result of regeneration. Experiments would seem to indicate that these islands were result of regeneration possibly in areas supplied by a nerve (ext. cutan.) that had been injured but not severed. But with this they had the unusual return of epicritic sensibility for light touch before the return of that for prick and for heat and cold. Head's area would be relevant here, but for the fact that there were found other areas in their case—those of loss for prick and for gross heat and cold. The conclusion is that the irregular form of regeneration was due in part to the form of neuroplasty, and partly to injury without severance of the external cutaneous nerve, and partly to the peculiarity, overlapping, of the nerve supply of the areas affected. Even this guess leaves much to be desired and a fruitful field invites further research into the normal mode of regeneration in nerves.

EXCISION OF BRACHIAL PORTION OF ULNAR NERVE FOR
MULTIPLE NEURO-FIBROMATA, WITH RECIPROCAL
GRAFTING OF THE ULNAR NERVE INTO THE
MEDIAN NERVE, AND OF A PORTION OF THE
MEDIAN INTO THE ULNAR; HYPERALGESIA
OF MEDIAN AREA; MECHANISM; PAR-
OXYSMAL NEURAL PAINS

By R. H. M. Dawbarn, M.D., and Joseph Byrne, M.D.

The patient, a young German, æt. 26, cook, single, had no venereal history, nor trauma. Apparently there spontaneously developed, beginning six years ago, a long swelling over the region of the ulnar nerve, and extending from high in the axilla to a point well below the elbow; involving in fact the entire brachial portion of this nerve. This was accompanied by considerable and steadily increasing tenderness of the diseased area, for which condition relief was asked. The tumor mass was in places as large as the fist, and was translucent. The muscular power of the hand, where supplied by the ulnar nerve, while not wholly lost, was largely so, with obvious wasting of the interossei muscles and of the thenar and hypothenar eminences. Electrical reaction (faradic) was absent or greatly impaired compared with the normal side. The muscles involved left no doubt as to