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Advances in Peripheral Nerve Repair in Emergency Surgery of the Hand

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The development of microsurgical techniques has changed the surgical treatment of severe hand injuries over the last 25 years. Not only has the repair of vessels by microvascular surgery brought new possibilities of treatment, but the results in repair or peripheral nerves have been improved by the use of new microsurgical techniques, such as perineural suture and interfascicular nerve grafts. The use of vascularized nerve grafts in multiple digit amputations has been a further new idea in emergency hand surgery. The operative treatment of lesions of the brachial plexus has become possible. Nevertheless, the traditional secondary operations such as tendon and muscle transfers are necessary in order to reach an optimal functional reconstruction following nerve injuries.

The function of the hand is especially dependent on the function of its sensory and motor nerves. This fact is illustrated by the scores used in describing the function of the hand. For example, the total loss of median nerve function in an injured hand reduces hand function to 50% of normal. If the surgical treatment of an injured digit results in a digit devoid of sensibility, then the patient will frequently ask the surgeon for an amputation of this digit which is unable to be used in daily life. Even in digital replantation, the integration of replanted parts into the function of the hand is related to sensory recovery.

The subsequent fate of a severely injured hand is determined by the tactical management during the emergency surgery. In our clinic, the choice of method of nerve reconstruction is mainly dependent on the mechanism of injury and associated lesions of other structures.

Classification of Nerve Injuries

In 1943, Seddon [1] described three types of nerve injuries: neuropraxia, axonotmesis and neurotmesis. In 1951, Sunderland [2] found a distribution of 5 types of nerve injuries. Neuropraxia (first degree injury according to Sunderland) is a conduction block without disruption of the anatomical structure of the nerve. Wallerian degeneration does not occur distal to the injury. Nerve function returns after a time interval of 12 weeks. In cases of axonotmesis (second degree injury of Sunderland), Wallerian degeneration occurs. Endoneurium and perineurium are not injured; there will be a complete regeneration as the final result. The third degree injury has a lesion and later a scar of the endoneurium. A complete regeneration of nerve function cannot occur. In fourth degree injuries, the continuity of the nerve is bridged by scar tissue. The Tinel's sign cannot proceed. There will be no spontaneous recovery of nerve function. Neurotmesis (fifth degree of Sunderland) is defined as complete division of the nerve.

Diagnosis of the Nerve Lesion

A thorough and exact clinical examination in a patient with a potential nerve lesion is the most important step in obtaining an accurate diagnosis. Only in rare cases are specialized neurophysiologic tests required to reach the diagnosis. The motor function should be examined by the evaluation of the muscles which are typical for a special nerve. The sensibility should be measured by testing the values of the static and moving two-point discrimination [3, 4]. After a time interval of 6 weeks following injury, the Tinel's sign is a simple but very effective method of localizing a nerve injury.

Surgical Treatment of Nerve Injuries according to the Mechanism of the Lesion

Cut Lesions

The most atraumatic mechanism of injury in hand surgery is the "cut". The nerve lesion is often associated with division of tendons and vessels. In the regions of the digits and the palm of the hand, our goal is the primary repair of all injured structures. The simultaneous microsurgical repair of arteries and nerves and suture of tendons are the methods of choice. After the coaptation of digital or common palmar digital nerves, the hand is immobilized by a plaster splint for 10 days. Dynamic physical treatment of the sutured tendon can be utilized without danger to nerve coaptation.

We find another situation in "cut" lesions in the wrist, forearm and upper arm region. In the wrist region, several flexor tendons and a nerve are often injured simultaneously. By suturing both structures, more scar tissue will develop surrounding the nerve coaptation. Additionally, more tension is

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found between the divided nerve stumps in the wrist area compared to the digital region. The quality of nerve regeneration is diminished by increased tension and increased formation of scar tissue between the nerve stumps [5]. We use primary nerve suture in these regions only in cases where the coaptation can be achieved using 10–0 suture material and by immobilizing the wrist in a functional position. In all other cases we prefer to graft the nerve secondarily.

Laceration Wounds

Lesions in the Digital and Palmar Region of the Hand including Digital Replantations. In emergency hand surgery, we often find circular saw injuries and other mechanisms of trauma causing a primary defect of all injured structures. First, surgical debridement is necessary. There may be associated damage to vessels, tendons and bone, and ultimately subtotal or total amputation. In such cases, we attempt a primary repair of all injured structures. The early use of severely injured digits helps to integrate these digits in the complex function of the hand. Small nerve defects allow primary suture in these regions. In complex hand injuries it is not always possible to preserve a severely injured digit. However, such parts are an ideal source for harvesting nerve and arterial grafts for use in the primary repair of remaining injured digits. In special cases, one can harvest a digital or common palmar digital nerve together with the accompanying artery as a vascularized nerve graft. A further method for primary nerve grafting, even in replantation cases with nerve defects of both palmar digital nerves, is to use, for example, the ulnar-side nerve of the index finger which is not so important for hand function, harvested as a primary graft for the radial-side digital nerve.

Lesions in the Wrist Forearm and Upper Arm Region. In fresh laceration injuries in these regions, we perform a primary repair of the associated injured structures, followed by a secondary interfascicular nerve graft as the preferred method. This kind of surgery should be performed from 6 weeks to 3 months after the injury. In the intervening time period, intensive active and passive physical training is necessary to reach an optimal situation for the nerve grafting procedure.

Amputations in the Wrist, Forearm and Upper Arm Region. In these severe injuries, the destruction of large areas of tissue is common. After radical debridement, shortening of the amputated part is avoided and in most cases vein grafts are necessary for revascularization. We perform a secondary nerve repair with nerve grafts.

Soft Tissue Defects and Nerve Injuries

Defects of vessels, nerves and soft tissue may occur as a result of traffic accidents or crush injury. Following radical debridement, nerves or bony structures may be exposed and must be covered by suitable skin flaps primarily, or at least within 48 hours of injury. Following the repair of bone and vascular structures, soft tissue coverage has the next priority of treatment. Free microvascular tissue transfer to cover such large defects and provide well vascularized tissue coverage has been possible for the last 20 years. In such cases, secondary nerve grafting to reconstruct nerve defects should be performed. A well vascularized bed is essential for the successful survival and function of nerve grafts, especially where long gaps have to be bridged. Therefore, in such cases we rarely see an indication for vascularized nerve grafts [6].

Fractures and Nerve Injuries

Fractures in the upper extremity, typically in the mid-shaft of the humerus, may be accompanied by a radial nerve injury. This may also occur following osteosynthesis. A primary radial nerve palsy is an indication for open reduction, osteosynthesis, and exploration of the nerve. In cases where the radial nerve is in continuity, one should wait up to 6 months for recovery of nerve function. If there is no return of function in this time, a secondary nerve graft is necessary. Where there is a primary nerve disruption, secondary nerve grafting is carried out, 6 weeks to 3 months later.

Special Aspects in Brachial Plexus Lesions. Lesions of the brachial plexus and total amputations of the arm are the most severe injuries of the upper extremity. The personal and social development of the mostly young patients is shattered. The lesions occur after motorcycle accidents or other high velocity injuries. Life saving measures take first priority in the treatment of such cases, including the management of head and intra-abdominal injuries as well as fractures. In cases where the subclavian vessels have been disrupted, vascular repair is essential, and secondary nerve grafting is carried out at a later stage. We perform an exploration and repair of the brachial plexus 3 to 6 months following the accident in all cases in which total or partial paralysis is present. Preoperatively, a program of intensive active and passive physical therapy is commenced. In special cases with partial lesions, splints can improve some muscle function. The principle of operative treatment in brachial plexus lesions is the dissection of the supra- and infra-clavicular components of the plexus. The subsequent intraoperative findings will determine the appropriate surgical procedure. The prognosis is largely dependent on the quality of the proximal nerve stumps or on the preserved continuity of the plexus. The measurement of intraoperative somatosensory evoked potentials can provide important information concerning a possible rupture or avulsion of the proximal nerve stumps [7]. Where continuity of the nerves is demonstrated, a neurolysis is performed. Nerve defects with good proximal stumps should be bridged using interfascicular nerve grafts. Where an avulsion of the nerve roots has occurred, neurotization of the plexus, using parts of the accessory or intercostal nerves to the musculocutaneous and median nerve, is performed (Fig. 1). Only an experienced surgeon should attempt primary repair of brachial plexus lesions (following some injuries, such as shotgun and stab wounds). An integrated concept is necessary for the optimal management of brachial plexus lesions [8]. This concept consists of preoperative and postoperative physical therapy, the use of splints, and a two-stage surgical treatment. The first stage is reconstruction of the nerves. The second stage consists of tendon and muscle transfers, tenodesis or arthrodesis. In our opinion, all stages of therapy should be undertaken in the same clinic. Treatment of a complete lesion extends over a 4 year period. The aim of treatment is to achieve a useful and functional upper limb [9]; a painless stable shoulder, active

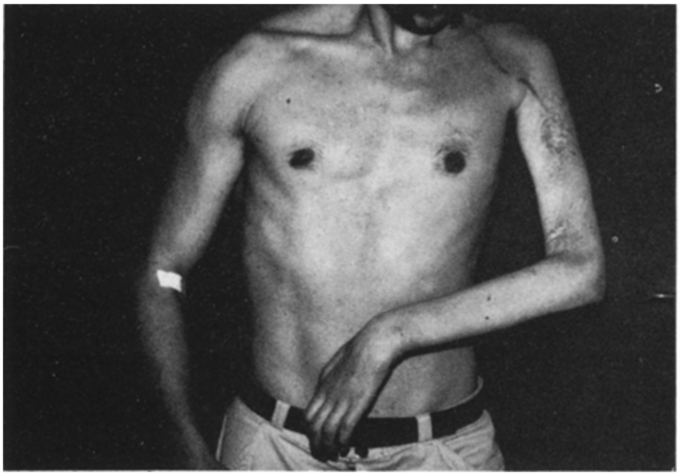

Fig. 1. Postoperative result after intercostal nerve transfer to the musculo-cutaneous nerve in a complete brachial plexus palsy.

Fig. 2. Interfascicular dissection of both nerve stumps before nerve grafting.

elbow joint flexion, and in the hand, primitive sensibility and grip.

Surgical Technique of Nerve Suture and Nerve Grafting. Successful nerve surgery requires atraumatic microsurgical technique, an operating microscope, microsurgical instruments, and 10–0 monofilament suture material. The most important rule in peripheral nerve reconstruction is the avoidance of tension between the nerve stumps when the extremity is in the neutral position [5]. If a primary coaptation between the nerve stumps in not possible using a 10–0 suture, then a nerve graft should be used. Our technique in primary nerve coaptation is to use a mixture of perineural and epineural sutures [11, 12]. We perform the nerve coaptation following removal of the tourniquet in a dry operative field. The goal of therapy is optimal anatomic coaptation with a minimum of suture material. A diagram drawn from a microscopic view of the cross section of the exposed nerve stumps in polyfascicular nerves is helpful in identifying the corresponding nerve fascicles. A soft silicone drain (without suction) is employed. The nerve should lie in a well vascularized bed following wound closure.

For nerve grafting, we use an interfascicular technique [5]. Dissection of the proximal and distal nerve stumps commences in healthy undamaged tissue. Both nerve stumps should be shortened until normal fascicular structures are visible (Fig. 2). Corresponding fascicles or groups of fascicles are identified. The defect is bridged using autologous sural nerve grafts without tension (Fig. 3).

Donor Sites of Autologous Nerve Grafts. Possible donor nerves are the sural nerve, the tibial nerve, the medial and lateral cutaneous nerves of the forearm, and the terminal branch of the posterior interosseous nerve. We harvest the sural nerve through 4 or 5 transverse incisions in the skin of the calf from the ankle to the popliteal region.

Donor Sites of Vascularized Nerve Grafts. Different donor sites for vascularized nerve grafts have been described [12–15]. In emergency surgery of the hand, vascularized digital nerves and

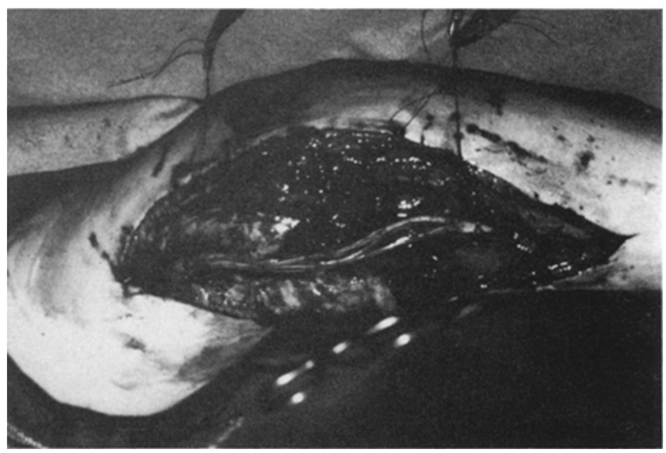

Fig. 3. Interfascicular sural nerve grafts to a 15 cm long defect of the radial nerve.

common palmar digital nerves can be harvested from amputated parts and can be used as primary vascularized grafts for the reconstruction of vessels as well as nerves. In brachial plexus surgery, a vascularized ulnar nerve graft can be used in cases of C8 and T1 root avulsions for the reconstruction of defects in the upper part of the plexus (Fig. 4). Harvesting of the sural nerve as a vascularized nerve graft has the advantage of an acceptable donor site. This site should always be considered in amputation cases where a vascularized nerve graft is required.

Postoperative Treatment. Following nerve grafting, immobilization should be continued for 10 days with a plaster splint, maintaining the intraoperative position of the distal joint. Digital nerve and common palmar digital nerves are immobilized for 10 days, while nerve suture in the wrist and arm region requires 3 weeks. A special plaster cast is required for immobilization of the arm and head in brachial plexus surgery and must be maintained for 10 days. Intensive physiotherapy is necessary after the period of immobilization. Patient motivation

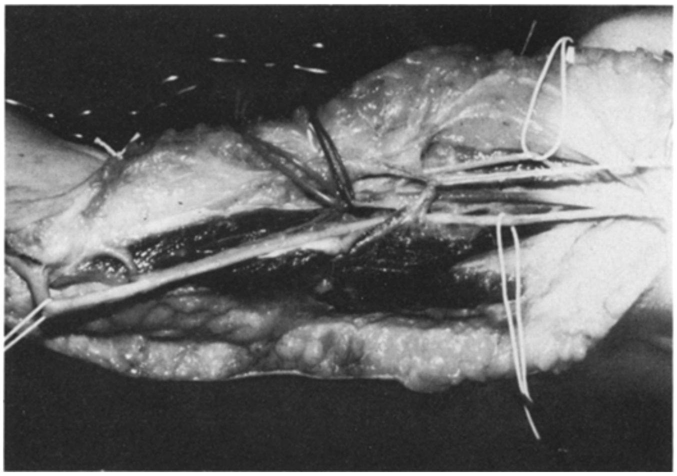

Fig. 4. Blood supply of the ulnar nerve in the upper arm by the collateral ulnar vessels from the brachial artery and vein.

Table 1. Distribution of nerves in primary nerve repairs.

Nerve	No. of nerve repairs	No. of follow–ups obtained
Digital	125	110
Common palmar digital	10	6
Median	17	10
Ulnar	14	10
Radial	2	2
Superficial branch of radial nerve	5	5
Total	173	143 (82.7%)

to regain function of the paralyzed parts is an important factor for later nerve regeneration. Paralyzed muscles should be kept in good condition by external electrical stimulation. Nerve regeneration is monitored in our out-patient clinic every 3 months. Distal progression of a Tinel's sign is an important parameter for monitoring nerve regeneration. Special splints are used to prevent joint contractures pending the return of muscle function. Complete treatment requires more than nerve reconstruction alone in the more proximal lesions of peripheral nerves and in older patients. An acceptable functional result may, in these cases, only be achieved by appropriate muscle and tendon transfers, as well as tenodeses and, sometimes, arthrodeses.

Results of Primary Nerve Sutures. Between May 1981 and December 1985, 173 primary nerve repairs in 143 patients were performed in our clinic. In most cases, digital nerves (72.3%) were injured (Table 1). One hundred and twenty patients with 143 nerve repairs were followed up in a special examination (the follow-up rate was 82.7% of all operated patients). In 86% of the patients, the mechanism of injury was a "cut"; in 14% it was a laceration.

Twenty percent of the patients suffered only nerve injuries. There were additional injuries of tendons and muscles in 18.3%, of vessels in 18.3%, and of bony or articular structures in 19.2%. All patients underwent operation within 48 hours of the accident. Ninety percent of these were evaluated initially in our clinic. The median interval between trauma and operation was 6 hours. Twelve patients had exploratory surgery at other hospitals and were then referred to our clinic for management of the nerve injury. These patients were operated in our clinic 12 to 48 hours later. The follow-up examinations were performed after a minimal time interval of 6 months for digital nerve injuries and 12 months for other cases. The mean interval between nerve injury and follow-up was 24 months.

Table 2. Sensory recovery after primary repair of digital nerves.

Result	No. of nerves	Percentage
Digital nerve		
S0	1	0.9
S1	0	0
S2	1	0.9
S2+	8	7.5
S3	21	19.6
S3+	51	47.7
S4	25	23.4
Total	107	
Common palmar digital nerve		
S2	1	16.7
S2+	3	50.0
S3+	2	33.3
Total	6	

We used the Highet score [16] for evaluation of sensory and motor recovery. The results for the different nerves are shown in Tables 2–4. The values for static 2-point discrimination (s2PD) and moving 2-point discrimination (m2PD) tests were established.

After digital nerve repair, an s2PD could be measured in 71% of cases (Table 5). An excellent result, Highet S4, 2sPD < 6 mm, was obtained in 19%. A good result, Highet S3+, s2PD 7–15 mm was obtained in 27%. A fair result, Highet S3, s2PD > 15 mm was obtained in 18%. A poor result was obtained in 36%.

After digital nerve repairs, the m2PD returned in 79.4% of cases (Table 5). An excellent result, m2PD < 4 mm was obtained in 18%. A good result, m2PD 4–8 mm, was obtained in 15%. A poor result was obtained in 31%.

In 10 cases of median nerve repair, the s2PD returned in 7 cases, and the m2PD returned in 6. There were 2 high lesions at the upper arm level. The s2PD test values were: 3, 6 mm and 2, 8 mm. The m2PD test values were 3, 4 mm and 3, 6 mm. In 10 cases of ulnar nerve repair, the s2PD returned in 7 cases. The m2PD returned in 8 cases. The s2PD test values were: 1, 4 mm, 2, 5 mm, 2, 6 mm and 2, 8 mm. The m2PD test values were: 1, 3 mm, 5, 4 mm and 2 with none.

It was found that the age of the patient significantly affected the results of primary repairs as evaluated by the s2PD and m2PD tests (Tables 6, 7). All of the patients aged 10 years and younger achieved a s2PD of 3–6 mm and a m2PD of 2–6 mm. In the older patients, fewer and fewer attained a measurable 2-point discrimination. In the 51–60 year old patients, 7 out of 18 achieved a discernible s2PD, and 10 out of 18 a m2PD.

There were some factors which influenced sensory recovery following nerve repair. The age of the patient was the most critical factor. The experience of the surgeon was found to be an important point. In the group of patients with the more experienced surgeon, more than 70% of cases achieved S3+

Table 3. Sensory and motor recovery after primary nerve repair at the wrist.

	Sensory			Motor		
	Result	No. of nerves	Percentage	Result	No. of nerves	Percentage
Median nerve						
	S0	2	20.0	M3	1	10.0
	S2+	2	20.0	M4	6	60.0
	S3	1	10.0	M5	3	30.0
	S3+	1	10.0			
	S4	4	40.0			
		Total 10			Total 10	
Ulnar nerve						
	S1	1	10.0	M1	1	10.0
	S2	1	10.0	M2	1	10.0
	S3	2	20.0	M3	3	30.0
	S4	6	60.0	M4	4	40.0
				M5	1	10.0
		Total 10			Total 10	

Table 4. Sensory and motor recovery after primary repair in radial nerve.

Radialis			Superficial branch of radial nerve		
Result	No. of nerves	Percentage	Result	No. of nerves	Percentage
S0/M4	1	50.0	S2+	2	40.0
S2/M4	1	50.0	S3	2	40.0
			S4	1	20.0
Total	2			5	

Table 5. Static and moving 2 point discrimination after primary repair of digital nerves.

2 point discrimination (mm)	Number of nerves (%)	
	static 2PD	moving 2PD
2	–	5 (4.7)
3	7 (6.5)	14 (13.1)
4	6 (5.6)	9 (8.4)
6	7 (6.5)	15 (14.0)
8	10 (9.3)	14 (13.1)
10	9 (8.4)	7 (6.5)
12	10 (9.3)	9 (8.4)
15	8 (7.6)	–
20	13 (12.2)	–
25	6 (5.6)	–
None	31 (29.0)	34 (31.8)
Total	107	107

and S4, compared with 53% in the group of patients operated on by a less experienced surgeon. Furthermore, the influence of an associated injury could be found in the combination of nerve, muscle, tendon and bone injuries. In the group, only 58% of the patients achieved S3+ and S4, compared with more than 70% in which there was only a nerve injury. In 16 patients, Kleinert's traction was used because of associated tendon sutures. In both groups the results were not different from those who were immobilized for 3 weeks. Fourteen patients without tendon injury were immobilized for 21 days. There was no difference in the degree of sensory recovery between these groups of patients.

Sensory re-education [17] was found to be a valuable postoperative adjunct to patient rehabilitation. There was a clear training effect demonstrated in that cessation of sensory re-education and return of the patient after a prolonged interval resulted in diminution of the measured m2PD.

Results of Interfascicular Nerve Grafting. Between May 1981 and December 1985, 161 nerve grafts in 140 patients were performed in our clinic. The distribution of the different nerves can be seen in Table 8. One hundred and seven patients with 119 nerve grafts were followed up in a special examination. The follow up rate was 76.3% of all operated patients. In 57% of the patients, the mechanism of the injury was a "cut", in 40.2% it was a laceration, and in 2.8% it was a more severe lesion. Nerve injuries only were seen in 22.4% of the patients. There were additional injuries of tendons and muscles in 29%, of vessels, tendons, and muscles in 11.2%, of bony or articular structures in 10.3% and of tendons, muscles, vessels and bones in 26%. The initial operations were performed in our clinic in 35.5% of cases. In these cases, primary nerve suture was not possible because of too much tension between the nerve stumps. Most of the nerve grafts were performed between 3 and 8 months after injury (Table 9). In 47% of patients nerve grafts were performed later than the optimal time interval of 6 months due to late referral from other surgeons. The follow-up examinations were performed after a minimal time interval of 6 months for digital nerves and 12 months in the other cases. The mean interval between grafting and follow-up was 24 months. Donor nerve grafts were from the sural nerve in 90.7%, the medial antebrachial cutaneous nerve in 2.8%, both in 1.9% and other nerves in 4.7%. The length of the grafts was less than 3 cm in 19.6%, between 3 and 6 cm in 41.1%, and more than 6 cm in 33.3%.

Table 6. Static 2 point discrimination after primary repairs dependence on age of patient.

Age (yr)	2 point discrimination (mm) 2	3	4	6	8	10	12	15	20	25	None	Total
0–10	–	3	1	4	–	–	–	–	–	–	–	8
11–20	–	3	3	5	3	4	5	4	3	–	9	39
21–30	–	1	2	1	3	2	2	1	4	4	4	24
31–40	–	–	–	–	5	2	1	2	–	3	6	19
41–50	–	–	1	1	1	–	3	1	5	–	12	24
51–60	–	–	–	1	2	2	–	–	2	–	11	18
>60	–	–	–	–	1	–	1	–	–	–	4	6
Total	–	7	7	12	15	10	12	8	14	7	46	138

Table 7. Moving 2 point discrimination after primary nerve repairs dependence on age of patient.

Age (yr)	2 point discrimination (mm) 2	3	4	6	8	10	12	None	Total
0–10	2	2	2	2	–	–	–	–	8
11–20	2	10	4	3	5	4	1	10	39
21–30	1	2	4	2	4	1	1	9	24
31–40	–	–	3	3	4	–	4	5	19
41–50	–	1	1	4	2	1	2	13	24
51–60	–	–	2	4	1	1	1	9	18
>60	–	–	1	1	–	–	–	4	6
Total	5	15	17	19	16	7	9	50	138

Table 8. Distribution of number and sites of nerve grafts.

Nerve	No. of grafts	No. of follow-ups obtained
Digital	21	15
Common palmar digital	8	7
Median	53	39
Ulnar	42	32
Radial	11	8
Peroneal	11	10
Accessory	6	4
Other	9	4
Total	161	119 (73.9%)

Table 10. Sensory recovery of digital nerves after nerve grafting.

Result	Number of grafts
Digital nerve	
S0	1
S2+	3
S3	4
S3+	7
Total	15
Common palmar digital nerve	
S2+	1
S3	5
S3+	1
Total	7

Table 9. Time interval between injury and nerve grafting.

Months	Percentage of grafts
below 1	0.9
2–3	16.8
4–5	34.6
6–8	24.3
9–12	13.1
More than 12	10.3

In 15 digital nerve grafts, 7 patients reached S3+, 4 reached S3, 3 reached S2+ and 1 reached S0 (Table 10). In common palmar digital nerves, 1 patient achieved S3+, 5 achieved S3 and 1 achieved S2+ (Table 10). In median nerve lesions in the forearm, 17 of 26 patients reached S3 or better and 18 of 26 reached M4 and M5. After ulnar nerve repair in the forearm, 9 of 16 patients reached S3 or better and 10 of 16 patients reached

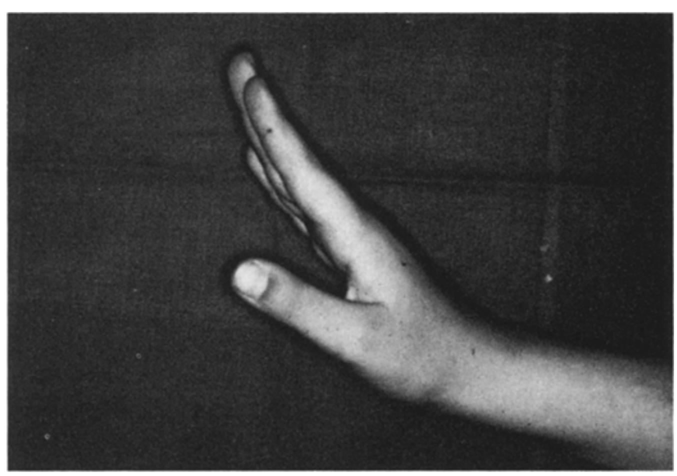

Fig. 5. Result after nerve grafting to the radial nerve in a 15 year old girl.

Table 11. Sensory and motor recovery after nerve grafting.

	Sensory		Motor	
	Result	No. of grafts	Result	No. of grafts
Median nerve, low lesion				
	S0	1	M0	1
	S1	1	M2	1
	S2	2	M3	6
	S2+	5	M4	11
	S3	10	M5	7
	S3+	3		
	S4	4		
		Total 26		Total 26
Ulnar nerve, low lesion				
	S0	2	M1	1
	S2+	5	M2	5
	S3	6	M3	4
	S3+	1	M4	5
	S4	2	M5	1
		Total 16		Total 16
Ulnar nerve, high lesion				
	S0	1	M2	1
	S3	6	M2+	2
			M3	2
			M4	1
			M5	1
		Total 7		Total 7
Combined median and ulnar nerve, low lesion				
	S0	2	M1	1
	S2+	5	M2	5
	S3	6	M3	4
	S3+	1	M4	5
	S4	2	M5	1
		Total 16		Total 16
Combined median and ulnar nerve, high lesion				
	S2+	2	M1+	1
	S3	1	M2	1
	S3+	1	M2+	1
			M3	1
		Total 4		Total 4
Radial nerve				
			M1	1
			M2	3
			M3	1
			M4	2
			M5	1
				Total 8

M3 to M5. After ulnar nerve repair in the upper arm, 6 of 7 patients reached S3 and 4 of 7 patients reached M3 to M5. In combined lesions of the median and ulnar nerves in the lower arm, 9 of 16 patients reached S3 to S4 and 10 of 16 patients reached M3 to M5. In combined lesions of the median and ulnar nerves in the upper arm, 2 of 4 patients reached S3-S3+ and M2+ to M3. In 8 nerve grafts to the radial nerve, 4 patients reached M3 to M5 (Fig. 5). In 2 high lesions of the median nerve, S2+/M4 and S3/M4 were reached. These results are summarized in Table 11.

The age of the patients influenced the results. Except for one case, all of the children reached S3+ and S4. All the children reached M4 to M5. In the 11 to 40 year old patients, 69% reached S3-S4 and 67.3% M3-M5. In the older patient group, 41.7% reached S3-S4 and 41.2% M3-M5. The second factor was the associated injury. In those patients without damage to other structures, 68.4% reached S3-S5 and 81.3% M3-M5. In patients with the combination of nerve, muscle, tendon, and vessel injury, 63% reached S3-S4 and 79.4% reached M3-M5. In the group with bone injury, 61.8% of the patients reached S3-S4 and 19% M3-M5. The length of the grafts also influenced the results. Eighty percent of the patients with graft lengths of less than 3 cm achieved a score of S3-S4, between 3 to 6 cm 61.4%, and more than 6 cm only 43.5%. Eighty two point four per cent of the patients with a graft length of less than 3 cm reached M3-M5, between 5 to 10 cm 75%, and more than 10 cm, only 12.5%. Furthermore, the time interval between injury and grafting was an important factor. In the group with grafting 2 to 6 months following injury, 75.7% of the patients reached M3-M5 and 64.8% S3-S4; in the later treated group, only 38.9% reached M3-M5 and 63% S3-S4.

Résumé

Le dévelopement des techniques microchirurgicales a transformé le traitement des lésions graves de la main ces 25 dernières années. Non seulement la réparation de vaisseaux par les techniques microvasculaires apportait de nouvelles possibilitées de traitement mais aussi les résultats de réparation nerveuse étaient améliorés par les techniques microchirurgicales telles que la suture périneurale et la greffe nerveuse interfasiculaire. L'utilisation des greffons nerveux vascularisés dans les amputations digitales multiples est une nouvelle idée dans la chirurgie de la main. Le traitement des lésions du plexus brachial est une réalité de nos jours. Néanmoins, des interventions sécondaires classiques telles les tranferts de tendons ou de muscle sont souvent nécessaires pour obtenir un résultat fonctionnel optimal après la reconstruction nerveuse.

Resumen

El desarrollo de las técnicas microquirúrgicas ha modificado et tratamiento de las lesiones graves de la mano en los últimos 25 años. La reparación de los vasos mediante cirugía microvascular ha traido nuevas posibilidades de tratamiento, pero los resultados de la reparación de los nervios periféricos han sido mejorados por el uso de nuevas técnicas microquirúrgicas, tales como la sutura perineural y los injertos interfasciculares de nervio. Un nuevo desarrollo en la cirugía de urgencia de la mano es el uso de los injertos vascularizados de nervio en casos de múltiples amputaciones de dedos. El tratamiento operatorio de las lesiones del Plejo Braquial se hizo factible. Sin embargo, las tradicionales operaciones secundarias tales como las transferencias de tendón y de músculo son todavía necesarios para lograr una óptima reconstrucción funcional en las lesiones de los nervios.

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