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Comparing primary and secondary repair of median and\or ulnar nerve based on electro-diagnostic assessment and clinical examination

INTRODUCTION

Peripheral nerve injuries may cause significant deficits that impair functional recovery (1,2). However, treatment of injuries to major nerve trunks in the hand and upper extremity, such as the median or ulnar nerve, remains a major and challenging reconstructive problem. Microsurgical techniques, such as primary or secondary nerve sutures and nerve grafting, are suggested for treatment of peripheral nerve injuries. Primary closure has been found to be superior to secondary closure (3,4). However, to ensure that the repair is successful and undisturbed during the healing process, certain criteria should be met. The condition of the wound itself is important. It should be a limited lesion, preferably a sharp transection, rather than a crush-type injury.

Supporters of delayed repair suggest that waiting provides increased fibrosis and mechanical support to the wound and suture. Some also suggest that waiting to perform the repair allows it to coincide with maximal axoplasmic synthesis, which occurs approximately three weeks after injury, although this has not been demonstrated to be beneficial in most patients (5,6). Another consideration is the condition of the patient. Large numbers of concomitant injuries, especially in the same area, present contraindications because of the stress on the patient and the mechanical disruption that can occur during additional repair surgeries. This means that, in a complex wound, the nerve repair should be delayed until all other injuries have been treated. The patient should be stable enough to be considered for elective surgery, and the patient should be able to give informed consent (5,6). As mentioned above, choosing the best surgical approach is controversial. The present report describes the outcome of the trial in regard to sensory and motor clinical examinations and electro-diagnostic assessment for the use of both primary and secondary repair for the treatment of median and\or ulnar nerve clean transection injury.

METHODS AND MATERIALS:

This trial study was conducted from March 2008 to December 2009 in the Department of Orthopaedic Surgery at Al-Zahra University Hospital (Isfahan University of Medical Sciences), and the Ethics Committee of Isfahan University of Medical Sciences approved the study protocol. The study was registered at ClinicalTrials.gov (Identifier: NCT01116362).

One hundred and eighty patients with clean transection injuries were included in the study. After acquiring biographical data from the patients, they were divided into two groups that were similar in baseline charactristics, such as age, gender, and level of injury. The patients received either primary or secondary surgical repair, and the outcomes were evaluated 18 months after surgery. Unfortunately, of the 180 patients, only 61 in clinical examinations and 46 in electro-diagnostic assessment participitated in the outcome measurements in the study.

Primary repair was considered within the first few days, delayed primary repair was considered by the end of the first week, and, beyond that, secondary closure was considered. The outcomes of primary and delayed repair were added together and compared with secondary repair.

In clinical examinations, identification of motor and sensory levels were conducted based on the British Medical Research Council's guidance (Tables 1 and 2). The Abductor Pollicis Brevis (APB) was used for the median nerve, and the Abductor Digiti Minimi (ADM) was used for the ulnar nerve. The results were scored as follows: 0, S_0, S_1, and S_2; 1 and S_3; 2, S_4, and S_5. For motor examination, the results were scored as follows: 0, M_0, M_1, and M_2; 1 and M_3; 2 and M_4.

Table-1. Classification of Sensory Recovery*

Grade Recovery of Sensibility	
S_0	No recovery of sensibility in the autonomous zone of the nerve
S_1	Recovery of deep cutaneous pain sensibility within the autonomous zone of the nerve or Recovery of superficial pain sensibility
S_2	Recovery of superficial pain and some touch sensibility or with overresponse
S_3	Recovery of pain and touch sensibility with disappearance of overresponse, 2PD _ 15 mm or localization of the stimulus is good and there is imperfect recovery of 2PD (7-12 mm)
S_4	Complete recovery, 2PD _ 7 mm

2PD, classic two-point discrimination.
*From Mackinnon, S. E., and Dellon, A. L. Results of nerve repair and grafting. Surgery of the Peripheral Nerve. Thieme, 1988.P. 115.

Table-2. Classification of Motor Recovery*

Grade Recovery of Motor	
M_0	No contraction
M_1	Return of perceptible contraction in the proximal muscles
M_2	Return of perceptible contraction in both proximal and distal muscles
M_3	Return of perceptible contraction sufficiently powerful to act against gravity
M_4	All muscles act against strong resistance and some independent movements are possible
M_5	Full recovery in all muscles

*From Mackinnon, S. E., and Dellon, A. L. Results of nerve repair and grafting. Surgery of the Peripheral Nerve. Thieme, 1988.P. 115.

For electro-diagnostic assessment, Nerve Conduction Velocity (NCV) was tested as motor and sensory. Motor NCV (NCV.M) was performed by electrical stimulation of a peripheral nerve, and recording was performed from a muscle supplied by the nerve. The time required for the electrical impulse to travel from the stimulation site to the recording site was measured. Sensory NCV (NCV.S) was performed by electrical stimulation of a peripheral nerve, and the recording was performed from a purely-sensory portion of the nerve, such as on a finger. The recording electrode was the more proximal of the two. The results were categorized according to the Yale sensory scale, and the severity of sensation and function of the nerves was scored as follows: 0, no sensation; 1, decreased or abnormal sensation; 2, normal sensation.

For an EMG, a needle electrode was inserted through the skin into the muscle that the injured nerve supplied. The presence, size, and shape of the waveform were registered, and the ability of the muscle to respond when the nerves were stimulated was noted. Also, these results were scored as follows: 0, no activity; 1, a single movement or a few movements; 2, partial activity; 3, full activity.

After the scores were collected, we used the Student's t-test, Mann-Whitney test method, and covariance to compare them statistically. The threshold value of $P = 0.05$ was used to provide sufficient evidence to reject the null hypothesis and state that the difference is statistically significant.

SURGICAL TECHNIQUE

First, damaged tendons and muscles were repaired. Then, for nerve repair, the wound was explored to find the cut ends of the nerve. Both of the cut ends of the nerve were trimmed with a new sterile razor blade, and the cut ends of the nerve were matched in their correct anatomical positions without rotation. Then, the nerve repair was conducted as an end-to-end (epi-epineurium, epi-epineurium) anastomosis. Post-operative care included limb immobilization by a cast splint for 2-3 weeks, and attention was paid to active finger motions in order to avoid fixed deformities.

RESULTS

The patients who participated in the study consisted of 31 males and 30 females. The mean age of the primary repair group was 25.6 years (SD: 7.9), and the mean age of the secondary repair group was 24.4 years (SD: 9.8), so there was no statistical difference between the two groups based on age ($p = 0.59$).

In the primary repair group, 12 ulnar nerves and 8 median nerves had been injured. In this group, there were 8 patients who had damage to both of these nerves. In the secondary repair group, there were 9 patients with ulnar nerve injuries and 5 patients with median nerve injuries; in this group, 19 patients had both ulnar and median nerve injuries. The involvement of both nerves in the secondary repair group was significantly greater than it was in the primary repair group. Therefore, to prevent bias, we used the covariance test in our analysis.

Frequencies and levels of injuries are shown in Table 3. According to the Student's t-test, there was no statistically significant difference between the two approaches.

Table-3. Frequencies of nerve injury level.

Level of injury	Number of patients in Primary repair group	Number of patients in secondary repair group
Wrist	10	11
Forearm	7	12
Elbow	1	1
Arm	0	4

Sensory distribution results are shown in Table 4. According to the Mann-Whitney test, the patients treated with the primary repair method had statistically significant sensory recovery compared to the patients treated with secondary repair (P = 0.037). Motor examinations and results are shown in Table 4. According to the Mann-Whitney test, the patients treated with the primary repair method had a statistically significant sensory recovery compared to the patients treated with secondary repair (P = 0.01).

Table-4. Distributions of sensory and motor examinations

Sensory and Motors	Number of patients in primary repair group	Number of patients insecondary repair group
S_0	0	0
S_1	0	0
S_2	0	4
S_3	13	19
S_4	11	7
S_5	4	3
Average Score	1.5	1.18
M_0	0	0
M_1	0	0
M_2	1	3
M_3	12	23
M_4	15	7
Average score	1.5	1.12

There were three patients in the primary repair group who scored zero for NCV.S, but there were 18 patients who scored zero in the secondary repair group. Nine patients in the primary repair group and five patients in the secondary repair groups had scores of 1, whereas six patients in the primary group and five patients in the secondary group scored 2. The average score of the primary repair group was 1.16, whereas it was 0.53 for the secondary repair group. So, applying the Mann Whitney statistical assessment showed a statistically significant difference between the two groups (P = 0.006).

For NCV.M, two patients in the primary group and seven patients in the secondary repair group had scores of zero. Finally, eight patients in the primary group and seven patients in the secondary group had scores of 2. The average score of the primary and secondary groups were 1.3 and 1,

respectively. According to the Mann-Whitney test, there was no statistically significant difference between the two groups for this outcome (P = 0.124).

In EMG assessment, the primary repair group had no patients with a score of zero or 1. However, in the secondary group, one patient had a score of zero, and eight patients had scores of 1. In primary repair group, nine patients had a score of 2, and nine patients had a score of 3, whereas, in the secondary group, 15 and five patients had scores of 2 and 3, respectively. The average score of the primary repair group was 2.5, and it was 1.9 for the secondary repair group. According to the Mann-Whitney test, there was a statistically significant difference between the two groups for this outcome (P = 0.0004).

DISCUSSION

Determining the optimal treatment for a patient is a complex task that depends on the results of a complete patient assessment. The questions involved with nerve repair involve two main areas, namely, (1) when to do the repair and (2) what type of repair to perform. Primary repair is generally considered within the first few days, delayed primary by the end of the first week, and secondary closure beyond that. Surgical options generally include end-to-end closure, nerve graft placement, vascularized nerve graft placement, and nerve transfer.

In this study, the results indicated that primary repair had better clinical and electro-diagnostic outcomes (except for NCV.S) compared with secondary repair. Several factors determine the outcomes of the repair of peripheral nerve injuries, and this study was focused on such injuries to the median and ulnar nerves. In some studies, the patient's age has been shown to be the single most important factor that influences the success of nerve recovery (7-11).

In one meta-analysis study, the significant prognostic factors that influenced outcomes were found to differ for motor and sensory recoveries. For motor recovery, age, delay, site, and type of nerve that was injured were found to predict outcome; for sensory recovery, age and delay were significant prognostic factors (12).

The level of injury and associated median nerve injury are other important factors that were controlled in this study (17). Therefore, prevention of effects due to these three factors eliminated any bias associated with them, which allowed a clear and useful comparison between primary repair and secondary repair.

Kilinc et al. showed that the existence of a high number of tendon injuries was a factor associated with poor prognosis (15). Unfortunately, we had no control over this factor, and it may have had some effect on the results.

In clinical examination, we used the British Medical Research Council's scale for both motor and sensory function testing, because it is the most widely accepted scale for scoring the outcome of repairs of peripheral nerve injuries (13). In this study, sensory and motor outcomes were better in the primary group. These results do not agree with the results of a study conducted by Ertern et al., which showed secondary repairs produced better results than primary repairs, although the difference was not significant (16). Also, in contrast to our results, Merle et al., working with a small group of patients, found a higher percentage of failures after nerve repair performed on an emergency basis than after secondary repair (14).

In the electro-diagnostic assessments, we found a significant result that, to our knowledge, has not been reported before. As opposed to NCV.S, we found no statistically significant difference between the two surgical approaches for NCV.M. However, we showed that patients who had primary repair had significantly better outcomes compared with patients who had secondary repair.

CONCLUSIONS

Our results indicate that both primary and secondary repair are efficient and safe methods for managing clean transection injuries, but primary repair had better results. Future studies of non-surgical approaches are warranted.

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ABSTRACT

BACKGROUND: Treatment of injuries to major nerve trunks in the hand and upper extremity remains a major and challenging reconstructive problem. Our goal was to compare primary and secondary repair of median and\or ulnar nerve by electro-diagnostic assessment and clinical examination.

METHODS AND MATERIALS: Forty-six patients, 7-55 years of age, with clean transection injury between the shoulder and wrist were divided into two groups, and each patient received either primary or secondary surgical repair. The patients who underwent primary or delay nerve repair were in the primary repair group, and the remaining patients were in the secondary nerve repair group. Electro-diagnostic tests and clinical examinations (motor and sensory, based on the British Medical Research Council's guidance) were compared between the two groups 18 months after surgery. All repairs were performed by the senior author using standard techniques.

RESULTS: The two groups were similar in baseline characteristics, and there were no significant differences between range of ages ($p > 0.05$) and level of nerve injury ($p > 0.05$) in the two groups. Those with primary repair had statistically significant recoveries in sensory and motor level ($p < 0.05$ and $p < 0.05$), NCV.S (sensory) ($p < 0.05$), and EMG results ($p < 0.05$), but there was no statistically significant difference between the two groups in NCV.M (motor) ($p > 0.05$).

CONCLUSIONS: Our results showed significant benefits of primary repair compared with secondary repair of injuries to the median and ulnar nerves. The outcomes with primary repair were also better than those with secondary repair. Future studies on non-surgical approaches are warranted.

Keywords: Ulna; Median; Primary repair; Secondary repair