Early vs Delayed Repair of Sharp Peripheral Nerve Injuries of The Upper Extremity

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Abstract

Nerve injury is a major clinical health problem that usually leads to functional impairment that can occasional be permanent and with significant socioeconomic impact on the patient. The traditional treatment for nerve injuries is microsurgical repair, which remains challenging and the timing of surgery remains debatable. This prospective study was conducted on 30 patients suffering from sharp peripheral nerve injury on the upper limb.

The patients were divided into 2 groups. Group A had been treated by early surgical intervention within the first 48 hours. Group B were treated by delayed intervention from 3 weeks post injury to 6 months. Cases requiring nerve grafting were excluded from this study. Pre-operatively all the patients were evaluated clinically and only group B patients were evaluated electro-physiologically, then all patients were evaluated both clinically and electro-physiologically at 3- and 6-months intervals.

Our results show no statistically significant difference in clinical outcome between the 2 groups at short term (3 months) and intermediate term (6 month) follow up. 6.7% of cases achieved good result and 40% of cases had satisfactory outcome in early intervention group, while only 33.3% of cases had satisfactory outcome in delayed intervention group at 6 months follow up. No cases in Group A (early intervention) needed nerve graft, while in Group B (delayed intervention) 66.6% of cases was repaired by sural nerve grafting. Studies on absorbable conduits with nerve growth factors are ongoing but nerve autografting is still the gold standard technique in bridging nerve gaps. Both early and delayed repair for sharp peripheral nerve injuries are valid options with comparable results.

INTRODUCTION

Nerve injury is a major clinical health problem that usually leads to functional impairment that can occasional be permanent and with significant socioeconomic impact on the patient.(1) They are the most common types of injuries to the nervous system affecting hundreds of thousands of individuals in the United States and Europe.(2)

Peripheral nerve injuries cause partial or complete disabilities affecting motor and/or the sensory functions. The incidence of such injuries is steadily growing over the last few decades. And despite the development and advances in different microsurgical techniques, the functional outcomes are still unsatisfactory.(3)

The principles of the surgical management of nerve injuries were established during the First World War. They include resection of scar until a healthy bed is secured, excision of damaged nerve until healthy stumps are reached, and tension-free suture by adequate mobilization and flexion of adjacent joints, or by grafting.(4)

The traditional treatment for nerve injuries is microsurgical repair, either by primary nerve suture, delayed repair, with or without nerve graft. The surgical treatment remains challenging and highly demanding procedure and the timing of surgery remains debatable.(5)

PATIENTS AND METHODS

This is a prospective study done on 30 patients presenting to the Ain Shams University Hospitals with open peripheral nerve injuries between January 2014 and December 2015. The patients were divided into 2 equal groups, group A whose patients underwent immediate repair, defined as within 48 hours, and group B whose patients underwent delayed repair after 3 weeks to 6 months after injury. All patients signed informed consents for surgery and were followed up clinically and electro-physiologically after 3 and

6 months from surgery.

Inclusion criteria were included patients of all ages, sexes, and occupations. Patients diagnosed with diabetes mellitus and/or wound infection, and patients requiring nerve grafting during surgery were all excluded from the study

All patients were subjected to the following pre and postoperatively complete medical history and clinical examination including neurological evaluation which was done including sensory and motor examination. Examination included inspection for deformities, trophic changes and wound infection, palpation for any neuromas and scar evaluation regarding healing and relation to the course of the injured nerve.

The most commonly used grading system for nerve recovery is the one developed by British Medical Research Council Nerve Injury Committee(6).

Motor Assessment

M0: No contraction

M1: Return of perceptible contraction of the proximal muscles

M2: Return of perceptible contraction of proximal and distal muscles

M3: Return of function in both proximal and distal muscles to such a degree that all important muscles are sufficiently powerful to act against gravity

M4: Stage 3 with capacity for synergistic and independent movements

M5: Complete recovery

Sensory Examination

S0: No sensory recovery

S1: Recovery of deep cutaneous pain sensibility

S2: Recovery of superficial cutaneous pain sensibility

S3: Recovery of pain and touch sensibility with disappearance of overresponse

S3+: As in S3, but localization of stimulus is good; static 2-point discrimination 7–15 mm

S4: Complete recovery; static 2-point discrimination 2–6 mm

The final status of motor function and sensory recovery was classified as follows:

Good: S3+ or S4 and M4 or M5

Satisfactory: S3 and M3

Moderate: S2 and M2

Bad: S0 or S1 and M0 or M1 (7).

Electromyography and nerve conduction studies were done for the patients in group B only preoperatively for confirming the diagnosis and the degree of injury and was repeated postoperatively in both groups after 3 and 6 months for subjective evaluation of nerve function recovery and results were identified as improving, no change or worsening.

Surgical technique included external neurolysis by freeing nerves from the surrounding tissues. Which was always performed whether the nerve was found to be entrapped or not. Surgical resection of compressive extra neural scar to further promote the recovery of nerve function. Epineurial suturing and repair was done after appropriate preparation of the severed ends using fine sutures (i.e. 4-0 to 6-0 Vicryl), while carefully attempting to maintain the original alignment of the fascicles.

Patients were discharged within 2 days after surgery and physiotherapy was recommended to start 2 weeks after surgery for all patients. All patients were followed up clinically and by electromyography and nerve conduction velocity studies 3 and 6 months after surgery.

Data was collected and verified. Categorical variables were expressed as their absolute and percentage values, while continuous variables were presented as mean values ± standard deviation. Comparisons were made between the 2 groups using the T-test for continuous variables and the chi square test & Pearson correlation coefficient for categorical variables. Statistical analysis was performed using SPSS statistical package version 17. Differences were considered statistically significant at a p value <0.05 level and highly significant at a p value < 0.001.

RESULTS

The study sample consisted of 2 groups with 20 patients in each group. Group A had 14 male patients and 6 female patients, mean age was 24.8 years (range from 15 to 46), while group B had 18 males and 2 females with a mean age of 21.95 (range from 15 to 40). The mean interval from

injury to surgery in group B was 2.6 months while group A patient were all operated within 2 days of injury. Comparison between the 2 groups regarding age and sex distribution was found to be statistically insignificant.

The median nerve was the most common finding in both groups, in group A this was followed by the ulnar nerve, the least incidence was radial and combined median and ulnar nerve injury with equal numbers. Whereas in group B the median nerve was followed by equal incidence of ulnar and combined median and ulnar nerve injury, the least incidence again was for radial nerve injury. The distribution of different nerves in the two groups were compared and found to be statistically insignificant (P value > 0.05) as shown in table 1.

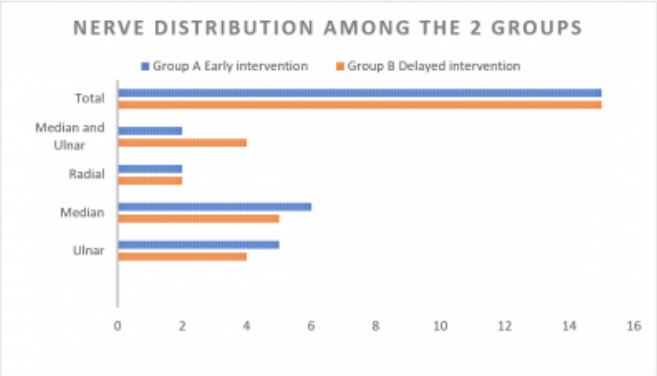
Table 1

Statistical significance test of difference between injured nerve in both group

Nerve	Group A Early intervention	Group B Delayed intervention	Total	P value
Ulnar	5	4	9	0.833
Median	6	5	11	
Radial	2	2	4	
Median and Ulnar	2	4	6	
Total	15	15	30	

Figure 1

Nerve distribution among both groups



Regarding the level of injury, both groups had injuries proximal injuries (in the arm, above or just below the elbow) in 40% of the cases while, the other 60% of injuries were distal (mid forearm and around the wrist).

The surgical outcome is classified as good, satisfactory, moderate or bad as previously described. At 3 months follow up, group A had 46.7% of cases with bad outcome and 53.3% of cases with moderate outcome, while group B cases of 60% had bad outcome and 40% of cases had moderate outcome. Electrophysiological assessment at same time point showed 60% of cases in group A with improvement while only 33.3% from group B showing improvement.

At 6 months follow-up, group A patients had 6.7% of cases achieving good result, 40% of cases with satisfactory outcome, 40% had moderate outcome and 13.3% of cases had bad outcome. While in group B no cases achieved good results, 33.3% of cases had satisfactory outcome, 46.7% had moderate outcome and 20% of cases had bad outcome. The electrophysiological assessment at 6 months showed improvement in 93.3% of cases in group A and in 80% of cases in group B.

Regarding the correlation between the injured nerve and the outcome, in group A best 6 months results were in cases of radial nerve injury with 50% of cases achieving good and 50% achieving satisfactory outcome, followed by median nerve with satisfactory outcome in 66.6% of cases, then the ulnar nerve with satisfactory outcome in 20% and moderate outcome in 60% of cases and the worst results were in combined median and ulnar injuries with moderate outcome in 50% of cases but these results were statistically insignificant (P value > 0.05).

In group B best 6 months results also were in cases of radial nerve injury with satisfactory outcome in 100% of cases, followed by ulnar nerve with satisfactory outcome in 50% of cases, then median nerve with satisfactory outcome in 20% and moderate outcome in 80% of cases and the worst outcome also with combined median and ulnar nerve injury with moderate outcome in 75% of cases, again these results were statistically insignificant (P value > 0.05).

Table 2

Showing correlation between injured nerve and surgical outcome in both groups at 6 months follow up

	Nerve	Bad		Moderate		Satisfactory		Good		P value
		N	%	N	%	N	%	N	%	
Group A	Ulnar	1	20	3	60	1	20	0	0	0.138
	Median	0	0	2	33.3	4	66.6	0	0	
	Radial	0	0	0	0	1	50	1	50	
	Median and Ulnar	1	50	1	50	0	0	0	0	
Group B	Ulnar	2	50	0	0	2	50	0	0	0.051
	Median	0	0	4	80	1	20	0	0	
	Radial	0	0	0	0	2	100	0	0	
	Median and Ulnar	1	25	3	75	0	0	0	0	

Figure 2

Group A outcome shown by injured nerve

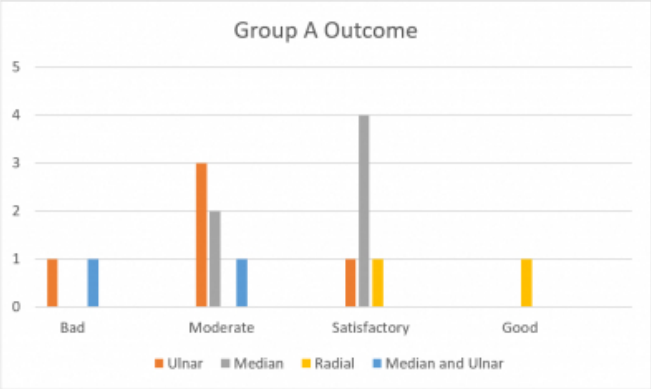
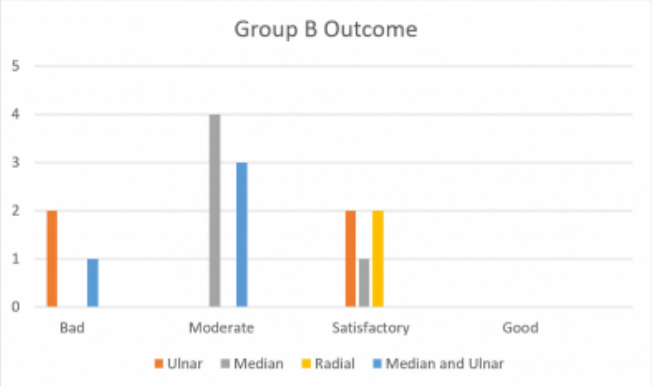


Figure 3

Group B outcome shown by injured nerve



Correlation Between Surgical Outcome and Level of Injury

At the end of the 6 months follow-up period, group A proved to have satisfactory outcome in 42.9% of the cases and good outcome was achieved in 14.3% in proximal injuries while satisfactory outcome was achieved in 37.5% of patients with no cases achieving good result in distal injuries but these results were statistically insignificant (P value > 0.05). While group B satisfactory outcome were achieved in 33.3% in both proximal and distal injuries while no cases achieved good outcome, but these results were also statistically insignificant (P value > 0.05).

Table 3

Showing correlation between level of injury and surgical outcome in both groups at 6 months follow up

	Level	Bad		Moderate		Satisfactory		Good		P value
		N	%	N	%	N	%	N	%	
Group A	Proximal	2	28.57	1	14.28	3	42.85	1	14.28	0.131
	Distal	0	0	5	62.5	3	37.5	0	0	
Group B	Proximal	1	16.6	3	50	2	33.3	0	0	0.961
	Distal	2	22.2	4	44.4	3	33.3	0	0	

Figure 4

Group A outcome shown by level of nerve injury

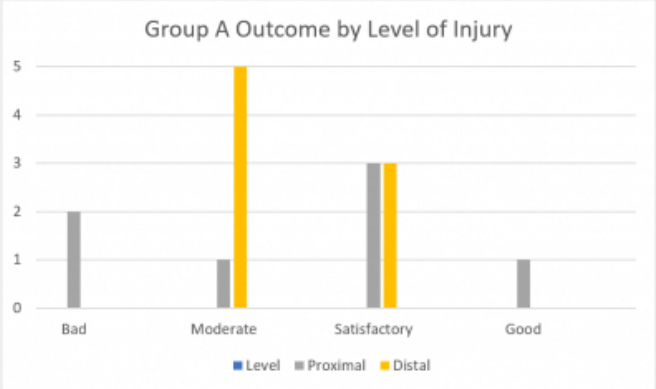
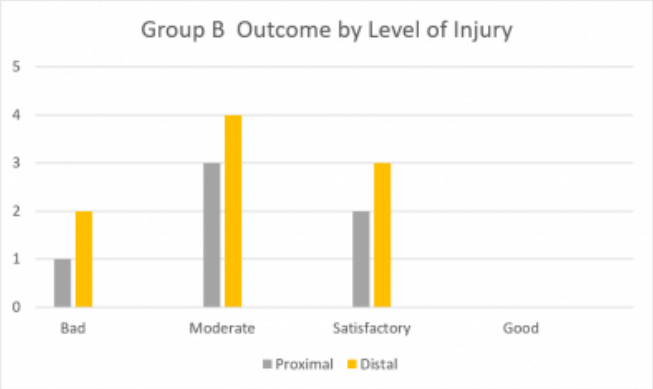


Figure 5

Group B outcome shown by level of nerve injury



DISCUSSION

Peripheral nerve injury can affect all age groups of both genders and usually has a devastating effect on the individual's job and life in general(8). And it has been always a been a debate between early repair and delayed repair, with no doubt that surgical repair is the method of choice for sharp nerve injuries.

Early repair has some advantages if being possible to reach good fascicular alignment due to presence of surface marking on the nerve (epineurial vessels) and It has lower chance for presence of nerve gap which allows direct repair, as well as that early reinnervation of the target muscles which carries better outcome.(9) Yet as Campbell recommended in 2008, early repair is recommended in case the completely sectioned with healthy ends and minimal surrounding tissue injuries(10). It was also recommended by Siemionow and Brzezicki in 2009 that for early nerve repair, favorable conditions include good blood supply, minimal or no crushing of tissues and the wound would be clean; while secondary repair would be advised for cases where these conditions are not met or if the nerve is incompletely injured(11).

Taking these recommendations into consideration this study was conducted on 30 patients suffering from sharp peripheral nerve injury in the upper extremity where the patients were divided into 2 groups according to timing of surgical intervention: group A which was managed by early surgical repair (within 48 hours of injury), and group B which was managed by delayed surgical repair (3 weeks to 6 months after injury)

Palispis and Gupta said that epineurial repair is the traditional method of repair for severed peripheral nerves. They assumed that successful repair entails proper rotational alignment without any tension and that can be achieved by using external markers (vessels), or by matching mirror images of the fascicular pattern in the proximal and distal ends(12). Campbell believes that the best results with nerve repair occur with primary end-to-end neurorrhaphy, while results with grafting are not as good as with end-to-end repair(10). In our study all cases underwent direct repair, whether early or delayed, with tension free suturing of the epineurium, after freeing the nerve form any surrounding adhesions when necessary.

The criteria to determine meaningful recovery has been determined in literature and is defined as return of motor function to M3 or greater, and sensory recovery to S3 or greater (12).

In our study we adopted Jaquet et al. classification of motor and sensory recovery(7):

Good: S3+ or S4 and M4 or M5

Satisfactory: S3 and M3

Moderate: S2 and M2

Bad: S0 or S1 and M0 or M1.

According to these criteria, meaningful recovery is either good or satisfactory recovery as defined by Jaquet et al.

In our study there was a difference in clinical outcome between the 2 groups at short term (3 months) and intermediate term (6 month) follow up and there was a trend favoring outcome in early intervention group. 6.7% of cases achieved good result and 40% of cases had satisfactory outcome in early intervention group (meaningful recovery adding up to 46.75%), only 33.3% of cases had satisfactory outcome in delayed intervention group at 6 months follow up, yet those results were statistically insignificant.

Several studies have compared early with delayed repair, in 2010 Mohesni et al. compared their results in median and ulnar sharp injury and they found favorable results in early repair more than delayed repair where the result of early repair was excellent in 23%, good in 55% and fair in 22%, yet he did not define a specific time frame for early or delayed repair. While the result of delayed repair was good in 32%, fair in 44% and bad in 24%.(13)

In our study the level of injury didn't affect the surgical outcome in statistically significant way, where in early intervention group satisfactory and good outcome were

achieved in 42.85% and 14.28% respectively in proximal injuries (meaningful recovery in 57% of patients) while satisfactory outcome was achieved in 37.5% of patients with no cases achieving good result in distal injuries.

In the delayed intervention group satisfactory outcome were achieved in 33.3% in both proximal and distal injuries while no cases achieved good outcome in both levels of injury, again these results were statistically insignificant. This means that there was a trend favoring better outcome in more proximal lesions which is different from the literature favoring better outcome in more distal lesions.

In his study Basar et al. was studying ulnar nerve injury where they classified it into 3 groups; Early clean transaction injury, early massive soft-tissue-associated injury, delayed partial clean transaction injury. When comparing their results according to the level of injury the found better outcome in distal lesions rather than proximal ones.(14)

Ruijs et al found in their meta-analysis on upper extremity nerve injuries that the level on injury was a good predictor for motor recovery only rather than sensory improvement, the distal injuries were more favorable than proximal injuries. Other predictors included the timing on repair, where they favored early repair as long as there are no contraindications, and also that median nerve repair usually favored better outcome compared to ulnar nerve.(15)

Ruijis et al also found better motor recovery in median nerve injuries compared with ulnar nerve injuries and no difference for sensory recovery. Combined ulnar and median nerve injury has been identified as a predictor for worse prognosis.(15)

Murovic reviewed results of nerve repair in upper limb for 1873 cases from 3 different hospitals and concluded that median and radial nerves had equally good results after primary suture repair in 91% of cases. For similar repairs at all levels in the ulnar nerve, satisfactory outcomes were found in 73%. Median nerve secondary suture repairs had 78% of cases attaining a grade 3 or better outcome. Radial nerve lesions had good results in 69% undergoing secondary repair. Ulnar nerve secondary suture repairs resulted in good outcomes in 69% of cases.

He attributed repair results for the nerves difference to the median nerve's innervation of proximal, large-finger, and thumb flexors and the radial nerve's similar proximal input and innervation of muscles that do not perform delicate movements. This is contrary to the ulnar nerve's major innervation to the distal fine intrinsic hand muscles. Additionally, the radial nerve has a motor fiber predominance, reducing cross motor/sensory reinnervation, and radial nerve-innervated muscles are synergistic, decreasing the chance of antagonistic muscle innervations.(16)

In our study the relationship between the injured nerve and the surgical outcome was statistically insignificant, however there was a trend that results of radial nerve is the best with 50% of cases achieving good and 50% achieving satisfactory outcome in early intervention group and 100% of cases showing satisfactory outcome in delayed intervention group. The result of median nerve was better than ulnar nerve in early intervention group, while the result of ulnar nerve was slightly better than median nerve in delayed intervention group. The worst result was also for combined median and ulnar nerve injury in both groups.

CONCLUSION

Peripheral nerve injury is a common and disabling problem with unsatisfactory results in a high percentage of the cases. Immediate repair is the option of choice for repair of sharp nerve injuries in clean wounds. If early repair is not a valid option due to nerve contusions or delayed presentation, then delayed repair is a valid option with comparable outcome. In this study we conclude that satisfactory results are associated with early repair, distal injures rather than proximal injuries and that radial nerve carries the best chance of recovery among the nerves of the upper extremity. It is also worth to note that there was a direct correlation between the surgical outcome and the nerve findings of electrophysiological studies.

References

1. Modrak M, Talukder MAH, Gurgenashvili K, Noble M, Elfar JC. Peripheral nerve injury and myelination: Potential therapeutic strategies. J Neurosci Res. 2019 Oct 13;
2. Houshyar S, Bhattacharyya A, Shanks R. Peripheral Nerve Conduit: Materials and Structures. ACS Chem Neurosci. 2019 Aug 21;10(8):3349–65.
3. Liu Y, Wang H. Peripheral nerve injury induced changes in the spinal cord and strategies to counteract/enhance the changes to promote nerve regeneration. Neural Regen Res. 2020 Feb;15(2):189–98.
4. Birch R, Misra P, Stewart MPM, Eardley WGP, Ramasamy A, Brown K, et al. Nerve injuries sustained during warfare: part II: Outcomes. J Bone Joint Surg Br. 2012 Apr;94(4):529–35.
5. Elhoseny AL, Zeineldin A, Mohammed MS. Comparative study between primary versus delayed peripheral nerve repair after various types of injury. Menoufia Med J. 2015;28(1):80.
6. Liu X, Zhu J, He B, Zhu Z, Zhu Q, Zhou X, et al. Factors predicting sensory and motor recovery after the repair of

upper limb peripheral nerve injuries. Neural Regen Res. 2014;9(6):661.
7. Jaquet JB, Luijsterburg AJ, Kalmijn S, Kuypers PD, Hofman A, Hovius SE. Median, ulnar, and combined median-ulnar nerve injuries: functional outcome and return to productivity. J Trauma. 2001 Oct;51(4):687–92.
8. Ryu J, Beimesch CF, Lalli TJ. (iii) Peripheral nerve repair. Orthop Trauma. 2011 Jun;25(3):174–80.
9. Dahlin LB. The Role of Timing in Nerve Reconstruction. In: International Review of Neurobiology [Internet]. Elsevier; 2013 [cited 2019 Sep 23]. p. 151–64. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780124200456000079
10. Campbell WW. Evaluation and management of peripheral nerve injury. Clin Neurophysiol. 2008 Sep;119(9):1951–65.
11. Siemionow M, Brzezicki G. Chapter 8: Current techniques and concepts in peripheral nerve repair. Int Rev Neurobiol. 2009;87:141–72.
12. Palispis WA, Gupta R. Surgical repair in humans after traumatic nerve injury provides limited functional neural regeneration in adults. Exp Neurol. 2017;290:106–14.
13. Mohseni M-A, Pour JS, Pour JG. Primary and delayed repair and nerve grafting for treatment of cut median and ulnar nerves. Pak J Biol Sci PJBS. 2010 Mar 15;13(6):287–92.
14. Basar H, Basar B, Erol B, Tetik C. Comparison of ulnar nerve repair according to injury level and type. Int Orthop. 2014 Oct;38(10):2123–8.
15. Ruijs ACJ, Jaquet J-B, Kalmijn S, Giele H, Hovius SER. Median and ulnar nerve injuries: a meta-analysis of predictors of motor and sensory recovery after modern microsurgical nerve repair. Plast Reconstr Surg. 2005 Aug;116(2):484–94; discussion 495-496.
16. Murovic JA. Upper-extremity peripheral nerve injuries: a Louisiana State University Health Sciences Center literature review with comparison of the operative outcomes of 1837 Louisiana State University Health Sciences Center median, radial, and ulnar nerve lesions. Neurosurgery. 2009 Oct;65(4 Suppl):A11-17.

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