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PERIPHERAL NERVE INJURIES OF THE UPPER EXTREMITY

Sensory Return of 137 Neurorrhaphies

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The results of sensory recovery of 137 neurorrhaphies of the upper extremity in 96 patients are reviewed. There were 85 primary and 52 secondary repairs. Various factors influencing the results and an evaluation based on the 2-point discrimination test are presented. Secondary repair within 3 months in the hand area gives better results than primary repair.

Key words: nerve injuries; neurorrhaphies; nerve repair, primary/secondary; two-point discrimination

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There are several procedures for evaluating sensory nerve recovery after nerve division, but there is still a lack of objective methods. In most of the tests we have to rely on the co-operation and power of concentration of the patient. Tests for the modalities of temperature, pain and touch do not reveal the whole truth. Even though these modalities appear satisfactory the hand may still function poorly. Tests for the functional value of sensibility—tactile gnosis—are therefore more important. Many authors consider the two-point discrimination test ("compass-test", 2-PD) valuable in grading tactile gnosis and expressing the results numerically (Stromberg et al. 1961, Moberg 1962, Önne 1962, v. Prince & Butter 1967). In addition, there are other interesting ancillary examinations in existence such as vibration sensograms (McQuillan 1970).

The question of primary or secondary nerve repair is still controversial. The main purpose of the present study was to compare the results of primary and secondary nerve repair and to investigate the influence of age, delay in repair and other factors.

MATERIAL

The series consists of 96 patients with 137 neurorrhaphies in the upper extremity treated at the Department of Orthopaedics and Traumatology, University Central Hospital, Helsinki, from 1960–1969 (Kanpaanpää & Bakalim 1973). During this time the operating microscope was not available at this hospital. For this reason no funicular transplants were done. There were 28 females and 68 males in the series. The age and sex distribution can be seen in Figure 1. The follow-up varied from 1–10 years (mean 4 years 11 months). The minimum follow-up was 1 year (3 patients). Nerve lesions caused by glass or a knife were the most common, occurring in 55 patients. Seven patients had attempted suicide. A ragged wound in association with the nerve lesion was treated in 33 cases (circular saw, compression in machine, explosion, bullet wound etc.). The proportion of ragged wounds was

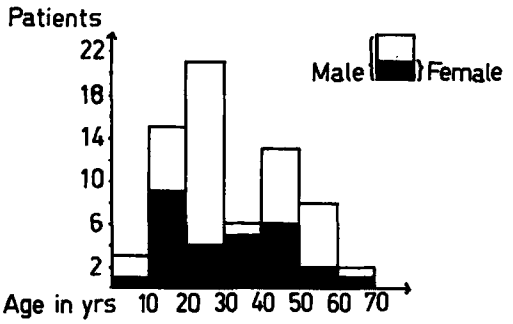

Figure 1. Age and sex distribution of the 96 patients.

higher in the area of the hand and fingers (42 per cent) than in the wrist region (24 per cent). Included were 28 injuries to the median nerve, 23 to the ulnar nerve, one to the superficial radial nerve and 85 to the palmar and digital nerves. Primary repair of the nerve was performed in 85 instances and secondary repair in 52.

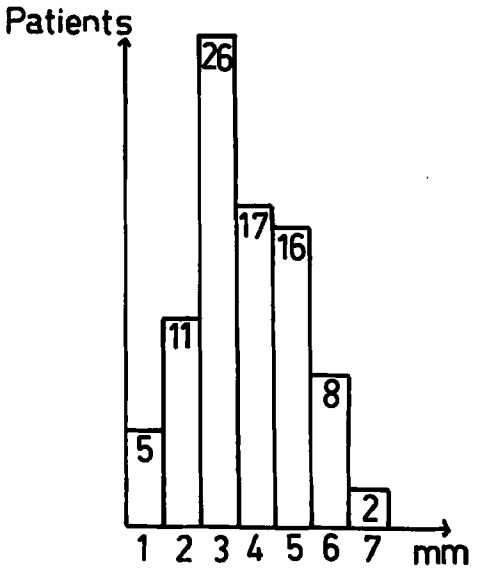

Figure 2. Distribution of the 2-point discrimination values in the uninjured hand of 85 patients. Mean 3.7 mm.

RESULTS

Ninety-six patients were interviewed and examined by the authors. The appearance of the hand was noted, particular attention being paid to the presence of neuromas of the median and ulnar nerves. The Ninhydrin test, light touch (cotton wool), pinprick and two-point discrimination tests were performed. The uninjured hand was also examined using the 2-PD-method. Grading of 2-PD values was done as illustrated in Table 1. This was based on the examination of the fingertips on the control hand (Figure 2). These values can be considered normal and 98 per cent of the patients had a 2-PD ranging between 1 and 6 mm (the poorest finger on the control hand).

Of the 96 patients, nine had some diminished staining of the fingerprints with Ninhydrin, compared with the control fingers. Seven of these belonged to the 2-PD grades III–IV and two to the grades I–II. The remaining 87 patients had a normal Ninhydrin test. Skin atrophy was found on the injured fingers of 20 patients. Atrophy was distributed equally between the four 2-PD grades.

Table 1. Grouping of the results according to the different 2-point discrimination (2-PD) values.

Group	2-PD
I	$\leqq$ 6 mm
II	7–15 mm
III	16–20 mm
IV	> 20 mm

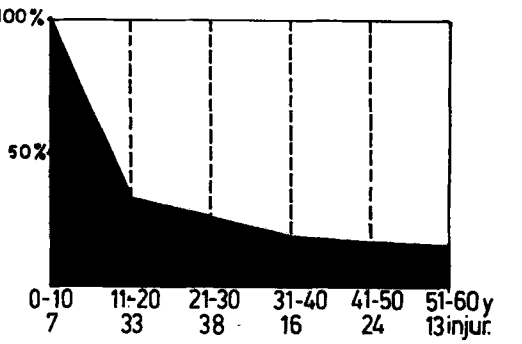

Figure 3. Percentage of 2-PD-grade I ($\leqq$ 6 mm) in the various age groups.

Figure 4. Results in the various nerves

A neuroma was noted in 6 out of 29 patients with median or ulnar nerve lesions. A neuroma was present in the 2-PD grade I in three cases, grade II in two cases and grade III in one case.

The results seem to be influenced by the different degrees of training of the surgeons involved. There were three surgeons who specialized mainly in hand surgery, 10 general orthopaedists and several registrars operating during the years 1960–1969. Seventy-two neurorrhaphies were done by registrars, 28 by general orthopaedists and 37 by hand surgeons. The registrars had 18 per cent good results (2-PD grade I) and the more trained groups 37 and 39 per cent, respectively. Regarding the poorest grade (2-PD IV) the results are reversed: Registrars 47 per cent, orthopaedists and hand surgeons 29 and 26 per cent, respectively.

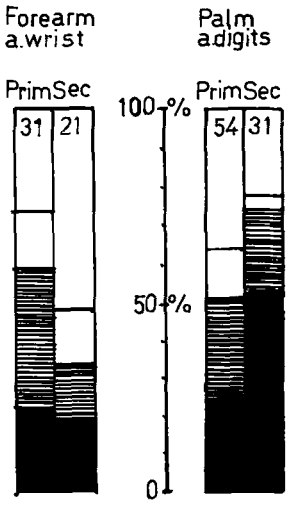

Figure 5. Results of primary and secondary suture of wrist-forearm-arm nerves compared with those of the palm and digits.

The clinical material was divided into age intervals of 10 years (Figure 3). Seven nerve repairs were done in four children aged from 7 to 10 years. The two-point discrimination test was done with care and patience and it can be regarded as reliable. All of them had good sensory recovery. In the two older groups 16–17 per cent obtained good results (2-PD grade I).

Median and ulnar nerve lesions were mainly in the region of the wrist (42/51) the remainder being in the forearm and arm (5/51 and 4/51). The percentage of grade I repairs was as follows: median 25 per cent, ulnar 13 per cent, palmar-digital 34 per cent (Figure 4).

The results of primary and secondary nerve repairs were compared. Considering all the repairs, grade I results were achieved in 21 per cent of the 85 primary repairs and 38 per cent of the 52 secondary repairs. In the palmar-digital group, satisfactory results were found in 24 per cent of 54 primary repairs, compared with 52 per cent of 31 secondary repairs. In the group wrist-forearm-arm, grade I results were recorded in 22 per cent of 27 primary repairs and 19 per cent of 21 secondary repairs (Figure 5).

When the suturing was performed within 24 hours of the injury it was considered to be primary. The secondary repairs were divided into the following groups: 0–1, 2–3, 4–6, and 7–9 months. Forty-nine of the 52 secondary sutures were done within 9 months. The remaining three were repaired after 12 months. Figure 6 illustrates the results of primary repair (left side of the histogram) and the variation in results with time in cases of secondary repair (right side of the histogram). The most suitable time for secondary suture seems to be between 1 and 3 months.

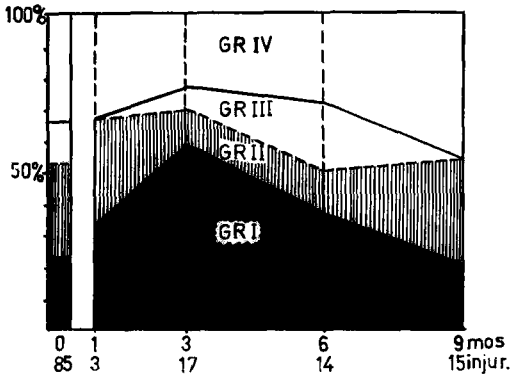

Figure 6. The effect of suture delay on the results, evaluated by the 2-point discrimination test. O = primary suture.

DISCUSSION

Three to five millimeters have been considered to be the normal 2-PD values for adults (Stromberg et al. 1961, Önne 1962, v. Prince & Butter 1967). The present examination of uninjured fingertips gave approximately the same result (Figure 2). Stromberg et al. (1961) and Sakellarides (1962) believe that maximum recovery cannot be expected until 2 years have elapsed from the time of injury.

The Ninhydrin test was developed by Moberg (1958, 1968) and its use was encouraged by, for example, Flynn & Flynn (1962). Since then there have been many authors who do not consider that the return of sudomotor function occurs *peripessu* with sensory return (Stromberg et al. 1961, Moberg 1962, Simon & Mann 1966). The Ninhydrin test was found to be positive within 5–7 months after injury. In the present study we found staining of the fingerprints in 87 of the 96 patients. The test becomes positive before full sensory recovery takes place.

The operating microscope was not available for these nerve repairs. Usually some other form of magnification (magnifying glasses etc.) was used. Hand surgeons performed their neurorrhaphies in the daytime in undisturbed circumstances and most of their repairs were secondary. This, in addition to their experience, may well explain the differences in results.

It is well known that children and young adults achieve the best results after nerve repairs. This has been reported by many authors (Stromberg et al. 1961, Sakellarides 1962, Önne 1962, Brown & Brown 1967) and was found also in the present study. Children seem to possess unknown factors which improve their recovery.

Seddon (1949, 1957) and Brown & Brown (1967) have supported the idea of secondary neurorrhaphy because suturing is technically easier in the thickened epineurium and it is easier to judge the extent of the damage and the infection risk is less. Sakellarides (1962), Önne (1962) and Hagen (1970) advise primary repair if conditions are ideal (cleanly divided nerve, skilful operating team etc.). In this study of nerve injuries to the upper extremity, secondary repairs gave better results. When the injuries were divided into palmar-digital area and forearm-wrist-arm area the former had better results when repaired secondarily but with the latter there was no marked difference between the results of secondary and primary repair. Most of the secondary repairs were done by general orthopaedists and hand surgeons. Another reason is also that the hand-finger area had a higher incidence of ragged wounds (42 per cent) compared with the wrist-forearm area (24 per cent).

Views diverge regarding the timing of secondary nerve repair. Brown & Brown (1967) support the opinion that the longer the delay the greater the chances of irreversible changes in the distal end of the nerve. The most suitable time would be within the first 6 months (Önne 1962, Sakellarides 1962) following injury. According to Seletz (1966) at 3–6 weeks it is possible to see the total limits of the central neuroma and the extent of the

neural damage. The results of the present investigation support the concept of secondary nerve repair especially in lesions of the hand region and under conditions similar to those described in this hospital during the years 1960–1969.

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