

Long-term results of primary repair of combined cuts on the median and ulnar nerves in the forearm

Kemal Özaksar, M.D.,¹ Hüseyin Günay, M.D.,² Levent Küçük, M.D.,² Erhan Coşkunol, M.D.²

¹Department of Orthopedics and Traumatology, EMOT Hospital, İzmir-Turkey

²Department of Orthopedics and Traumatology, Ege University Faculty of Medicine, İzmir-Turkey

ABSTRACT

BACKGROUND: The objective of this clinical study was to evaluate sensory and motor functions in the later period following primary repair of combined injuries of the ulnar and median nerves in the forearm at proximal, middle, and distal levels.

METHODS: Later period sensory evaluation of ulnar and median combined cuts was performed using two-point discrimination and monofilament tests. On the other hand, motor evaluation was performed by determining dorsal palmar interosseus strength for the ulnar nerve and abductor pollicis brevis muscle strength for the median nerve. Cold intolerance, object recognition, and weight discrimination were also reviewed.

RESULTS: In total, 26 patients with ulnar-median combined cut and aged between 5 and 59 years were included in this study. Although no deficiency was observed in the sensory functions of any of the patients, a decrease in tactile sensation was detected in the median sensory region in 12 (46%) patients and in the ulnar sensory region in 7 (26%) patients. The most significant loss in terms of motor functions was detected in the opposition pinch strength. Two patients developed claw hand and two showed joint contracture.

CONCLUSION: Ideal treatment for peripheral nerve injuries should be primary repair. Restoration of the motor function in the median nerve is relatively easier than that in the ulnar nerve. No significant difference was observed in terms of sensory function. An alternative is needed for primary repair because of lack of motor function in proximal ulnar incisions. There is no standardization of tests performed for peripheral nerve repair.

Keywords: Forearm; median nerve; primary repair; ulnar nerve.

INTRODUCTION

Nerve injuries often occur with penetrating lacerations or glass cuts on the forearm and are most commonly accompanied by tendon and/or vessel injuries. These injuries may be isolated median or ulnar nerve injuries as well as a combination of both, particularly on the volar side of forearm. Combined nerve injuries are very important reasons of morbidity in young and active persons that may cause sensorial and motor sequel. In this study, sensory and motor functions were evaluated after primary repair of combined injuries of the ulnar and median nerves in the forearm.

MATERIALS AND METHODS

Of a total of 71 patients who underwent early primary repair after being admitted to the emergency service because of ulnar-median combined nerve cuts in one extremity at the forearm level, 26 patients were included in this study. The patients in this group were aged 5–59 years and were followed up for an average of 119 (75–168) months. Twenty-five of the patients were male (96%), while only one was female (4%). Of all the patients, 20 had a cut on the right forearm, whereas six had a cut on the left forearm. Injuries were detected on the dominant arms in 24 patients and on the non-dominant arms in 2 patients.

Patients were prepared using a pneumatic tourniquet on the arm level in the supine position. Debridement and irrigation were performed on the surface of the injury. Tendons were sutured using modified Kessler method with 3–0 or 4–0 polydioxanone suture (PDS) after exploring the vessels, nerves, and tendons on the forearm. Vessels and nerves were repaired using 8–0, 9–0, and 10–0 nylon sutures. The epiperineural suture technique was employed during nerve repairs.

Address for correspondence: Hüseyin Günay, M.D.

Ege Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, İzmir, Turkey

Tel: +90 232 - 390 27 12 E-mail: drgunayh@yahoo.com.tr

Submitted: 28.06.2016

Accepted: 07.02.2017

Ulus Travma Acil Cerrahi Derg

2017;23(5):410–414

doi: 10.5505/tjtes.2017.92744



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Patients were provided with a short- or long-arm dorsal splint postoperatively. All sutures were removed on the 14th day and controlled active–passive exercises were begun from the 3rd day onward. Splints were kept intact for at least 3 weeks. Median and ulnar nerve sensory evaluations of the follow-up patients were performed according to British Medical Research Council’s Sensory Recovery Classification (BMRC) modified by Mackinon and Dellon.^[1] A comparison was performed based on the uninjured extremity’s motor and sensory examinations. Tactile and pressure sensations were evaluated using Semmes–Weinstein monofilaments.^[2] The static and dynamic two-point discrimination test was used for detecting the distance between two points sensible in the injured nerve innervation. The test was performed on the second finger pulp for the median nerve and on the fifth finger pulp for the ulnar nerve.^[3] Water cups cooled down to +4°C were used for the cold intolerance evaluation.

Patients were shown 10 different objects to perform the object recognition test, having been asked to recognize the objects blindfolded on a given duration first using their non-operated hand and then using their operated hand.^[4]

Weight discrimination test was performed by asking patients to discriminate similar-looking objects of different weights first using the non-operated hand and then using the operated hand. A total of 10 objects were used in our study, ranging from 75 to 125 g.

Grip strength was observed using the Jamar hydraulic dynamometer for motor innervation evaluation. A mean score was recorded after repeating the measurement three times. Tip, key, and palmar pinch and opposition strength were evaluated using a pinch meter.^[5]

All measurements were performed by a single hand surgeon (Table 1).

In statistical analysis of the results, paired t-test was used for metric measurements and one-way ANOVA and Kruskal–Wallis test were used for comparison between different groups. If significant differences were observed between the groups, Mann–Whitney test was performed, having performed Bonferroni correction. In addition, Spearman and Pearson correlation tests were performed.

RESULTS

Fifty-two nerves from 26 patients who responded final examination call, were evaluated in terms of motor and sensory recovery. In line with BMRC criteria, 15 patients with median nerve cuts revealed good results, whereas 8 patients had perfect and 3 patients had bad results on sensory evaluation. Same evaluation showed good results in 16 patients with ulnar cuts, perfect results for 7 patients, and bad results for 3 patients (Table 2).

In dynamic and static two-point discrimination test, high scores discovered in favor of the operated hands as opposed to the non-operated ones were regarded as significant ($p < 0.05$). No result of significance was manifested in two-point discrimination tests at the innervation sites of the median and ulnar nerves on the operated sides ($p > 0.05$).

Anesthesia was not spotted in any of the patient during the monofilament test. An improvement in protective sensation was observed in all patients. Although a decrease in tactile and protective sensations was detected in 12 and 7 patients, respectively, who underwent median nerve repair; 7 patients showed normal values for tactile and protective sensations. In the ulnar nerve, a decrease in tactile and protective sensations was observed in 7 and 11 patients, respectively, whereas 8 patients displayed normal results tactile and protective sensations (Table 3).

The abductor pollicis brevis muscle strength did not reveal any bad results, whereas it was shown to be average for 12 pa-

Table 1. Tests used for evaluation

Sensory evaluation	BMRC modified Mackinon-Dellon Two-point discrimination Cold intolerance Median nerve, 2. fingers Ulnar nerve, 5. finger pulp
Tactile pressure	Semmes-Weinstein Object recognition test Weight recognition test
Motor evaluation	Jamar hydraulic dynamometer Pinchmeter Pinch (tip, key, and palmar) Oppositon strength

Table 2. Results according to BMRC criteria

	Perfect	Good	Bad
Ulnar	8	15	3
Median	7	16	3

BMRC: British Medical Research Council’s Sensory Recovery Classification.

Table 3. Monofilament test – number of patients with diminished sensory function

	Tactile sensation	Protective sensation	Normal
Ulnar	7	11	8
Median	12	7	7

Table 4. Motor strength evaluation (abductor pollicis brevis muscle strength for the median nerve and dorsal interosseus muscles strength for the ulnar nerve)

	Good	Average	Bad
Ulnar	7	11	8
Median	12	7	7

tients and good for 14 patients during motor evaluation of the median nerve. The dorsal palmar interosseus muscle strength was evaluated for the ulnar nerve. Results were bad in 13 patients, average in 11 patients, and good in 2 patients (Table 4). Grip strength results were 32.27 kg for operated hands and 40.41 kg for non-operated hands. The average loss of strength for grip was 20.2%. Considering a durable hand at 100% strength, the highest loss of strength was observed in the opposition pinch (57.33%).

In an evaluation that divides patients' forearms in three equal

parts, 10 injuries were observed at the distal, 11 at the median, and 5 at the proximal levels. During motor strength evaluation, while recovery was observed to be fine in median nerve injuries at the distal level, the same recovery rate was detected to be average for the ulnar nerve. An evaluation of the median and proximal regions showed average recovery for the median nerve and bad recovery for the ulnar nerve. Although no significant difference was spotted for sensory recoveries, the average results were observed as good (Fig. 1).

Cold intolerance was found to be disturbing for 3 patients and mediocre for 12 patients and no intolerance was detected in 11 patients. A negative correlation was observed between cold intolerance, sensory recovery of the median nerve, and object recognition test ($p < 0.05$).

Another negative correlation was observed between age, object recognition, and weight discrimination tests. A positive correlation was observed between object recognition and sensory and motor recoveries in the median nerve ($p < 0.01$).



Figure 1. Postoperative 75th month.

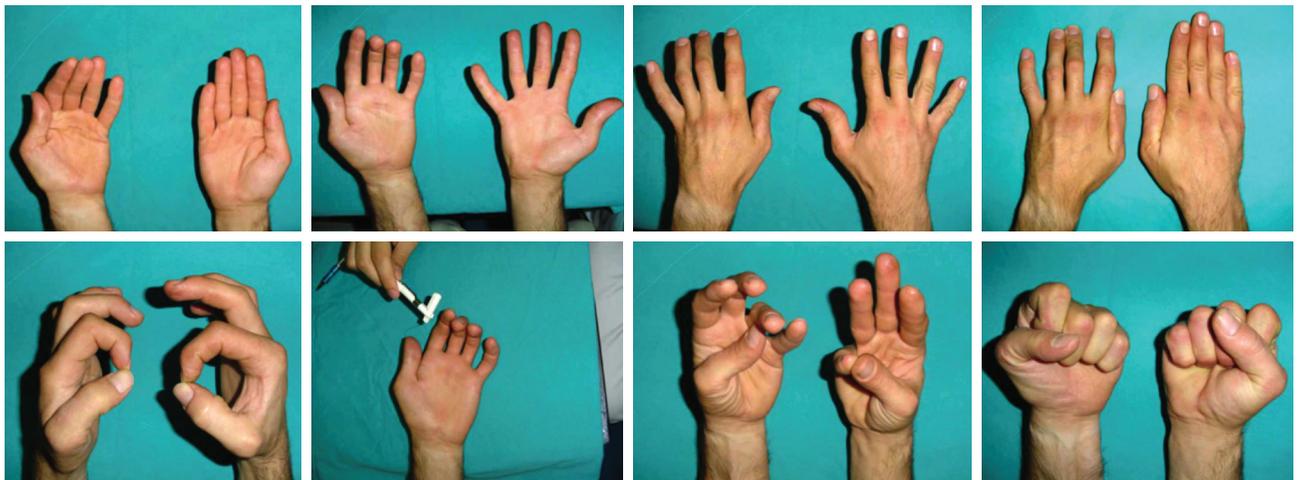


Figure 2. Postoperative 156th month.

Table 5. Difficulties in daily activities

Daily activity	Buttoning	Taking money out of wallet	Opening jars	Cold intolerance
Number of cases with complication	15	11	9	14

Although two patients showed claw hand development on physical examination, one patient had proximal interphalangeal joint contracture in his second finger by 20° and another in his fourth finger by 30°. Opposition loss was detected in 11 patients (Fig. 2).

In terms of daily activities, 15, 11, and 9 patients had difficulty in buttoning, taking money out of a wallet, and opening jars, respectively. Three out of 5 patients with proximal injury and 9 out of 11 patients with mediocre injury were reported to return their jobs prior to the incident. Four patients were reported to change profession (Table 5).

DISCUSSION

Upper extremity nerve injuries are often the result of glass cuts or injuries by perforating objects. These are mostly accompanied by vessel or tendon injuries. Physiological outcomes that follow nerve injuries and their repair depend on the proximity of the injury to the nerve cell, quality of axonal growth, adaptation of regenerated axons, distance of the end motor organ to the injury zone, and vitality. Ideal treatment for peripheral nerve injuries because the neurotransmitter secretion will continue, is primary repair with best results can be obtained.^[6] All of our patients underwent early primary repair.

In literature, large series are encountered where long-term results of ulnar nerve combined cuts were evaluated.^[4,7] Combined cuts are particularly mentioned in journals alongside isolated cuts, and it is reported that repair results badly influence motor functions. In their compilation of 130 journals, Ruijs et al. reported that of a total of 638 cases of forearm nerve cuts, 138 cases (21.6%) were of combined cuts.^[7] Kılınc et al. reported that of their 40 case series, 13 were combined injuries and that sensory functions were protected better in isolated ulnar cuts than in isolated median cuts, but that no difference was present in motor functions, adding that most cases of combined cuts needed a secondary surgery (92%).^[8] Although differences were found to be significant when the injured and non-injured sides were compared, no difference was observed between the median and ulnar on the operated side. Brich did not come across bad results in 108 median and ulnar nerve cuts with primary repairs.^[9] In our study, too, no bad results were encountered in terms of sensory abilities, and it was thought that a sensory flaw would regain function in time. Age being an important factor in sensory defect recovery was reported on a better emphasized platform on cuts to which a primary repair was performed during the adolescent period.^[10] A loss in motor function was observed, although the recovered muscle strength in the median innervation region was

better than that in the ulnar innervation region. Although the recovery of median nerve was found to be sufficient in 14 patients, only 2 patients with ulnar nerve cuts showed a sufficient motor recovery. As the level of the lesion extended proximally, poor motor recovery of the ulnar nerve was detected. Better function was obtained in intrinsic muscles by transferring the terminal branch of the anterior interosseus nerve to the ulnar motor branch in ulnar nerve lesions present on higher levels or combined median ulnar cuts.^[11,12]

Moberg was the first who studied the relationship between two-point discrimination and functional tests. It was reported that recovery of dynamic two-point discrimination and functional tests, as they are related to rapidly adapting fibers, could be influenced by the rehabilitation program and that because the conveyance of static two-point discrimination is concerned with fibers that adapt slowly, it will reflect the surgical outcome better.^[13] On sensory evaluation of median cuts at the wrist level, Polatkan et al. detected no correlation between monofilament test and two-point discrimination.^[14] In our study, significant correlation was detected between these two tests in both median and ulnar autonomous regions.

The object recognition test has an ostensible sensibility rate in terms of displaying changes over time. No standardization exists between the test materials. Because the region on which the test can be performed includes only the first three fingers in the radial region, it can only be used in median nerve cuts. Although a significant correlation was detected between object recognition and median nerve recovery in our study, the same correlation was not seen in ulnar nerve recovery. This test displayed a negative correlation with age and a positive correlation with weight discrimination ($p < 0.01$).

Claw hand deformity, discorded finger movements, and loss of lateral hand movements of fingers as well as diminishing grasp and grip strength are among the basic restrains peculiar to ulnar nerve lesions. Noamann in his own series reported that following combined cuts, 6.5% patients showed a major deformity, 13.5% patients showed a minor deformity, and 80% showed no signs of deformity.^[15] Hudson reported observing 7 claw deformities throughout the 49 months of follow-up in his 15 combined cut series.^[16] Only two patients developed claw hand deformity in our series including 26 patients.

The epiperineural suture technique was used on our patients using a microscope or loop magnification. Experimental and clinical studies have not indicated the superiority of fascicular repairs over epineural repairs. A discussion still persists on

this subject.^[17-19] The general impression focuses on obtaining nerve integrity using simple suture techniques.

Conclusion

In combined cuts, sensory recovery is in an acceptable level in lesions of all levels. No significant difference was detected between median and ulnar nerves in terms of sensory recovery. Motor function recovery was observed to be better in the median nerve than in the ulnar nerve. Insufficient motor recovery causes important limitations in patient's daily activities and work lives.

Conflict of interest: None declared.

REFERENCES

- Mackinnon SE, Dellon AL. Surgery of the peripheral nerve. New York: Thieme Medical Publishers; 1988.
- Bell-Krotoski JA, Fess EE, Figarola JH, Hiltz D. Threshold detection and Semmes-Weinstein monofilaments. J Hand Ther 1995;8:155-62.
- Dellon AL, Mackinnon SE, Croby PM. Reliability of two point discrimination measurements. J Hand Surg 1987;12:693. [CrossRef]
- Bruyns CN, Jaquet JB, Schreuders TA, Kalmijn S, Kuypers PD, Hovius SE. Predictors for return to work in patients with median and ulnar nerve injuries. J Hand Surg Am 2003;28:28-34. [CrossRef]
- Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluations. J Hand Surg Am 1984;9:222-6.
- Trehan SK, Model Z, Lee SK. Nerve Repair and Nerve Grafting. Hand Clin 2016;32:119-25. [CrossRef]
- Ruijs AC, Jaquet JB, Kalmijn S, Giele H, Hovius SE. Median and ulnar nerve injuries: a meta-analysis of predictors of motor and sensory recovery after modern microsurgical nerve repair. Plast Reconstr Surg 2005;116:484-94. [CrossRef]
- Kilinc A, Ben Slama S, Dubert T, Dinh A, Osman N, Valenti P. Results of primary repair of injuries to the median and ulnar nerves at the wrist Chir Main 2009;28:87-92. [CrossRef]
- Birch R, Raji AR. Repair of median and ulnar nerves. Primary suture is best. J Bone Joint Surg Br 1991;73:154-7.
- Rosén B, Lundborg G. The long term recovery curve in adults after median or ulnar nerve repair: a reference interval. J Hand Surg Br 2001;26:196-200. [CrossRef]
- Haase SC, Chung KC. Anterior interosseous nerve transfer to the motor branch of the ulnar nerve for high ulnar nerve injuries. Ann Plast Surg 2002;49:285-90. [CrossRef]
- Phillips BZ, Franco MJ, Yee A, Tung TH, Mackinnon SE, Fox IK. Direct radial to ulnar nerve transfer to restore intrinsic muscle function in combined proximal median and ulnar nerve injury: case report and surgical technique. J Hand Surg Am 2014;39:1358-62. [CrossRef]
- Chassard M, Pham E, Comtet JJ. Two-point discrimination tests versus functional sensory recovery in both median and ulnar nerve complete transections. J Hand Surg Br 1993;18:790-6. [CrossRef]
- Polatkan S, Orhun E, Polatkan O, Nuzumlali E, Bayri O. Evaluation of the improvement of sensibility after primary median nerve repair at the wrist. Microsurgery 1998;18:192-6. [CrossRef]
- Noaman HH. Management and functional outcomes of combined injuries of flexor tendons, nerves, and vessels at the wrist. Microsurgery 2007;27:536-43. [CrossRef]
- Hudson DA, De Jager LT. The spaghetti wrist. Simultaneous laceration of the median and ulnar nerves with flexor tendons at the wrist. J Hand Surg Br 1993;18:171-3. [CrossRef]
- Mafi P, Hindocha S, Dhital M, Saleh M. Advances of peripheral nerve repair techniques to improve hand function: a systematic review of literature. Open Orthop J 2012;6:60-8. [CrossRef]
- Marsh D, Barton N. Does the use of the operating microscope improve the results of peripheral nerve suture? J Bone Joint Surg Br 1987;69:625-30.
- Nakatsuchi Y, Matsui T, Handa Y. Funicular orientation by electrical stimulation and internal neurolysis in peripheral nerve suture. Hand 1980;12:65-74. [CrossRef]

ORJİNAL ÇALIŞMA - ÖZET

Ön kol seviyesinde median ulnar sinir kombine kesilerinin primer tamirinin uzun dönem sonuçları

Dr. Kemal Özaksar,¹ Dr. Hüseyin Günay,² Dr. Levent Küçük,² Dr. Erhan Coşkunol²

¹EMOT Hastanesi, Ortopedi ve Travmatoloji Kliniği, İzmir

²Ege Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, İzmir

AMAÇ: Bu klinik çalışmada amaç ön kolda proksimal, orta ve distal seviyelerde ulnar ve median sinirin birlikte kesilerinin erken primer tamiri sonrası geç dönemde duyu ve motor fonksiyonlarının değerlendirilmesidir.

GEREÇ VE YÖNTEM: Ulnar ve median kombine kesilerde geç dönem duyu değerlendirilmesi iki nokta ayırım testi, monofilaman testi ile yapıldı. Motor değerlendirme ise ulnar sinir için dorsal palmar interosseöz gücü, median sinir için abduktör pollicis brevis kas gücü değerlendirildi. Soğuk intoleransı, obje tanıma ve ağırlık ayırt etme de değerlendirildi.

BULGULAR: Çalışmaya ulnar median kombine kesisi olan 5-59 yaş arası 26 hasta dahil edildi. Hastaların hiç birinde duyu fonksiyonlarında yetersizlik gözlenmezken median duysal alanda 12 (%46) hastada, ulnar duysal alanda yedi (%26) hastada dokunma duyusunda azalma saptandı. Motor fonksiyon açısından en anlamlı kayıp oppozisyon pinch gücünde saptandı. İki hastada eklem kontraktürü gözlemlendi.

TARTIŞMA: Periferik sinir yaralanmalarında ideal tedavi primer tamir olmalıdır. Motor fonksiyon dönüşü median sinirde ulnara göre daha iyidir. Duyusal açıdan anlamlı fark yoktur. Distal seviyede median ve ulnar sinirin grup yapısı oluşturması nedeniyle epiperinöral tamir yerine grup fasiküler tamir tercih edilmelidir. Proksimal ulnar kesilerde motor fonksiyon yetersizliği nedeniyle primer tamire alternatif gerekmektedir. Periferik sinir tamiri için yapılan testlerde standartizasyon yoktur.

Anahtar sözcükler: Median sinir; önkol; primer tamir; ulnar sinir.

Ulus Travma Acil Cerrahi Derg 2017;23(5):410-414 doi: 10.5505/tjtes.2017.92744