

THE TREATMENT OF THE UPPER EXTREMITY NERVE INJURIES WITH MICROSURGICAL METHOD AND THE EVALUATION OF THEIR LATE RESULTS

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83 patients, who had a follow up period of 5 years or more among 283 patients, on whom neuroraphy with microsurgical method was applied, were called for the evaluation. According to the detailed sensory, motor and EMG examinations of the 21 patients; 12 acceptable, 1 moderate, 1 insufficient results are obtained in the mix nerves, while 6 acceptable and 1 bad result are obtained in the sensory nerve.

Key words : Neuroraphy, Long follow up period, Upper extremity.

INTRODUCTION

The application of the microsurgical method for the repairing of the nerve injuries leads to an important development as it helps to evaluate the result objectively with its evaluation criteria and testing materials. Nerve injuries in upper extremities are common. The age, the grade and type of the injury and the period between the injury and its repair effect the healing (11, 12). Sunderland (1978) has suggested that, to evaluate the nerve healing after the surgery a period of 5 years for adults and a period of 2 years for children is necessary (17). The aim of this study is to evaluate the sensory, motor capacity and electrophysiology of the nerves, which were operated in the last 5 years or before due to upper extremity nerve injuries, and to evaluate the results we obtained in nerve healing.

THE PATIENTS AND THE METHOD

Nerve repair operations with microsurgical method were applied on 283 patients lesions between April 1986 and March 1993 (Table I). 36 of our cases had upper extremity multiple nerve injuries, 72 had Median nerve injury, 62 had ulnar nerve injury, 9 had radial nerve

injury, 88 had digital nerve cuts and 16 had subtotal cuts in various nerves. Although 83 patients, whom we operated before March 1989 were called, 22 of whom with upper extremity nerve cuts were able to come. The examinations of these patients lasted about 1-1.5 hours and were done by the same doctor, later on all the patients were sent to an EMG laboratory and had their EMGs taken by the same doctor. After all the examinations were done, the physical examination findings and the EMG results were compared (Figure 1).

TABLE - 1

NERVE INJURIES	
DIGITAL	65
COMMON DIGITAL	23
MEDIAN + ULNAR + RADIAL	2
MEDIAN + ULNAR	34
MEDIAN	64
MEDIAN + RADIAL DSD	5
MEDIAN MOTOR	1
MEDIAN SENSORY	1
MEDIAN PALMAR CUTANEOUS	1
ULNAR	54
ULNAR + ULNAR DSD	3
ULNAR + MEDIAN SENSORY	1
ULNAR MOTOR	2
ULNAR SENSORY	1
ULNAR DSD	1
RADIAL DSD	8
RADIAL DORSAL INTEROSSEOUS	1
MEDIAN SUBTOTAL	6
ULNAR SUBTOTAL	7
MEDIAN + ULNAR SUBTOTAL	1
MEDIAN SUBTOTAL + RADIAL	1
MEDIAN SUBTOTAL + RADIAL DSD	1
TOPLAM	283

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The sensitive and motor examinations of the patients were done according to the forms we have developed. Mackinnon and Dellon's modification of Thighet and Sander's nerve specific detailed diagram and BMRC's motor healing grading scale were applied for motor results (2,10). Sencibility for sensitive evaluating by the application of BMRC's diagram of sense healing gradation in nerve cuts, and Janet Wayett's Logic tree diagram (10, 18). The sense tests which were applied are: Hofman-Tinel test, Neuroma Control, Kinetic Touch, Static Touch, Vibration 30 and 256 CPS, Semmens-Weinstein monofilaman test (16, 19), localization, kinetic two-point discrimination (3), static two-point discrimination and object recognition part of the Moberg Pick-up test (13), (Figure 2). sense tests were only measured in autonomic zones. Motor tests, examination of

the extrinsic and intrinsic muscles, grip power, key grip and pulp grip strength measurements were taken, and the ability to make 12 daily activities (1) were asked (Figure 3). Sympathetic vasomotor, sudomotor and trophic situations were examined. Finally, their subjective decisions and complaints were determined. All the test were done with vision blockage according to the written rules (7) after the sensual and visual learning process (Figure 4). The ages of our 22 patients were between 2-61 with a mean of 22.6 years. In our series there are 7 cases between the ages of 0-15, 7 cases between the ages of 16-25, 6 cases between the ages of 26-40, 2 cases between the ages of 41-61. Three of these were female and the remaining 19 were male. 14 patients were injured in the left hand while 8 were injured in the right. In 8 cases, the injury was in the dominant hand and in 14 cases it was in



Figure 1: Blocking the vision.



Figure 2: Complete Test Set-Boxes.



Figure 3: Patient's hadn rest at the putty bad (the Putty bad for the confort of the patient and for the reliability of the tests.)

Table 2: The Treatment of the Upper Extremity Nerve Injuries With Microsurgical Method And The Evaluation Of Their Late Results

MEDIAN and ULNAR NERVES	6
MEDIAN NERVES	4
ULNAR NERVES	5
COMMON DIGITAL NERVES	5
DIGITAL NERVES	2

the nondominant hand. Injury type was sharp in 15 cases, local crush in 6 cases and crush in one case.

The injured nerves were median - ulnar nerves in 6

Table 3: The Treatment of The Upper Extremity Nerve Injuries With Microsurgical Method And the Evaluation of Their Late Results

ARM 1/3 MIDDLE	: 2	
ARM 1/3 DISTAL	: 1	-> PROXIMAL -> 5
ELBOW	: 2	
FOREARM MIDDLE	: 1	-> FOREARM -> 10
WRIST	: 9	
PALM	: 5	-> HAND -> 7
FINGER	: 2	

patients, median nerve in 4 patients, ulnar nerve in 5 patients, multiple digital nerves in 5 patients and digital nerves in 2 patients (Table II). As a result, 10 median nerves, 11 ulnar nerves and 7 pure sense nerves were examined, 5 of the cases had proximal lesion, 10 of the cases had forearm and wrist lesions and 7 had palm and finger lesions (Table III). All of the lesions were total nerve cuts. The period between the occurrence of the lesion and the operation was between 0-1095 days. The average period of delay was 121 days (4 months). Only two of the cases had surgery under emergency conditions. 17 patients had epineural repair. 4 had sural nerve grafting, 1 had repair by an epineural grafting to the median nerve and an ulnar nerve dorsal sensitive branch grafting to the ulnar nerve. The average operation period was 4.7 hours. The accompanying lesions and diseases were arterial cut in 10 cases, flexor tendon cut in 13 cases, hemangioma in 1 case, fracture in 1 case, extensor tendon cut in 1 case,

finger amputation in 1 case and romathoid arthritis in 1 case. After 4 weeks of splinting, the patients began physiotherapy and they were protected for 1 more month with splint. Physiotherapy was applied to the patients in 0-52 weeks, with an average of 7.2 weeks. The follow up period of our patients was between 56-95 months with an average of 70.2 months.

12 patients, among the examined 22, accepted EMG examination. Among those, 2 had median - ulnar nerve cut, 4 had median cut, 5 had ulnar cut and one had common digital nerve cut. Motor unit potential, maximal muscle, contraction spontaneous denervation, sensory and motor conduction velocity, M-response amplitude, sensory and motor distal latencies were determined by a Neurology specialist on each patient and the results were notified. The normal lower limit of the sensory conduction velocity was taken as 40 m/sec, the normal lower limit of the motor response was taken as 3 mV. The decrease in the sensory and motor conduction velocity was accepted as significant for the demyelination and the decrease in M-response was accepted as significant for the axonal degeneration (5).

RESULTS

The results of the detailed motor, sensory, sympathetic and EMG examinations of the 22 patients, whose nerves were repaired with microsurgical to microsurgery method due to upper extremity injuries average 5 years 10 months ago, are seen on Table IV. According to this, cold intolerance is the most common symptom. Insensitivity in 10 cases, hypersensitivity in 5 cases, weakness in 5 cases, colding, pain and sizzling in 4 cases, formication, lack of ability to perceive objects and thin objects, feeling heavy and color difference of skin, and symptoms like these make it clear. Only in 2 of the cases no complaint were given (Table V). In other words, an average of at least two symptoms exists in our 20 cases. In agreement with this, intolerance of cold and insensitivity are observed almost one half of our patients. Hypersensitivity and weakness occurs in a quarter of our patients. However, the patients stated that especially cold intolerance and insensitivity decreased after the fourth year although they were felt significantly in the first two years.

The most common type of the sympathetic and trophic function pathologies is the fingertip arthropathy that is observed on 14 cases. Temperature difference in 10 cases, fingernail pathologies in 6 cases (the narrowing of the nail compared to the opposite side in 2 cases), lack or

Table - 4

	Nerve	Age	Level Injury	Motor BMRC	Duyu		Object Recognition	Hyper	EMG	
					BMRC	JW			Motor	Sensory
1	Median Ulnar	24	Prox Graft	M3 M2	S3+ S3+	S3+ S4	8/12	- -	D* D	AD** AD
2	N. Medianus	29	Prox	M5	S3+	S2	8/12	+	D	AD
3	N. Ulnaris	9	Prox	M3+	S3+	S2+	7/12	-	D	D
4	N. Ulnaris	8	Prox	M3	S4	S4	2/12	-	R	R***
5	N. Ulnaris	30	Prox	M3+	S3+	S2	2/12	+	D	AD
6	Medianus	28	Forearm Ulnaris	M4	S3+ Graft	S2+ M2+	1/12 S3+	+ S2+		
7	Medianus	61	Wrist Ulnaris	M2	S1	S1+ M2	0/12 S1	- S1		
8	Medianus	40	Wrist Ulnaris	M4	S3+	S2 M3+	9/12 S3+	+ S2		
9	Medianus	26	Wrist Ulnaris	M2	S3+	S4 M3	12/12 S3+	+ S2	AD	D
10	Medianus	24	Wrist Ulnaris	M	S3+	S2+ M3	12/12 S3	+ S2		
11	N. Medianus	47	Wrist	M4	S3+	S3+	3/12	+	D	AD
12	N. Medianus	20	Wrist	M5	S4	S4	12/12	+	R	D
13	N. Medianus	11	Wrist	M5	S3+	S4	12/12	-	D	D
14	N. Ulnaris	30	Wrist	M3	S3+	S2	1/12	+	R	AD
15	N. Ulnaris	19	Wrist	M3+	S3+	S2	5/12	+	D	D
16	Com. Digital	17	Palm Graft	-	S4	S4	-	+		
17	Com. Digital	13	Palm Graft	-	S1	S1+	0/12	+		
18	Com. Digital	2	Palm	-	S4	S4	10/12	+		
19	Com. Digital	14	Palm Graft	-	S4	S4	11/12	-		
20	Com. Digital	9	Palm	-	S4	S4	11/12	-		D
21	Digital	17	Finger	-	S4	S4	-	-		
22	Digital	17	Finger	-	S4	S4	11/12	+		

* Demyelination

** Axonal Degeneration

*** Regeneration

insufficiency of perspiration and skin color difference in 4 cases and thinness of the hair in 1 case are noticed. Neither sympathetic nor trophic function pathologies was found in 5 of the cases (Table IV).

In the measurements we made by Jamar dynamometer and Pinchmeter we calculated that the grip power was 75.9, key grip strength was 72.5 %, pulp grip strength was 67.8 %, compared to the normal side. These were 79 %, 71 %, and 67 % in order, for the patients with median nerve cuts. The percentages for the patients with ulnar nerve cuts were 82 %, 78 % and 81 %. These results indicated that 20-30 % of strength loss in median nerve cuts and 20 % of strength loss in ulnar nerve injuries could be observed. We did not come across neuroma formation in the examinations that were done with palpation and percussion on 11 of our patients. Neuroma was determined in the 5 median, 6 ulnar and 3 digital and common digital nerves. Hyperesthesia, although it is one of the major clinical symptoms, was not observed in 8 cases while in 14 cases it was observed due to the complaints of the patient while and the static and moving touch sensation and vibration tests.

Two-point discrimination and Semmens Weinstein Monofilament tests determine the sensory scale directly (18). In our series of 22 cases, only 2 of the patients had lack of two-point discrimination. The SWE values of these patients are between 4.31 and 6.1 with their object

recognition tests are 0/12. One of our patients had an operation at the age of 61 due to wrist level N. Medianus and Ulnaris cuts (Table IV, Patient No. 7) Another patient is 13 years old and had 3 operations due to finger amputations and digital nerve cuts in the last 1.5 years (Table IV, Patient No. 17). The sensory values of both of our cases are S1 and S1 -.

Moving two-point discrimination average was 6.7 mm in the 9 median nerves of our 20 patients, and static two-point discrimination average was 10.4 mm. These values are 8.6 mm and 11.1 mm in 10 ulnar nerve lesions and they are 3.6 mm and 4.8 mm in 6 digital nerve lesions.

In the Semmens Weinstein monofilament test, a normal value of 2.83 and less were achieved in four of the 11 fingers having 3 median, 2 ulnar and 1 digital nerve lesions. Despite this, sensitivity on the protective sensibility level is perceived in the 8 ulnar nerve lesions. It was determined that 20 of the 22 patients had straight localization, 1 had cross localization and 1 had no localization.

The most difficult ones of the 12 daily activities were observed to be cutting with scissors and buttoning up. 5 patients were able to do these 12 daily activities completely. Object recognizing shows the sensory, functional, cortical recognition and perceptive capacity. Our patients have recognized 7 of the 12 objects (approximately 57 %) we use in our daily life. The static and moving two-point discriminations of the patients, the Semmens Weinstein monofilament test results and the distribution and interrelation of the object recognizing results of Moberg's pick-up test were seen.

Although 20 of the 22 patients pointed out that they

Table V: The Treatment Of The Upper Extremity Nerve Injuries With Microsurgical Method and The Evaluation Of Their Late Results

Subjective Symptoms	
Cold Intolerance	11
Colding	3
Aching	3
Hypersensitivity	5
Having Pins and Needles	1
Failure To Recognize Light Objects	1
Failure To Recognize Objects	1
Colour Difference	1
Mild Pain	3
Feeling The Extremity Heavy	1
Weakness	5
Absent	2
Total	42
Absent	2

Table VI: The Treatment Of The Upper Extremity Nerve Injuries with Microsurgical Method and The Evaluation Of Their Late Results

Sympathetic and Trophic Function	
Heat Difference	10
Colour Difference	4
Sweating	4
Pulp Atrophy	14
Nail Growth Disturbances	6
Atrophic Hair	1
Absent	5

were satisfied with their hands, 7 of them had to change their occupations 8 children and 7 adult patients continued with their occupations. In Motor evaluation according to the ratings done by the evaluation scale Of BMRC, 3 of the 10 median nerves had M5, 3 had M4, 2 had M3 and 2 had M2 level motor function rate, while 4 of the 11 ulnar nerves had M3+, 4 had M3, 1 had M2+ and 2 had M2 level motor function rate. Similarly, in the evaluations done according to the criterias of BMRC, the levels for the 10 median nerves were S4 for 1, S3 + for 8 and S1 for 1 nerve. The levels for 7 digital nerve patients were S4 for 6 and S1 for one. Among the 22 upper extremity nerve injuries, 3 median nerves had normal levels in respect to motor, 6 digital nerves had normal levels in respect to sensory and 1 median and 1 ulnar nerves had normal levels (Table IV).

The median nerve had better recovery period than the ulnar nerve, without discriminating level difference clinically, from the aspects of motor and sensory results. 14 nerves of 12 patients were observed with EMG. (Table IV). Among the 13 nerves with motor component the spontaneous denervation potential was found normal in 6 and the motor conduction velocity was found normal in 3. Motor latencies were found on an average of 5.0 m/sec in N. Medianus and 4.0 m/sec in N. Ulnaris. Sensory conduction velocities of a nerve with 14 sense components were determined as normal in one and no response occurred in six. The average of the sensory latencies, N. Ulnaris and Medianus were calculated as 3.2 m/sec. There was no sensory latency response in six patients. The M-response was below 3 mV in only one patient. This was evaluated as moderate axonal degeneration findings. M-responses of the other patients were of normal levels. In the EMG evaluation, in only one of our patients, normal sensory and motor electrophysiologic findings were determined. The findings of this patient are in accordance with the clinical findings (Table IV, Patient No. 4). Apart from this, in 2 of our patients motor electrophysiologic values were on normal levels. (Table IV, patient No. 12, 14).

SUMMARY OF RESULTS AND DISCUSSION

We found out that;

1. For either motor or sensory healing, the age of the patient is of extreme importance (11, 14, 15, 17), the injury level is not a primary determinant (12), grafting and delay have negative effects (14, 15).

2. Findings clinical and of EMG examinations show

parallelism in extremely good and poor cases (4), perfect results could be obtained in pure sensory nerves (6, 7), but a normal sensory would never occur (6, 9), healing of motor function in mixed nerves is better (14), the median nerve has better sensory and motor regeneration than the Ulnar nerve (11, 12, 15).

3. The majority of the patients (20/22) had at least two symptoms (colding, insensitivity) 20 % decrease occurred in the motor strength compared to the normal level, the symptoms continued in the first two years and decreased in the following two years reaching a minimum in the fifth year.

4- As seen in Table IV, our results in mixed nerves are; acceptable: 12, moderate: 1, poor: 1 and our results in sensory nerves are;

Acceptable: 6, poor: 1

P.S: Acceptable > M2S2 ≥ Moderate > M1S1 ≥ Poor (8)

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