

Functional Outcome of Anterior Interosseous Nerve Transfer to The Motor Branch of The Ulnar Nerve for High Ulnar Nerve Injuries

Karam Rasool Basra, Khalid Masood, Khalid Zulfiqar Qureshi, Hafiz Muhammad Kashif Shafi, Belal Saadat, Muhammad Saif ur Rehman

ABSTRACT

Objective: To evaluate functional outcome of the anterior interosseous nerve transfer to the motor branch of the ulnar nerve for cases of high ulnar nerve injuries

Methods: This descriptive study was conducted in Hand and Upper Limb Surgery (HULS) CMH Lahore Medical College Pakistan from 21st July 2016 to 21st August 2018. A total of 13 patients (10 males, 03 females), mean age 32years(range 18 to 42) with injury to the ulnar nerve(high) were treated with anterior interosseous nerve(AIN) transfer to the motor branch of ulnar nerve. Functional outcome was evaluated clinically preoperatively, immediately postoperatively and 03 to 06 month follow up to evaluate motor functional grading system.

Results: In high ulnar nerve injury in whom anterior interosseous nerve was transferred all cases showed good outcomes (M3 to M4 by motor functional grading system) with mean initial recovery period of 3.5 months

Conclusion: Treatment of high ulnar nerve injury with transfer of the anterior interosseous nerve to the motor branch of the ulnar nerve results in early near normal intrinsic recovery and restoration of hand functions.

Keywords: Anterior Interosseous Nerve, High Ulnar Nerve Injury, Nerve Transfer

This article may be cited as: Basra KR. Functional Outcome of Anterior Interosseous Nerve Transfer to The Motor Branch of The Ulnar Nerve for High Ulnar Nerve Injuries. J Pak Orthop Assoc 2019;31(2):

INTRODUCTION

Injury to the Ulnar nerve is on the top among all the peripheral nerve injury. Seletz¹ in 1951 in a case series documented the incidence of ulnar nerve injury in 390 patients out of total 2037 peripheral nerve injuries. Mumenthaler² in 1991 in a study declared the incidence of 32.1% ulnar nerve injuries on the operated cases in American army during world war II. In complete ulnar nerve injury, motor and sensory functions both are lost including denervation of intrinsic musculature of hand and loss of sensation in the ring and little finger.

Injury to the ulnar nerve at the level at elbow despite having good microsurgical repair the outcome of recovery of hand muscles is poor.³ Like many studies showed a results of about 20% recovery of M4 or M5 in which ulnar nerve (at elbow level) was either

repaired primarily or with the use of graft.⁴⁻⁷ Hence, there is recommendation of distal tendon transfer instead of doing primarily nerve repair.^{8,9}

An alternate surgical technique, i.e. distal nerve transfer is a new technique which is now a days used with increasing frequency of ulnar nerve injury. In this technique the anterior interosseous nerve is transferred to the motor ulnar nerve to achieve functional outcome of the hand muscles. Different studies by Haase,¹⁰ Novack¹¹ and Battiston¹² showed that the use of this technique yields good improvement of motor function of hand.

The Objective of this study was to determine the functional results of transfer of anterior interosseous nerve of Pronator Quadratus muscle to the motor branch of deep ulnar nerve.

METHODS

This was a descriptive study of 13 Patients including 10 male and 03 female who had a high ulnar nerve injury and were operated for anterior interosseous nerve transfer to ulnar nerve (Fig I) The study was conducted in the Hand and Upper Limb Surgery (HULS) Center

*Department of Hand and Upper Limb Surgery (HULS)
CMH Lahore Medical College Pakistan
Correspondence to: Karam Rasool Basra
Email: drkarambasra@hotmail.com*

CMH Lahore Medical College Lahore, for a duration extended upto of two years (from 21st July 2016 to 21st August 2018). Single surgeon performed this procedure.

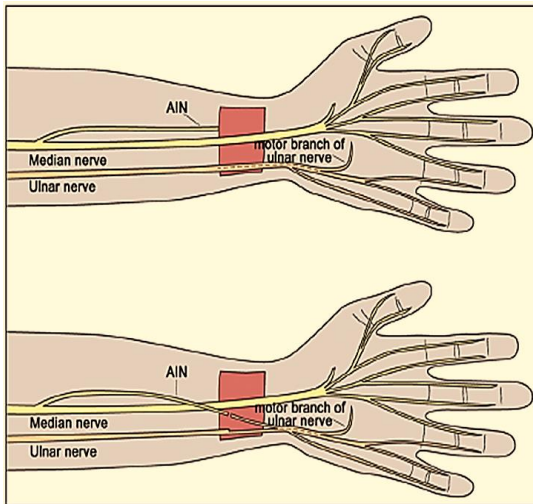


Fig I: Diagrammatic representation of anterior interosseous nerve transfer to motor branch of ulnar nerve.

The Ethical board of the hospital approved the study and informed consent was taken from all study participants.

All patients with isolated high ulnar nerve injury with duration less than 06 months who were willing for surgery were included. Patient with multiple nerve injuries, associated musculoskeletal injuries, polyneuropathy and duration more than 06 months (when intrinsic got atrophied) were excluded from the study.

The mechanism of injury in these patient were 09 sustaining sharp object injury, 03 firearm injuries and 01 having compression injuries. End to end anastomosis were performed in 08 patients and end to side anastomosis in 05 patients

All the surgeries were done under general anaesthesia and tourniquet control. To know the perioperative absence of ulnar function at wrist level nerve stimulator was used before doing intraneural dissection so that false result from neuropraxia can be avoided. The incision must include distal forearm and Guyon's canal. At the Guyon's canal the superficial and deep branches of ulnar nerve are separated through dissection upto the proximal edge of Pronator Quadratus(Fig II). In the next step anterior interosseous nerve is identified in the flexor tendons. (Fig III) Through careful dissection nerve was exposed and

mobilized where it started branching to gain maximum length for transfer. The motor branch of ulnar nerve was proximally divided while AIN distally and sutured to each other with 10/0 prolene and glue.(Fig IV) The incision was suture and hand was immobilized for 03 weeks. Motor rehabilitation was started immediately post operatively. Motor rehabilitation included passive movements wrist and fingers. Electricl stimulation of the muscles were initiated.



Fig II: Identification ulnar nerve branches (Superficial & Deep)



Fig III: Flexor muscle retracted to show AIN



Fig IV: Perioperative photograph showing tension free anastomosis of nerve

The final result were graded using motor functional system MRC Grading (M5 excellent, M4-M3 good and less than M3 poor). The strength of Abductor Digiti Minimi, Opponens Digiti Minimi, Palmar and Dorsal Interossei, and Adductor Pollicis were assessed.

RESULTS

Out of total 13 patients 10(77%) were male while 3(23%) were females. The mean age was 32years (range 18 to 42). The aetiology of nerve injury was sharp object in 75%,firearm in 17% and compression in 8%.The mean postoperative follow up was 12 months (Range 6 to 18 Months). A final follow-up was done at 18 months.

Mean initial recovery period 3.5 months.The surgical outcome of all cases were good (M3 and M4). But no excellent result(M5) was achieved in any case. (Table I)One patient needed tendon transfer to correct clawing. All the patients had no functional deficit in pronation.

Table I: Post operative Functional outcome

Muscle grade	M 5	M4	M3	M2	M1	Total
Number of Patient	0	7(53.8%)	6(46.1%)	0	0	13

DISCUSSION

Various studies showed that direct ulnar nerve repair at elbow or above results poor functional outcome in terms of clawing and restoration of intrinsic muscle function.^{8,9} However, if the nerve repair is done in children even by using graft it yields good prognosis.¹³

Secer⁵ showed that only 15% of his patients with ulnar nerve injuries due to gunshot injuries had good outcome (M3 or better). A meta-analysis of median and ulnar nerve injuries by Rujis 14 revealed that 71% of ulnar nerve had less chances of recovering its motor function than median nerve at the same level.The post-operative tendon transfer for complete recovery was documented by Pfaeffle⁹ while Taha⁸ did tendon transfers in 72% of his patients. The poor outcome of ulnar nerve repair not only due to longer area in between the nerve repair site and innervated muscle resulting in untimely reinnervation to regenerating axon but also due to the small motor unit of the distal muscle.

Previous anatomical study shows that nerve branch to the pronator quadratus muscle is the most suitable donor nerve to the deep branch of ulnar nerve. Wang and Zu¹⁵ in a study demonstrated anterior interosseous nerve(AIN) has 912±88 fibers whereas deep motor branch of ulnar nerve has 1216±108, though the diameter of both the nerves is same and due to this ideal nerve transfer, treatment of tendon transfers in High Ulnar Nerve injury is no more first treatment of choice. However 85% good results (M4 or better) has been reported by many studies using this nerve. But limited number of patients in these studies is a concern.^{11, 12, 15} We noted very good functional outcome of hand function including grip and key pinch in our patients. This nerve transfer technique has potential advantages. It is easy to perform. It does not need any graft. Transfer is near the target muscle and regenerating axons quickly reached muscle endplate.

We did intraneural dissection after identifying both branches in Guyon's canal and then separate it proximally as compared to visual neurolysis performed by Brown¹⁶. With our technique the nerve repair was tension free in four cases while in only one case we had to flex the wrist to ensure tension free repair. There are two techniques available for connecting the donor nerve to recipient nerve. End to side anastomosis in which connecting terminal branch is suture to the nerve on one side whereas in end to end anastomosis ends of both nerves are connected to one another. For first technique Schmidhammer¹⁷ in a study reported good results while other show poor reinnervation in which attempt to reconstruct was made in large nerve.^{18,19} In our opinion external neurolysis should be done very carefully and gently to avoid disrupting the epineurium and thin connective tissues around the nerve.

The sample size of our study was small.We recommend large sample size study with longer follow up on this important topic.

CONCLUSION

Although nerve transfers do not replace primary nerve repair, nerve graft and tendon transfers but treatment of high ulnar nerve injury with transfer of the anterior interosseous nerve to the motor branch of the ulnar nerve results in early near normal intrinsic recovery and restoration of hand functions.

Conflict of Interests: None

Funding Source/Grants: None

REFERENCES

1. Seletz E. Peripheral nerve surgery. Prog Neurol Psychiatry 1972;27:199-202.

2. Mumenthaler M, Schliack H. Peripheral nerve lesions. New York: Thieme Medical Publishers, 1991.
3. Kirklin JW, Murphy F, Berkson J. Suture of peripheral nerves. Factors affecting prognosis. *Surg Gynecol Obstet* 1949;88:719-730.
4. Roganovic Z. Missile-caused ulnar nerve injury: outcomes of 128 repairs. *Neurosurgery* 2004;55:1120-1229
5. Secer HI, Daneyemez M, Gonul E, Izci Y. Surgical repair of ulnar nerve lesions caused by gunshots and shrapnel: results in 407 lesions. *J Neurosurg* 2007;107:776-783
6. Kato H, Minami A, Kobayashi M, Takahara M, Ogino T. Functional results of low median and ulnar nerve repair with intraneural fascicular dissection and electrical fascicular orientation. *J Hand Surg Am* 1998;23:471-482
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;51:687-692
8. Taha A, Taha J. Results of suture of radial, median and ulnar nerves after missile injuries below the axilla. *J Trauma* 1998;45:335-339.
9. Pfaeffle HJ, Waitayawinyu T, Trumble TE. Ulnar nerve laceration and repair. *Hand Clinic* 2007;23:291-299
10. Haase S, Chung KC. Anterior interosseous nerve transfer to the motor branch of the ulnar nerve for high ulnar nerve injuries. *Ann Plast Surg* 2002;49:285-290
11. Novak CB, Mackinnom SE. Distal anterior interosseous nerve transfer to the deep motor branch of the ulnar nerve for reconstruction of high ulnar nerve injuries. *J Reconstruct Microsurg* 2002;18:459-463
12. Battiston B, Lanzetta M. Reconstruction of high ulnar nerve lesions by distal double median to ulnar nerve transfer. *J Hand Surg Am* 1999;24:1185-1191.
13. Vastamaki M, Kallio PK, Solonen KA. The results of secondary microsurgical repair of ulnar nerve injury. *J Hand Surg Br* 1993;18:323-326
14. 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;116:484-494.
15. Wang Y, Zu S. Transfer of a branch of the anterior interosseous nerve to the motor branch of the median and ulnar nerve. *Chin Med J* 1997;110:216-219
16. Brown JM, Yee A, Mackinnom SE. Distal median to ulnar nerve transfer to restore ulnar motor and sensory function within the hand: technical nuances. *Neurosurgery* 2009;65:966-978
17. Schmidhammer R, Redl H, Hopf R, van der Nest DG, Millesi H. Synergistic terminal motor end-to-side nerve graft repair: investigation in a non-human primate model. *Acta Neurochir* 2007;100(Suppl):S97-S101
18. Pienaar C, Swan MC, de Jager W, Solomons M. Clinical experience with end-to-side nerve transfer. *J Hand Surg Br* 2004;29:438-443
19. Bertelli JA, Guizoni MF. Nerve repair by end-to-side coaptation or fascicular transfer: a clinical study. *J Reconstruct Microsurg* 2003;19:313-318

Authorship and contribution Declaration

Karam Rasool Basra, Conception and design of the study, Acquisition of data

Khalid Masood, Acquisition of data

Khalid Zulfiqar Qureshi, Interpreted data

Hafiz Muhammad Kashif Shafi, Drafted the manuscript

Belal Saadat, Revised the manuscript critically for important intellectual content

Muhammad Saif ur Rehman, Final approval of the version for publication