Restoration of Digital Sensation after Transference of Nerves*

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Transfer of nerves to restore digital sensation has little application in clinical practice. Successful transfer will provide only a crude level of sensation. Hence even a mediocre result from anastomosis or nerve-graft is just as satisfactory. But when injury to the nerve is completely irreparable a transfer of nerves may restore some useful function. Sixteen years ago the author performed radial-median anastomosis on 4 patients. All 4 have been re-examined this year. In a fifth case a radial-ulnar anastomosis was performed 2½ years ago. The purpose of this paper will be to describe the quality and nature of the sensory function that was regained, and to discuss some implications of these clinical observations.

Radial-Median Anastomosis

These anastomoses were performed to obtain some useful sensory function in the index finger and thumb of individuals who had irreparable injury of a median nerve. The 4 patients were followed initially for an average of 28 months. Early results will be recounted briefly, and compared with the final results 16 years later. The notes will deal specifically with return of sensation in the autonomous zone, i.e. over the terminal phalanx of the index finger.

Case 1. K.W., aged 16. One and a half years after operation, pin-prick stimulus was delayed over the pad of the index finger but was well localized and could be distinguished from dull stimulus. Heat was slightly delayed over this same area, identified correctly, but referred to the whole finger. Light touch was felt occasionally but was not transposed correctly. It was referred to the medial side of the proximal phalanx of the thumb.

Eighteen years after operation pin-prick over the medial side and center of the pad of the index finger is localized correctly, but pin-prick over the lateral aspect of this phalanx is referred to the radial zone.

Case 2. J.E., aged 27. Two and a half years after operation he had regained crude reception of all forms of sensation except light touch over the tip of his index finger. Stimuli in this median autonomous zone were all referred to the radial cutaneous zone. Stimuli applied to the pad of the index finger were referred to different areas of the radial cutaneous zone according to the character of the stimuli.

Seventeen years later pin pricks over the pad of the index finger are acute but still delayed. The localization of this prick depends on its quality. A single prick is felt along the lateral border at about the center of the finger. Repetitive pricks are felt around a semicircle of the dorsum of the hand between the index finger and thumb. Strong prick is felt in this same area and extends out on the dorsum of the index finger and thumb to the base of their distal phalanges. Hot and cold are not identified.

Case 3. D.S., aged 21. A combined median and ulnar loss. Two years after operation he could not recognize objects by touch but appreciated pinch or pin prick of the pad of index finger as a tingle. He localized the tingle in the finger but could not state where.

Fifteen years later he can distinguish blunt from sharp over the pad of index finger and can differentiate clearly one side from the other with pin prick. He can identify hot and cold running water but not hot or cold contact. He has no recollection of ever having any sensation in the radial cutaneous zone after the operation of transference.

Case 4. F.M., aged 48. One year and 4 months after operation: There had been some return of sensation within 3 months of operation. Transference was complete. Pin prick was distinguished clearly from dull without delay. Heat and cold were recognized with delayed reaction and some over-response.

Fifteen years later pin-prick sensation is diminished slightly and a little delayed but always identified and localized accurately on either side.

Received for publication September 24, 1962.

* Read to Canadian Neurological Society, Winnipeg, Manitoba, June 14, 1962.
or center of the tip of the index finger. Hot and cold are identified. He cannot identify the size of a coin in his pocket with the tip of this finger nor recognize two-point stimulation.

In all of these cases the return of sudomotor function was early and very satisfactory, with restoration of normal cutaneous texture. This benefit contrasted with the comparative lack of recovery of sudomotor activity that is evident so frequently after end-to-end anastomosis.

Radial-Ulnar Anastomosis

Case 5. D.J., aged 13. This was a combined median and ulnar lesion in the upper arm with too much loss of both nerves to allow end-to-end suture. The ulnar nerve from the forearm was used as an autogenous graft to overcome a gap of 11 cm. in the median nerve of the upper arm. Satisfactory regeneration of the median nerve was obtained, with the return of useful power in all muscles of the forearm and the return of accurately localized quick sensation of pin prick over thumb and index finger and 2-point discrimination down to 1 cm. over the index finger (0.5 cm. on the normal side.)

One year after the injury, when it became evident that the median nerve was regenerating well, his radial nerve was severed 5 cm. proximal to the wrist and anastomosed with the distal end of the ulnar nerve. Sensation began to return to his fifth finger within the next year. When he first became certain about this feeling he noted an anomalous condition. If the ulnar side of his hand became itchy and he scratched it, he would feel the scratch in the radial cutaneous zone on the back of his hand. The itching would not be relieved until he scratched the radial zone. This phenomenon disappeared after about 6 months.

Two years after the operation he can identify and localize pin prick over his fourth and fifth finger with an occasional mistake. He always localized repetitive pin prick accurately. He does not have 2-point discrimination anywhere over the fifth finger but can distinguish heat from cold. A strong prick on the ulnar side of his palm occasionally is felt at the site of stimulus and also in the radial zone. All the fingers of this hand perspire less than the normal fingers but cutaneous texture is normal.

Discussion

Restoration of satisfactory function after the transference of peripheral nerves depends upon: (a) The complex factors that affect regeneration; and (b) the ability of the central nervous system to compensate when peripheral connections are altered. The choice of nerves for transference is of obvious importance. Consideration of the distal portion of the radial nerve as a vehicle for sensory stimuli suggests that this nerve may offer some special advantages.

The superficial terminal branch of the radial nerve is composed entirely of sensory (and sudomotor) nerve fibers. None of the fibers that cross the suture line and extend to the periphery is undertaking a hopeless journey. Some intrinsic specific characteristic ensures that sensory and sympathetic nerve fibers cannot establish connections with the motor-end plates of somatic muscle. They are available only for appropriate links.

It has been argued that the usual imperfect recovery of the finer grades of sensibility, after a conventional nerve suture, is an indication that the central nervous system is unable to compensate for abnormalities of peripheral re-innervation. According to this viewpoint the extent of functional recovery depends solely on the proportion of nerve fibers that establish their appropriate peripheral connections. The deliberate transference of peripheral nerves therefore would be destined to failure.

In a recent report from the British Medical Research Council, Bowden states: "On the whole, there is no definite evidence to suggest the existence of compensatory adjustments in the central nervous system to faulty peripheral connections." This observation follows immediately after the description of an unique case. A young man suffered severance of his brachial artery and both median and ulnar nerves. When the densely scarred wound was explored 6 months later the proximal end of the ulnar nerve was unwittingly sutured to the distal stump of the median nerve. Voluntary power returned to median muscles. There was recovery of sensibility which was referred first to the ulnar area, later to the median and ulnar areas and occasionally to the median area alone. Two years after injury the proximal stump of the median nerve was deliberately
sutured to the distal stump of the ulnar nerve. A year later “abnormal pain sensibility had returned to the hypothenar eminence, but was referred solely to the median area.”

In the cases that I have reported the restored perception of peripheral stimuli was oriented correctly in 3 of 4 radial-to-median shunts and in the 1 case of radial-to-ulnar. There was little or no restoration of discriminative sensation. Painful stimuli were recognized and usually oriented correctly. This is in contrast to the results in the median-ulnar crossover case that has been cited.

Studies of localization in the postcentral cortex have revealed discrete areas which appear to be foci for responses from the index and the little fingers. There is not an invariable point-to-point localization, but “an approximate somatopy.” The normal activity in this cortical area is concerned chiefly with discriminative function. Impressions of a painful or thermal character, initiated by stimuli on the surface of the index or little finger, are detected presumably at other levels. But some relay to the cortex must be involved to allow for correlation of these painful and thermal impressions with the body scheme. Unimportant areas on the surface of the extremities, like the radial cutaneous zone, are not likely to have well developed connections with this elaborate system. The radial nerve supplies a pathway to higher centers which has never been preempted by messages of importance for elaboration of the body scheme. When regeneration occurs after radial-nerve transference, and messages get through, finger-hand somatopy is restored with very little confusion.

Summary

These cases have illustrated that, provided there is some measure of technical success, the radial nerve, which nature intends to convey sensations from the dorso-lateral aspect of the hand, may be seconded for duty in other peripheral fields. With new attachments it can be made to convey sensations (albeit crude sensations) from the index or little finger. Correct localization of the restored digital sensation, after transference of peripheral nerves, is dependent not only on the usual variables that affect the prognosis in surgery of the peripheral nerves, but also on the brain’s ability to preserve the body scheme. The radial nerve, as a vehicle, may offer some special advantages in respect to the quality of regeneration and as a highway to new central connections.

References