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OPERATIVE TREATMENT OF ULNAR NERVE NEUROPATHY IN THE ELBOW REGION

A Clinical and Electrophysiological Study

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Thirty-three patients with ulnar nerve neuropathy due to a lesion in the ulnar groove were operated upon during a 5-year period. All the patients were analyzed preoperatively. One-third of the patients had a history of alcohol abuse. Twenty-five of the patients were subjected to anterior transposition of the ulnar nerve. The results after transposition have been compiled according to etiology, duration, age and alcohol abuse. All seven patients with only subjective symptoms improved; 11 out of 18 (61 per cent) with motor and/or sensory loss also improved but only six (33 per cent) recovered completely. Overall, 21 patients (84 per cent) were improved by the operation. In 11 of the transposition cases the ulnar nerve was examined electrophysiologically before and after operation and an improvement of the motor conduction velocity within the elbow segment of the nerve was found in 10 cases.

Key words: ulnar nerve compression, elbow region; operative treatment; alcohol abuse; electroneurography

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The etiology and operative treatment of ulnar nerve neuropathies in the elbow region have been discussed in many papers since the first operation for this lesion was performed by Panas (1878).

The ulnar nerve can be subjected to a primary lesion due to direct trauma or damaged as a consequence of a fracture about the elbow region. Neural involvement may occur several years after a fracture due to valgus deformity of the elbow and stretching of the nerve during flexion.

The anatomical features around the ulnar nerve may be responsible for compression neuropathy. When the ulnar nerve passes from the extensor aspect of the humerus into the forearm in the "cubital tunnel" (Feindel & Stratford 1958) it may be compressed between the fascial band bridging the two heads of the flexor carpi ulnaris and the capsular floor of the ulnar groove. The width of the tunnel is reduced in flexion of the elbow. Another factor causing narrowing of the cubital tunnel is synovitis with effusion (from osteoarthritis or rheumatoid arthritis) which protrudes into the groove. Rarely ganglia and soft tissue tumors may compress the nerve. In

some instances recurrent dislocation of the ulnar nerve may cause neuritis. Finally a group of patients remains in which none of these etiological factors are represented.

Three general categories of operative procedure have been used in the past:

1) Anterior transposition of the nerve, subcutaneously (McGowan 1950, Goldware & Maxwell 1972) or buried in the flexor mass (Childress 1956, Levy & Apfelberg 1972).
2) Neurolysis, i.e., breaking up of perineural adhesions (Osborne 1957, Feindel & Stratford 1958, Wilson & Krout 1973).
3) Epicondylectomy (Nicolle & Woolhouse 1965, King & Morgan 1970).

In this paper we present the etiology and clinical findings of 33 cases of ulnar groove syndrome, treated over a 5-year period. Of these, 25 were treated by anterior transposition of the ulnar nerve and were selected for a more intensive postoperative and recuperative study. The remaining eight patients received only freeing of the nerve.

MATERIAL AND METHODS

At the Orthopedic Clinic of St. Göran's Hospital, Stockholm, 33 patients underwent operation for ulnar groove syndrome during the period April 1969 to April 1974. The patients were referred to the orthopedic clinic from other clinics or from general practitioners. There were 11 women and 22 men and their ages varied from 9 to 69 years. The mean age was 48 years. Nineteen patients were "whitecollar workers", housewives or retired persons. Eleven patients were laborers. Three were children.

All patients were operated on. In 25 cases anterior transposition of the nerve was performed, while extra-epineural decompression was carried out in the remaining eight cases. Twenty-seven patients were examined with X-ray prior to operation.

Etiology

As the etiology was obscure to us in many cases, and as the majority of the cases in our material cannot be classified as post-traumatic, we suggest a classification as shown below:

A. Post-trauma neuropathy	12	
Fracture in the elbow region	(11)	Primary neuropathy 8
Dislocation of the elbow	(1)	Late onset of neuropathy 4
B. Non-traumatic neuropathy	21	
Postoperative	(1)	
Recurrent subluxation of the nerve	(2)	
Rheumatoid arthritis	(4)	
Idiopathic neuropathy	(14)	
Total	33	

A. *Post-traumatic neuropathy.* In this group eight patients had sustained intra-articular fractures with gross displacement, and two patients had small fractures about the proximal part of the ulna. Two children with fractures of the shaft of the humerus had been treated with olecranon traction.

Eight patients who had the onset of their ulnar nerve symptoms at the same time as the accident are classified as primary. The late neuropathy group, consisting of four patients, had all sustained fractures in or about the elbow. They developed their symptoms 3 months, 2, 7, and 56 years after the accident.

B. *Non-traumatic neuropathy.* In one patient the symptoms appeared after resection of an osteoid osteoma of the olecranon. Neuropathy in this case may have been due to prolonged stretching of the nerve in flexion during the immediate postoperative period. Four patients suffered from advanced rheumatoid arthritis. There were two patients with recurrent subluxation of the ulnar nerve. In the remaining 14 cases of the non-traumatic group, no exogenous factor was found explaining the nerve damage and they are classified as idiopathic.

A history of alcohol abuse (alcohol consumption: minimum 1 litre per week) was found in 11 patients. Eight patients could be referred to the idiopathic group, the remaining three belonged to the fracture group.

Duration of symptoms prior to operation

In the primary post-traumatic neuropathy group the mean duration of symptoms was 18 months, ranging from 1 day to 7 years. In the late post-traumatic group the duration of nerve symptoms varied from 4 to 19 months.

In the non-traumatic group the mean duration

Table 1. Etiology and symptoms in the whole material (33 cases).

Etiology	No. of cases	Subjective symptoms			Muscular wasting	Signs			Only subjective symptoms
		Numbness	Pain	Coldness		2 PD			
						No	7–15 mm	6 mm	
EFL primary	8	7	3	2	5	5	2	0	1
EFL late	4	4	4	1	1	1	0	3	3
Postoperative	1	1	1	0	0	0	1	0	0
RLU	2	0	2	0	0	0	0	2	2
RA	4	4	4	1	0	1	2	1	1
Idiopathic	14	14	8	3	12	8	4	2	1
Total	33	30	22	7	18	15	9	8	8
Alcohol abuser	11	11	6	4	8	6	3	2	2

EFL = Elbow fracture or luxation. RLU = Recurrent luxation of the ulnar nerve.
RA = Rheumatoid arthritis.

of symptoms was 11 months, ranging from 1 month to 24 months.

The alcohol abuse group presented a mean duration of symptoms of 17 months.

Clinical features

All the patients were right-handed. The neuropathy was confined to the right arm in 16 of the 33 cases and in the idiopathic group in five cases out of 14.

Symptoms: The dominant subjective symptoms were numbness and tingling in the little finger and the ulnar half of the ring finger and weakness of grip. These symptoms were present in all cases except three. Pain along the ulnar nerve in the forearm and hand was a dominant complaint in 22 cases. Seven patients had a sensation of coldness in the ulnar fingers. Eight patients had only subjective symptoms (Table 1).

Signs: All patients demonstrated a positive Hoffmann-Tinel's sign distal to the ulnar groove, indicating the level of the nerve injury. At clinical examination 18 patients demonstrated atrophy of the first interosseous muscle and the same 18 patients had positive Froment's sign, i.e., pronounced flexion of the interphalangeal joint of the thumb when pinching with the index finger. No patient had motor impairment exclusively.

The sensibility was measured on the volar aspect of the fifth fingertip with the two-point discrimination test (2 PD). Fifteen patients had complete loss of 2 PD, nine patients had impaired 2 PD (7–15 mm) and eight patients had normal or close to normal 2 PD (below 7 mm). In one patient sensibility could not be tested because of a previous finger amputation.

In the primary post-traumatic neuropathy group, seven out of eight patients demonstrated signs of motor and/or sensory dysfunction. In the late post-traumatic group three patients out of four had only subjective symptoms. Among the 14 patients in the idiopathic group there was only one patient with solely subjective symptoms.

Electrophysiological examinations

Estimation of motor nerve conduction velocity (MCV) was performed on 13 of the patients, of which 11 belonged to the transposition group (four from the post-traumatic and seven from the non-traumatic group). Only the results from these 11 patients will be discussed here.

Out of these 11 patients, electroneurography (ENeg) was performed in eight cases. The MCV and ENeG examinations were done using the usual technique (Dawson & Scott 1949, Gilliatt & Sears 1958, Buchthal & Rosenfalck 1966, Wennberg & Widén 1966). Electrode positions I–IV are shown in Figure 1. Electrical stimulation for the MCV estimation was always done with a unipolar needle electrode and the nerve action potentials were recorded with the same needle (an unisolated 0.2 mm tungsten electrode, electrolytically polished to a tip diameter of 5–15 μm, inserted through the skin). To insert the needle as close as possible to the nerve, a standardized procedure was used with the recording needle as stimulating cathode (Buchthal & Rosenfalck 1966). The preoperatively recorded MCV values of the 11 cases (mean ± standard deviation) for the different inter-electrode distances (cf. Figure 1) were:

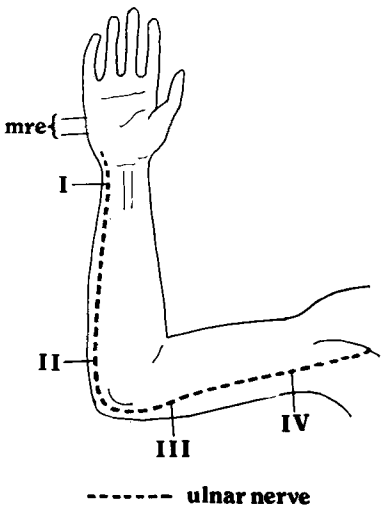

Figure 1. Ulnar nerve. Position of stimulation and recording electrodes. mre = muscle recording electrodes.

IV–III: 62.7 ± 9.3,
III–II: 37.1 ± 10.3 and
II–I: 56.1 ± 10.6 m/s.

ENeG was done with stimulation of the mixed nerve, at the positions I, II and III. Nerve action potentials were recorded at II (with stimulation at I) and at IV (with stimulation at II and III, respectively). At the preoperative examination all patients except one had no visible nerve action potential for the distances I–II and II–IV. In one case a 15 μV potential with the conduction velocity of 49 m/s was recorded for the distance II–IV. In all eight cases a nerve action potential was recorded for the distance III–IV. Its mean value ± standard deviation was 37.0 ± 23.9 μV, the conduction velocity was 69.9 ± 11.0 m/s.

EMG in the abductor digiti quinti muscle was recorded in nine cases. Partial denervation was found in five cases and in one case signs of a lesion of the peripheral motor neurons with reduction of voluntary activity but without signs of denervation was found. The other cases had normal EMGs.

Operative technique. Transposition of the ulnar nerve

In a bloodless field (tourniquet pressure 30–50 mmHg above patient's systolic blood pressure) and under general anesthesia the ulnar nerve was dissected free from the ulnar groove, from the distal part of the upper-arm and from the band joining the two heads of the flexor carpi ulnaris. This band was always split. Care was taken to resect the medial intermuscular septum in the supracondylar region to avoid kinking of the nerve. After freeing the first branch to the flexor carpi ulnaris muscle, the nerve was re-routed anterior to the medial epicondyle. Care was taken to secure a straight course for the nerve entering the flexor carpi ulnaris. In some instances the muscle had to be split, but usually the nerve was located subcutaneously. The new course of the nerve was secured by a thin flap of adipose tissue loosely sutured medial to the nerve. After release of the tourniquet, complete hemostasis was performed. A plaster slab was applied from the metacarpophalangeal joints to 10 cm above the elbow, keeping the elbow immobilized for 10 days in 80° of flexion. After this period the plaster slab and stitches were removed and free movement was encouraged.

Operative findings

Local swelling of the nerve was found in two cases of idiopathic neuropathy, in one case of rheumatoid arthritis and in two cases after a fracture (3 months or 56 years subsequent to the fracture). In three cases with symptoms occurring shortly after fracture, which were promptly operated upon, the ulnar nerves were edematous but there were no signs of pressure from bone fragments or any lesion of the nerve. No gross changes were seen in the remaining nerves.

Complications

There were two cases of hematoma that appeared on the first postoperative day. The patients were reoperated and in each case the bleeding vessel was ligated. In one of these two patients a partial ulnar nerve paralysis developed and persisted, but the patient considered himself as improved.

CLINICAL RESULTS

All the patients were re-examined at hospital. The follow-up period ranged from 6 months to 4 years (mean 19 months).

The following factors were considered at the follow-up investigation:

1) Muscular wasting, i.e., atrophy of the first dorsal interosseous muscle and/or paralysis of the adductor pollicis as demonstrated by Froment's sign.
2) Sensibility of the volar aspect of the little finger measured with the 2 PD test.

Table 2. Results after transposition of the ulnar nerve (n = 25).

Symptoms/signs	No.	Improved motor+sensory	Improved only sensory	Improved only subjective	Not improved
Motor and sensory loss	12	6 (4)*	1	2	3
Only sensory loss	6	.....	4 (2)*	1	1
Only subjective	7	.....	.....	7	.....
Total	25	6 (4)*	5 (2)*	10	4

* In brackets, complete recovery.

3) The patient's own evaluation with respect to pain, numbness tingling and weakness.

Improvement of muscular function was defined as disappearance of Froment's sign and/or reappearance of palpable contractions of the first dorsal interosseous muscle. Improvement of sensibility was defined as improved 2 PD, e.g., change from no 2 PD to 15 mm or a measurable improvement exceeding 3 mm.

Out of 12 patients with combined motor and sensory loss, six patients improved in both respects, but only four patients recovered completely (two posttraumatic neuropathies operated on soon after fracture, one with rheumatoid arthritis with a duration of nerve symptoms of 70 days and one with idiopathic neuropathy for 12 months). In one patient only the sensibility improved. The remaining five improved only subjectively or not at all.

Four out of six patients with only sensory loss improved as measured with the 2 PD test: two of these regained normal 2 PD. The only patient made worse had normal motor function preoperatively and demonstrated weakness of the first interosseous muscle at follow-up (post-hematoma).

Twenty-one patients (84 per cent) improved; three patients with objective symptoms improved only subjectively. All seven patients with only subjective symptoms improved (Table 2).

The results divided according to etiology are given in Table 3.

Table 3. Results after transposition divided according to etiology (n = 25).

Etiology	Improved	Not improved
Posttraumatic primary palsy	6	1
Late palsy	3	1
Recurrent luxation of nerve	2	.....
Rheumatoid arthritis	4	.....
Postoperative	1	.....
Idiopathic	5	2
Total	21	4

PROGNOSIS OF ULNAR NERVE TRANSPOSITION

In an attempt to forecast the outcome of ulnar nerve transposition the importance of the patient's age, the severity and duration of the symptoms, and the influence of alcohol abuse were investigated.

A. *Patient's age*

Twelve patients younger than 50 years were compared to 13 patients older than 50 years. In the younger group four out of five of the patients with with motor loss and five out of seven with impaired sensibility improved

Table 4. Improvement factor after transposition related to age (n = 25).

Symptoms/signs	No.	Motor function improved	Sensibility improved	Only subjective symptoms improved
< 50 years	12	4/5 (80 %)	5/7 (70 %)	5/5 (100 %)
> 50 years	13	2/7 (29 %)	6/11 (55 %)	2/2 (100 %)

Table 5. Improvement factor after transposition related to alcohol abuse (n = 25).

Symptoms/signs	No.	Motor function improved	Sensibility improved	Only subjective symptoms improved
Alcohol abuse	6	1/4 (25 %)	1/5 (20 %)	1/1 (100 %)
No alcohol abuse	19	5/8 (63 %)	10/13 (77 %)	6/6 (100 %)

postoperatively. Five patients with exclusively subjective symptoms all improved. Corresponding figures in the older group were motor improvement in two out of seven cases and sensory improvement in six out of eleven cases. Both patients with only subjective symptoms improved (Table 4).

B. *Severity and duration of symptoms*
Eighteen patients had motor and/or sensory loss preoperatively. Only six patients, with a duration of symptoms of 7 months, recovered completely. The other 12 improved only partially or not at all. The mean duration of symptoms in this group was 14 months. Seven patients with only subjective but typical symptoms all improved. The mean duration of symptoms in this group was 24 months.

C. *Alcohol abuse*
Six patients with alcohol abuse were compared to the remaining 19 patients. Only one out of four patients with muscular wasting and one out of five with sensory loss improved in the former group (duration of symptoms 19 months). In the non-alcoholic group the corresponding figures were five out of eight for motor improvement and 10 out of 13 for sensory improvement (Table 5).

ELECTROPHYSIOLOGICAL RESULTS

Postoperative electrophysiological examination was performed between 6 months and 2 years after the operation except in one case, which was examined after 1 month. In all cases an increase of the MCV could be demonstrated for the distance III–II (cf. Figure 1), which is the elbow region of the nerve. The MCV mean value ± standard deviation for this distance was postoperatively 47.7 ± 6.8 m/s, which is a highly significant ($P < 0.005$) increase from the preoperative value 37.1 ± 10.3 m/s. Postoperative MCV values for the other distances were: IV–III: 57.1 ± 4.1 and II–I: 53.4 ± 8.2 m/s. These values are not significantly changed in comparison with the preoperative values. The postoperatively recorded nerve action potential was for the distance III–IV: 37.8 ± 33.6 μV with conduction velocity 63.6 ± 6.0 m/s, which does not significantly differ from the preoperative values. In two cases it was possible to record nerve action potentials for the distances I–II and II–IV, where no measurable action potential could be recorded preoperatively. It was in both cases less than 20 μV.

Thus, in this material MCV in the nerve segment III–II was the only electrophysiological variable that was signif-

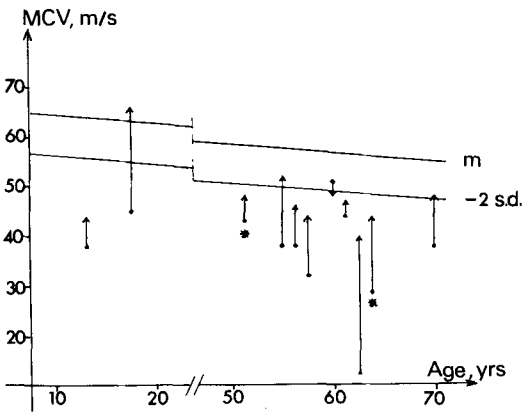

Figure 2. MCV in nerve section III–II (cf. Figure 1.). Every case is plotted as a vertical line, in which the dot marks the preoperative value and the arrow the postoperative value. The oblique lines denote mean values and −2 standard deviations in a material of healthy volunteers (from Knave et al. 1974). The two cases which were not improved clinically after the operation are marked with asterisks.

icantly changed between the pre- and postoperative examinations. This parameter is therefore displayed for each case separately in Figure 2. As can be seen in this figure, all cases improved except one. Two patients (marked with asterisks in the figure) were not improved clinically.

The extent of electrophysiological improvement was not correlated to the age of the patient, the duration of symptoms, the genesis of the lesion, the severity of clinical symptoms or whether or not the patient had a history of alcohol abuse.

Postoperative EMG examination was performed in only six out of nine preoperatively examined cases. Two were slightly improved, the others were unchanged.

DISCUSSION

In classifying ulnar nerve neuropathies, in which the continuity of the nerve is not lost, one usually makes a division of the lesions into:

A. Primary and secondary neuropathy resulting from trauma.
B. Late neuropathy resulting from old fracture, arthritis, congenital anomalies, etc.

In this material the group of late or tardy neuropathies consists of four cases —an astonishingly low figure in comparison with other consecutive series. These four patients had sustained fractures about the elbow 3 months, 2, 8 and 56 years prior to the neuropathy and only the patient with an interval of 56 years presented a cubitus valgus, thus fulfilling the criterion of the most common etiology of "tardy ulnar palsy" according to the classical observations of Broca & Mouchet (1899) and of Platt (1925).

Fourteen patients had no known previous injury to the elbow region. The etiology remains obscure to us in these cases and we could only find two cases of thickened nerve and no case of obvious compression of the nerve in this group.

A striking feature in this material, not stressed in earlier reports, is the relatively large group, 11 cases (33 per cent), with a history of alcohol abuse. The results after transposition in this group are inferior to the results in the non-alcoholic group. It is probable that the ulnar nerve in alcohol abusers is more frequently subjected to small injuries or to compression and/or prolonged stretching with the elbow in flexion during sleep.

This pathogenesis has been suggested by Mumenthaler (1961), who accounts for 44 cases of ulnar neuropathy after states of prolonged unconsciousness and by Engkvist (1972), who found 12 ulnar palsies consequent to surgical operations under general anesthesia. Two of the alcohol abusers in this material also had diminished sensibility within the median nerve area in both hands, indicating polyneuritis, and it should be considered that even a subclinical alcohol neurop-

athy may make the nerve more vulnerable.

There seemed to be a difference between the younger age group and those patients older than 50, in favor of the younger group. However, the difference is not statistically significant. In agreement with Harrison & Nurick (1970) we found that the duration of preoperative symptoms seemed to influence the outcome, but only in cases with clinically evident motor and/or sensory loss. The prognosis in cases with only subjective symptoms was uniformly good in this material irrespective of the duration of the preoperative symptoms. This group may be compared to McGowan's grade 1: "Minimal lesions with no detectible motor weakness of the hand". Most reports of the results after transposition of the ulnar nerve have been enthusiastic. Thus, McGowan reports 75–100 per cent success even in cases of "tardy palsy" in a group consisting of 46 patients. Gay & Love (1947) found "satisfactory results" in 80 per cent of 100 patients, but the majority were followed up by questionnaire and no data apart from the patients' opinions are given.

The results reported by Sunderland (1968) give another picture. Out of 14 patients only six improved (two patients were cured) and four patients were considered even worse after transposition.

In the present series, 11 out of 18 patients (61 per cent) with motor and sensory loss improved, but only six (33 per cent) recovered completely. The duration of symptoms of these six was half as long as in the group of 12 patients with partial or no recovery. Based on this series an early operation seems to give the best result.

The electrophysiological examinations showed improvement of motor nerve conduction velocity even in those cases where clinical improvement could not be recorded. This indicates that at least some of the electrophysiological examinations are more sensitive than the clinical ones, as in other types of neuropathies (Downie & Newell 1961, Lockner et al. 1969, Löfström et al. 1966). Our results are in good agreement with those presented by Payan (1970) of 13 patients with lesions of the ulnar nerve at the elbow.

Electromyography was, however, found to be a quite insensitive test of nerve recovery in this series.

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