Section: Plastic Surgery

Original Research Article

PROGNOSTIC FACTORS FOR OUTCOMES AFTER MEDIAN, ULNAR, AND COMBINED MEDIAN-ULNAR NERVE INJURIES

Pebam Manisana Singh[1], Laishram Oken Singh[2], Nehar Sinam[1], Akoijam Ibohal Singh[3]

[1]Chingmeirong, Imphal West, Manipur, India
[2]Uripok, Imphal West, Manipur, India
[3]Wangkhei, Imphal West, Manipur, India

Received : 31/05/2024
Received in revised form : 20/07/2024
Accepted : 05/08/2024

Keywords:
Peripheral nerve injury, nerve repair, functional outcome, prognostic factor.

Corresponding Author:
Dr. Nehar Sinam,
Email: dr.nehar.sinam@gmail.com

DOI: 10.47009/jamp.2024.6.4.101

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 515-520

Abstract

Background: Surgical reconstruction of peripheral nerve injuries continues to pose challenges, as the clinical outcomes still appear unsatisfactory. The aim of the study is to identify prognostic factors for the functional recovery of peripheral nerve injury of the forearm. **Materials and Methods:** The study was done on 13 patients that had undergone primary median and/ or ulnar nerve(s) reconstruction at the Department of Plastic Surgery, Regional Institute of Medical Sciences (RIMS). Correlation of epidemiological profiles, clinical parameters, operative findings, complications and outcome of surgery after primary nerve repair as well as the possible prognostic factors that may affect the outcome of primary median and/ or ulnar nerve (s) repair were studied. **Result:** 61.53% of patients had good motor recovery; motor recovery in median nerve injury was better than that after ulnar nerve injury. 85% regained some sensation by the time of assessment. Sensory recovery corelated with disability level and ADL performance. DASH score corelated with grip and pinch strength measurements. Poor motor recovery and functional outcome seen in those patients with combined nerve injuries. **Conclusion:** Younger age, smoking, associated flexor tendon injury, residual hand joint stiffness, post-operative rehabilitation, presence of scar tissue, and return to work were all significant factors that could predict functional outcome after nerve repair.

INTRODUCTION

Among upper-limb trauma, incidence of nerve injuries is reported to be 1.64%. Despite marked advances in the neuroscience arena, peripheral nerve injuries continue to pose challenges for surgical reconstruction, as the clinical outcomes still appear unsatisfactory.[1]

A major obstacle to successful nerve reconnection with the target organ is the slow speed of nerve regrowth. In high-level peripheral nerve injury, there is a long distance from the injured site to the target organ, and atrophy of denervated skeletal muscles often occurs which maybe irreversible.[2]

The objective of this study is to identify prognostic factors for the functional recovery of peripheral nerve injury in the forearm and their independent contribution in the outcome in the first year after reconstruction.

MATERIALS AND METHODS

The study was done on 13 patients operated for repair of peripheral nerve injury of forearm - median, ulnar or combined median-ulnar nerve injuries at the Department of Plastic Surgery, Regional Institute of Medical Sciences (RIMS) from December 2019 to November 2021. Patients under twelve years of age, thumb, index, middle finger amputation, bilateral nerve injury, neuromuscular disease and mentally ill cases were excluded from the study.

All patients underwent epineural suture technique for nerve repair with dorsal forearm splintage postoperatively for 3 weeks complete immbobilization, subsequently dictated by the concomitant tendon injury, focusing on early range of motion.

Preoperative assessment included age, sex of patients, education, smoking. Level of injury, type of nerve injury, number of damaged structures, number of damaged arteries and time of repair after injury.

Clinical evaluation of Outcomes

- Sensory testing was assessed according to the The British Medical Research Council (BMRC) scale(S0-S4) at dig II and dig V for median and ulnar nerves respectively.
- Muscle power strength testing of abductor pollicis brevis (APB) and adductor digiti minimi (ADM) muscles for median and ulnar nerve

ISSN (O): 2687-5365; ISSN (P): 2753-6556

injuries respectively graded by The British Medical Research Council (BMRC)scale for motor recovery (Grades M0-M5).

- Power grip and Pinch grip measured using a muscle handheld- Jamar dynamometer. This was bilaterally performed. Unaffected side measures were taken as control and values were calculated as percentage from normal side.

Functional evaluation of outcome

1. Ability to perform daily activities- Questionnaire (DASH) Disabilities of the Arm, Shoulder and Hand score was used to assess the disability of the affected extremities. A score was generated between 0 and 100 in which 0 corresponded to no disability and 100 to completely disabled.
2. Assessment of patient's opinion of recovery on a 0-10 numeric rating scale was done.
3. Psychological functioning- done by using Questionnaire, Impact of Event scale (IES).

Evaluation was done at one month, three month and sixth month post-surgery for hand function and work status.

Statistical analysis: Statistical analysis was done with Statistical Package for Social Sciences (SPSS Version 21). Descriptive statistics such as mean, median, percentage used to summarize the data. Chi square test, Mann Whitney test, Fischer exact test, t test used to assess the associations between variables of interest and prognosis of repair. P-value <0.05 was taken as significant.

Ethics issue: The study was conducted after getting clearance (REB-Comm (SP)/RIMS/2015/ 653/131 /2019) from Research Ethics Board, Regional Institute of Medical Sciences, Imphal.

RESULTS

Functional evaluation of surgical outcomes

- The median value of DASH among all study patients was 29.1(12-85). For median nerve was 39.8/100 and for ulnar nerve was 37.9/100 and for patients with both nerve repair was 49.8/100.
- The median value of patients' opinion of recovery at final follow up was 5(2-8) and the distribution of patients score is shown in Fig. 1. The median value for patients with median nerve was 6 for median nerve 5 for ulnar nerve and for both nerve repair was 3.
- The median value of hyperesthesia score was 3 (0–3) and the distribution of patient's scores is showed in Fig. 2. The median value for hyperesthesia for median nerve was 2.5, for ulnar nerve was 3 and for patients with both nerve repair was 3.

At the 6-month follow-up, manual labourers exhibited a lower rate of return to work compared to office workers (70% vs. 100%; p < .01). Additionally, office workers demonstrated superior motor and sensory recovery, as evidenced by higher grip strength (63.5 [52.8-77.5] vs. 56.7 [40-70.0]) and pinch strength (9.8 [8.0-12.5] vs. 7.5 [5.8-12]). Office workers achieved better scores on the Disability of Arm, Shoulder, and Hand (DASH) questionnaire (37 vs. 49). Manual labourers also presented with more severe initial injuries, including a higher incidence of injured concomitant structures and combined nerve injuries compared to office workers.

Injuries to the dominant extremity demonstrated better grip strength and pinch grip strength at 6 months follow up however, there was no clinically significant difference in MRC scores and sensory recovery score. There were no differences in return to work or DASH scores between dominant and non-dominant extremity [Table 8].

Evidence of Post traumatic stress disorder (PTSD) was seen in the study more in early phase after trauma at one month and an overall decrease in PTSD was observed across study over time. At one month, combined median and ulnar nerves injuries were accompanied by higher psychological stress indicating presence of PTSD with high mean IES scores of 33 at one month compared to single nerve injuries: median nerve (mean IES 24.6), ulnar nerve (mean IES 26.2);. (p<0.05). [Figure 3]

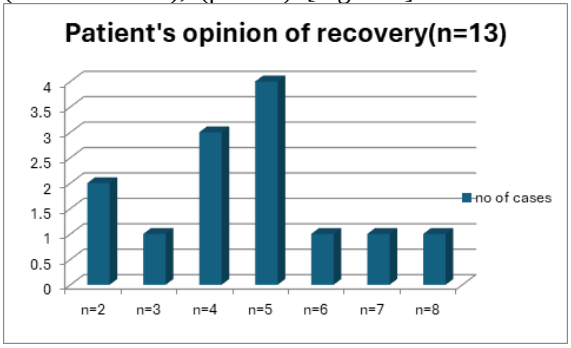

Figure 1: Distribution of study patients according to their self-related opinion of recovery (VAS- Score).

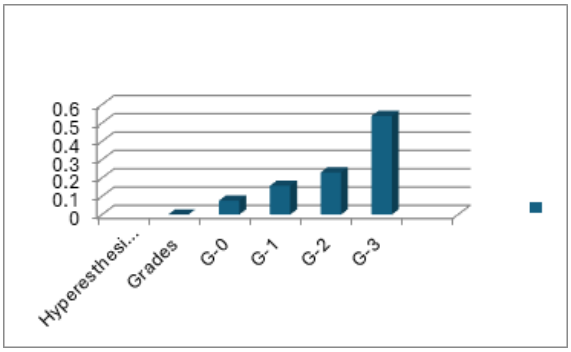

Figure 2: Hyperesthesia score

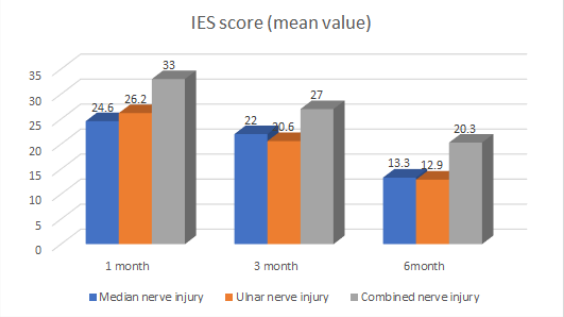

Figure 3: IES score follow-up for psychological stress

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Figure 4: Combined nerve injuries involving neurovascular, tendons-complex injury.

Figure 5: Nerve repair epineurorrhaphy with7-0 Polypropylene suture.

Table 1: Demographics and clinical data.

Characteristics	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
Age (median, interquartile range)	25(18-30)	32.28(15-55)	34.33(24-55)	P=.04
Gender Male Female	3	6 1	3	P=.26
Occupation Office Manual labour	1 2	1 6	1 2	P=.08
Smoking	2	3	1	

Table 2: Demographics and clinical data

Characteristics	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
Mechanism of injury Broken glass Work accident Suicide attempt	 1 2	 3 2 1	 2 1	P<.01
Injury and hand dominance Dominant hand Nondominant hand	 3	 5 2	 2 1	P<.01
Occupation Office Manual labour	 1 2	 2 5	 3	P=.08

Table 3: Demographics and clinical data

Characteristics	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
Time of surgery (median, interquartile range)	5(1-14)	2.42(1-7)	1	P<.01
Associated vascular injuries	2	5	3	P<.01
Tendons lacerated	FCR, FPL, PL	FCU, FDP, FDS	FCR, FPL, PL, FCU, FDP, FDS	P<.01

Table 4: MRC score for muscle strength recovery

MRC motor rating	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
M1 M2 M3 M4 M5	 1 1 1	1 2 3 1	 1 2	P<.01

Table 5: MRC score for sensory recovery

MRC sensation	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
S0 S1	1 1	1 3	 1	P<.01

ISSN (O): 2687-5365; ISSN (P): 2753-6556

S2 S3 S3+ S4	1	2 1	1 1	

Table 6: Grip strength and pinch grip recovery comparison

Outcomes at 3months follow up	Median Nerve	Ulnar Nerve	Combined Nerve Injury	P Value
Grip strength, median (interquartile range)	65.0(55.0-75.0)	60.0(40.0-70.0)	42.5(40.0-56.3)	P<.01
Pinch strength, median (interquartile range)	9.0(7.0-12.0)	10.5(9.0-14.3)	6.5(5.8-8.0)	P=.01

Table 7: Manual laborers versus office workers

Outcomes at 6 months	Office job	Manual laborers	P value
Grip strength Pinch strength	63.5(52.8-77.5) 9.8(8.0-12.5)	56.7(40-70.0) 7.5(5.8-12)	P<.01
DASH score	37	49	P<.01

Table 8: Dominant versus non dominant extremities.

Outcomes at 6 months	Dominant extremity	Non dominant extremity	P value
Return to work	80%	66.6%	P=.75
Grip strength	64.5(52.8-77.5)	53.5(40-65.0)	P<.01
Pinch strength	9.8(8.0-12.5)	7.5(5.8-12)	P<.01
DASH score	47(12-65)	61(50-85)	P<.01

DISCUSSION

61.53% of patients had good motor recovery (M3, M4) because of the distal site of injury (shorter distance to NMJ). However, none of the patients had reached full motor recovery (M5) and this may be because of the relatively short period of follow-up where motor recovery continues years after nerve repair.[3] Regarding motor recovery, the current results showed a less satisfactory grip and pinch strength measurements (59.2% and 9.3%, respectively). Rosen and Lundborg et al,[4] reported better grip strength recoveries of 88% and 89.9%, respectively after median and ulnar nerve repairs and this may be related to their larger sample sizes and longer period of follow up.

A statistically positive correlation was found between grip and pinch strength of the studied patients and the MRC scale for muscle power assessment. The formation of power grasp requires synchrony between the extrinsic and intrinsic muscles of the hand. Accordingly, intrinsic loss will affect grip strength by disrupting the mechanics of grasp and depriving the hand of the intrinsic muscle force contribution.[5]

Most of the patients (85%) had regained some sensation by the time of assessment but no one has reached S3+, S4 (2-point discrimination recovery) and 70% (9 patients) of them had sensory recovery below S3. This may be because of the relatively short follow-up period as sensory functions gradually improve over time and need longer period to recover completely. Several studies,[6,7] reported that the quality of sensory recovery improved from S1 to S3 by increasing the follow-up time and still complete (S4) recovery was not seen after 3 years of repair. However, in a study by Ruijs AC et al,[8] significant improvement was seen in the first 2 years.

Sensory recovery correlated with disability level and ADL performance and this result goes in agreement with Kadir et al,[9] and Rosen et al,[4] who reported poor functional evaluation in patients with median and ulnar nerve repairs with poor sensory grading. Motor recovery was better than sensory recovery regarding the MRC grading, due to the shorter distance that motor fibres had to travel from repair site to the target muscle compared to the longer distance travelled by sensory fibres to reach sensory receptors.

DASH Score results varied widely between the studied patients with a minimum score of 12/100 and a maximum score of 85/100. DASH score correlated with grip and pinch strength measurements indicating that recovery of motor function of the hand after nerve repair positively affects patient's daily living activities.[10] The current results showed that hyperesthesia score correlated with the rest of functional scores indicating that hyperesthesia can affect ADL performance in patients after nerve repair. This may be due to disturbing nature of hyperesthesia and its affection on hand manipulation and control.

The present study used a 0–10 scale to express the patient's opinion of recovery as one of the functional assessment tools. Patient's opinion of recovery reflects the interplay between the outcome of surgery and its impact on ADL, social life, and patient's emotions and anxiety. Younger patients in the present study had better grip strength and better functional scores, similar to study by Novak CB.[11] This may be because younger patients have a stronger regenerative capacity and better adaptation to the reorganization of the CNS.

No significant relation was found between gender as a prognostic factor and the studied outcome measures. This result goes in agreement with many studies that showed no difference between males and females regarding outcome after nerve repair.[12] However, a previously published meta-analysis of Ertem K,[13] reported that female gender has better

ISSN (O): 2687-5365; ISSN (P): 2753-6556

recovery of motor function after the repair of mixed nerve injuries. It was suggested that women may have better compliance with postoperative adjuvant treatments such as neurotropic drugs and functional exercises than men.

In the present study, despite not reaching a statistically significant level, motor recovery in median nerve injury was better than that after ulnar nerve injury. This may be because ulnar nerve innervates a small volume of muscle with a small muscle fibre size and accordingly loss of innervation and rapid degeneration and atrophy of muscle fibres. Moreover, the present study showed poor motor recovery and functional evaluation in those patients with combined nerve injuries which might be related to associated extensive soft-tissue damage similar results were reported in many studies.[14,15]

Many studies reported the negative effects of smoking on nerve healing.[16,17] Current results showed that smokers had poor sensory recovery, grip strength, and functional assessment than nonsmokers. Patients with clinically visible wound adhesions showed poor results regarding grip strength and functional score. In addition, excessive tension across the nerve suture line will increase the degree of fibrosis and this will impair the nerve healing process.[18,19]

At one month, combined median and ulnar nerves injuries were accompanied by higher psychological stress indicating presence of PTSD with high mean IES scores of 33 compared to single nerve injuries: median nerve (mean IES 22.3), ulnar nerve (mean IES 24; p¼0.021). Similarly, Ultee et al18 recently found, at one month, that patients with combined nerve injuries had high IES (mean 37.5_16.2), which was significantly different to those who injured an isolated nerve. No studies found a difference in the presence of PTSD between patients with isolated median and those with ulnar nerves injuries.[16,17] psychological stress in this patient group, which supports other reports following traumatic upper limb PNI.[19-21] There was evidence of significant symptoms of PTSD early after PNI and these symptoms decreased over the first year. Ciaramitaro P et al,[22] assessed depression after traumatic upper limb PNI reporting some evidence of a correlation with pain. However, overall, the findings are limited as few high-quality studies exist and those studies included varied methodology.

Showed that post-operative rehabilitation is one of the factors affecting surgical outcome after nerve repair. Proper rehabilitation ensures restoration of joint motion, reduces muscle wasting, decrease the formation of adhesions and maximizes sensory re-education as reported by Millesi H.[23] In addition, patients that returned to work early had better grip, pinch strength and functional assessment results than those who did not return to their work. Early return to work improves muscle strengths, sensory re-education, physical, and mental health as well as decreases stress, pain, and depression in those patients.[24]

Limitations of the study

- The number of patients with post-operative infection and/or associated vessel injury needs to be increased for reliable results about the effect of these factors on surgical outcome.
- The number of patients with combined nerve repair was too small for comparison with each single nerve repair.
- Since the follow-up period was relatively short, long term prognostic factors cannot be established.

CONCLUSION

MRC scales for motor and sensory evaluation, functional scores, grip, and pinch strength measurements have proven to be valuable tools for evaluation of functional outcome after peripheral nerve repair. Younger age, smoking, associated flexor tendon injury, residual hand joint stiffness, post-operative rehabilitation, presence of scar tissue, and return to work were all significant factors that could predict functional outcome after nerve repair.

This study found high prevalence of PTSD following traumatic upper limb PNI although evidence is currently limited due to the low number and limited quality of the studies.

REFERENCES

1. Wang Y, Sunitha M. How to Measure Outcomes of Peripheral Nerve Surgery. Hand Clin 2013Aug;29(3):349–61.
2. Zhang S, JiF. Side-to-side neurorrhaphy for high-level peripheral nerve injuries. ActaNeurochir 2012;154(1):527–32.
3. Kallio PK,Vastamäki M,Solonen KA.An analysis of the results of late reconstruction of 132 median nerves.J Hand Surg Br1993 Feb;18(1):97-105.
4. Rosen B, Lundborg G .A model instrument for the documentation of outcome after nerve repair. J Hand Surg 2000; 25:535–43.
5. Rinker B, Fink BF, Barry NG, Fife JA, Milan ME, Stoker AR, et al.The effect of cigarette smoking on functional recovery following peripheral nerve ischemia/reperfusion injury.Microsurgery 2011 Jan;31(1):59-65.
6. 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.
7. Desouches C, Alluin O, Mutaftschiev N, Dousset E, Magalon G, Boucraut J,et al.Peripheral nerve repair: 30 centuries of scientific research.Rev Neurol (Paris) 2005 Nov;161(11):1045-59.
8. 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.PlastReconstrSurg 2005 Aug;116(2):484-94.
9. Kadir E, Yurdaer D, Saim Y, Arslan B. The effect of injury level,associated injuries, the type of nerve repair, and age on the prognosis of patients with median and ulnar nerve injuries. Acta Orthop Traumatol Turc 2005 ;39(4):322–27.
10. Ultee J, Hundepool CA, Nijhuis TH, van Baar AL, Hovius SE.Early posttraumatic psychological stress following peripheral nerve injury: a prospective study.J PlastReconstrAesthetSurg 2013 Oct;66(10):1316-21.
11. Novak CB. Evaluation of the nerve-injured patient. Clin Plast Surg 2003;30(1):127–38.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

12. Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluations. J Hand Surg1984; 9(1):222–6.
13. Ertem K, Denizhan Y, Yoloğlu S, Bora A. The effect of injury level, asso- ciated injuries, the type of nerve repair, and age on the prognosis of patients with median and ulnar nerve injuries. Acta Orthop Traumatol Turc 2005;39(4):322–27.
14. Fakin RM, Calcagni M, Klein HJ, Giovanoli P. Longterm clinical outcome after epineural coaptation of digital nerves. J Hand Surg Eur 2015 ;6(1):114–122.
15. He B, Zhu Z, Zhu Q, Zhou X, Zheng C, Pengliang L et al. Factors predicting sensory and motor recovery after the repair of upper limb peripheral nerve injuries. Neural Regen Res 2014; 9(6):661–672.
16. Alotaibi NM, Aljadi SH, Alrowayeh HN. Reliability, validity and responsiveness of the Arabic version of the Disability of Arm, Shoulder and Hand (DASH-Arabic). Disabil Rehabil 2016; 38(25):2469–78.
17. Czarnecki P, Gorecki M, Romanowski L. Factors affecting the final outcomes after reconstruction of the median and ulnar nerve at the level of the forearm: Analysis of 41 patients. Injury 2000;3(20):191–97.
18. Stonner MM, Mackinnon ES, Kaskutas V. Predictors of functional outcome after peripheral nerve injury and compression. J Hand Ther 2020;22(1):1–6.
19. Lee JJ, Patel R, Biermann JS, Dougherty PJ. The musculoskeletal effects of cigarette smoking. J Bone Joint Surg Am 2013;95(1):850–9.
20. Wong LS, Martins-Green M. First hand cigarette smoke alters fibroblast migration and survival: implications for impaired healing. Wound Repair Regen2004; 12(1):471–84.
21. Wang ML, Rivlin M, Graham JG, Beredjiklian PK (2019) Peripheral nerve injury, scarring, and recovery. Connect Tissue Res. 60(1):3–9.
22. Ciaramitaro P, Mondelli M, Logullo F, et al. Traumatic peripheral nerve injuries: epidemiological findings, neuropathic pain and quality of life in 158 patients. J Peripher Nerv Syst 2010; 15(1): 120–27.
23. Bailey R, Kaskutas V, Fox I, et al. Effect of upper extremity nerve damage on activity participation, pain, depression, and quality of life. J Hand Surg Am 2009; 34(1): 1682–88.
24. Chemnitz A, Dahlin LB and Carlsson IK. Consequences and adaptation in daily life – patients' experiences three decades after a nerve injury sustained in adolescence. BMC Musculoskelet Disord 2013; 14(1): 252.

ISSN (O): 2687-5365; ISSN (P): 2753-6556