Research Article

Comparison of Patient Satisfaction of Return to Work in Early Post-operative Periods in Patients with High Radial Nerve Injury Undergoing Primary Nerve Repair Plus Tendon Transfer Versus Primary Nerve Repair Alone

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Abstract

Background: Complete nerve recovery can take 2 years or more if repaired primarily /grafted, with poorer results in proximal and extensive crush injuries. After tendon transfer, (usually done in the setting of irreparable nerve injury, inadequate functional recovery after repair, or late presentation), full activity can be resumed at 12 weeks. Our objective was to compare early return of work satisfaction level in patients with high radial nerve injury undergoing early tendon transfer combined with nerve repair, with patients undergoing nerve repair alone.

Methods: This was a non-randomized controlled trial conducted over a 2–year period (August 2017 to August 2019). All patients with high radial nerve injury, presenting within 1 year were included and divided into 2 groups. Group 1had nerve repair with tendon transfer and group 2had nerve repair alone. Post-operative follow-up was done at 6 and 12 weeks. Active range of motion was assessed and graded as excellent, good, fair or poor

Results: A total of 33 patients participated in the study. There were 16 patients in group 1 and 17 in group 2. The majority of patients were manual workers. At 12th week, all patients in group 1 were satisfied with the functional improvement and were able to continue their previous job. While in group 2 no improvement in function was noted in all the patients and the majority (88%) were not satisfied with recovery time and wanted to be splint-free. All the manual workers in this group expressed the desire to go back to work early.

Conclusion: Early tendon transfer at the time of nerve exploration and repair is highly beneficial and rewarding for patients, especially manual workers in terms of gain of function, return to work, and their satisfaction in performing daily activities.

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Introduction

Radial nerve injury is common and usually occurs as a result of blunt or penetrating trauma especially following humeral shaft fractures due to the nerve's proximity and long tortuous course in close proximity to the bone. Gunshot injuries and iatrogenic injuries are some other commonly reported initiating events.[1] Clinical signs depend on the site of nerve damage with a high, complete radial nerve injury presenting with loss of extension of wrist and fingers, and thumb abduction and extension, and an overall reduction in grip strength whereas in a low, posterior interosseous nerve injury (PIN injury) wrist extension is spared.[2,3,4] The algorithm of treatment includes primary nerve repair, repair with nerve graft, nerve transfer, and tendon transfer.[5] Results of nerve repair are disappointing in

very proximal injuries, those that require longer nerve grafts, and injuries that occur from extensive crush.[6] Moreover, the initial signs of nerve recovery are usually late i.e. can be delayed up to 6 months while complete recovery can take 2 years or more.[7,8] During this time patient needs to wait with a wrist extension splint applied for recovery with uncertainty about return of function.

A tendon transfer is the most reliable option to restore function after peripheral radial nerve injury and is done when the nerve is irreparable, does not recover after direct repair or with graft, and when the patient presents too late after the injury.[7] In one study Dunnet et al concluded 84% improvement in hand function and 64% increase in power grip after reviewing 49 cases undergoing tendon transfer surgery.[9] As per the algorithm of management of radial nerve injury, patients wait for 12 to 18 months after nerve repair for recovery. If there are no signs of recovery then tendon transfer procedure is done, increasing morbidity and overall time to return to work which has a negative effect on patients functional status, finances, and mental health. If tendon transfer is done early at the time of nerve repair, the patients can achieve full activity by the end of 12 weeks.[10] This will reduce the morbidity, improve functional outcome, and enable early return to work, while allowing simultaneous nerve recovery.[11]

The objective of this study was to compare the functional outcomes, and satisfaction level in patients with high radial nerve injury undergoing early tendon transfer combined with nerve repair, with patients undergoing nerve repair alone.

Methods

This was a non-randomized controlled trial conducted at the Department of Plastic and Reconstructive Surgery of a tertiary care hospital between August 2017 and August 2019. A total of 33 patients with high radial nerve damage were included. Patients were briefly informed about the pros and cons of both the procedures and were assigned in groups based on their choices. Patients in group 1 (n=16) underwent radial nerve repair with a full set of tendon transfer, whereas patients in group 2 (n=17)underwent radial nerve repair alone. Patients with excessive crush injury, extensive soft tissue loss, and multiple nerve injuries were not included in the study. In all group-1 patients, full set of tendon transfer was done along with radial nerve repair i.e. Pronator Teres (PT) to Extensor Carpi Radialis Brevis (ECRB), Flexor CarpiRadialis (FCR) to Extensor Digitorum Communis (EDC), and Palmaris Longus (PL)-rerouted to Extensor Policis Longus (EPL) via end to side technique while group 2 patients underwent radial nerve repair only either primary or with graft. All surgeries were performed by experienced plastic surgeons. Tendon repair was done with 2/0 non-absorbable suture with multiple weave-through technique. Postoperatively long arm splint was used with the wrist in 20-degree extension and fingers in extension for 4 weeks. Nerve repair was done under microscopic magnification with epineural repair technique using 8/0 proline suture. Post-operative management for all patients included complete immobilization with an above-elbow splint with elbow fixation at 90°, forearm mid-pronated, and wrist at 30° extension. Similarly, thumbs were kept abducted and extended and the finger's MCP joints extended keeping tension off the transferred tendon while simultaneously allowing nerve regeneration.

Post-operative follow-up for record purpose was done at the 6th and12th. Data was collected by the end of the 12th week using a standardized questionnaire.[12] Objective assessment was made by extracting the records of physical examination done by the end of the 12th post-operative week for active range of motion at wrist, fingers, and thumb. These were divided into 4 categories for the ease and simplicity of analysis: Excellent, good, fair and poor (Table:1).[12] Subjective assessment was made on patients opinion regarding their overall satisfaction (yes/no), ability and time to return to their previous jobs (yes/no) and to perform routine activities (yes/no), and whether he/she would be willing to undergo the same operation on the opposite limb provided the same occurred to that (yes/no), from both the groups by a standardized questionnaire.

Analysis

Data were entered and analyzed in the SPSS version 20.0 statistical package. The normality assumption of age was assessed using the Shapiro-Wilk test. Frequency and percentages were calculated for categorical variables. Chi-square was used for categorical variables to assess the relationship with outcome variables. Pie and bar charts are utilized for the graphical display of results (p-value < 0.05).

Results

There were 16 patients operated in group-1 (nerve repair with a tendon transfer) out of which 12 (75%) were males and 4 (25%) females. In group 2 (nerve repair alone), there were 17 patients, out of which 13 (76.5%)

Table 1: *Criteria for Grading Range of Motion of Wrist, Thumb, and Fingers.* [12]

	Excellent	Good	Fair	Poor
Wrist extension	0-80^0	0	45^0 Extension lag	70^0 Extension lag
Fingers extension	0-10^0	0	45^0 Extension lag	90^0 Extension lag
Thumb abduction and extension	80-99^0	60-80^0	30-50	0-29^0
Wrist flexion	Full	0-20^0	0	Dorsi-flexed

were males and 4 (23.5%) females.

Regarding occupation, majority of patients in both groups were manual workers (68.8% in group A and 58.8% in group B). Figure 1 shows the occupation details of patients in both groups. Figure 2 depicts the hand dominance patterns, showing that majority of the patients were right handed (81.2% and 82.4% in group A and Group B respectively).

Mechanism of injury was penetrating trauma in 14 (87.6%), and blunt trauma in 2(12.5%) patients in group A. similarly in group B, mechanism of injury was penetrating trauma in15 (88.2%) and blunt trauma in 2(11.8%) patients (Figure 3). 2 patients in each group has associated fracture of the humerus.

Table 2: *Subjective Assessment of Activities of Daily Living*

		Group-1	Group-2
Personal Care	Dressing	100 %	0.0%
	Tooth Brush	100%	0.0%
	Tap	100%	0.0%
	Cup	100%	0.0%
	Fork/Knife/ Spoon	87%	0.0%
Communication	Books	100%	0.0%
	T.V Remote	100%	0.0%
	Telephone	87%	0.0%
	Writing	75%	0.0%
Mobilization	Door (open/close)	100 %	0.0%
	Handles	100 %	0.0%
	Driving/ Riding bike	87 %	0.0%

Only patients who presented within 1 year of injury were included. In group A, 13 (81.2%) presented within 3 months, 2(12.5%) patients presented between 3-6 months, and 1 (6.2%) patient presented after 6 months of injury. In group 2, 14 (82.4%) presented within 3 months of injury, 2 (11.8%) patients presented between 3-6 months, and 1 (6.1%) patient presented after 6 months of injury.

Table 3: *Subjective Assessment of Improved Quality of Life*

		Group - 1	Group - 2	p-value
Able to return to work	Yes	14 (87.5%)	00 (0.0%)	0.000
	No	02 (12.5%)	17 (100%)	
Would like to opt for the same procedure in the future if needed	Yes	15(93.75%)	04(23.52%)	0.000
	No	01 (6.25%)	13(76.47%)	
Overall satisfied with the procedure	Yes	16 (100%)	02(11.76%)	0.000
	No	00 (0.0%)	15 (88.2%)	
Improved quality of life	Yes	16 (100%)	00 (0.0%)	0.000
	No	00 ((0.0%)	17 (100%)	
Willing to wait till nerve recovery	Yes	01 (6.25%)	02(11.76%)	0.000
	No	15(93.75%)	15 (88.2%)	

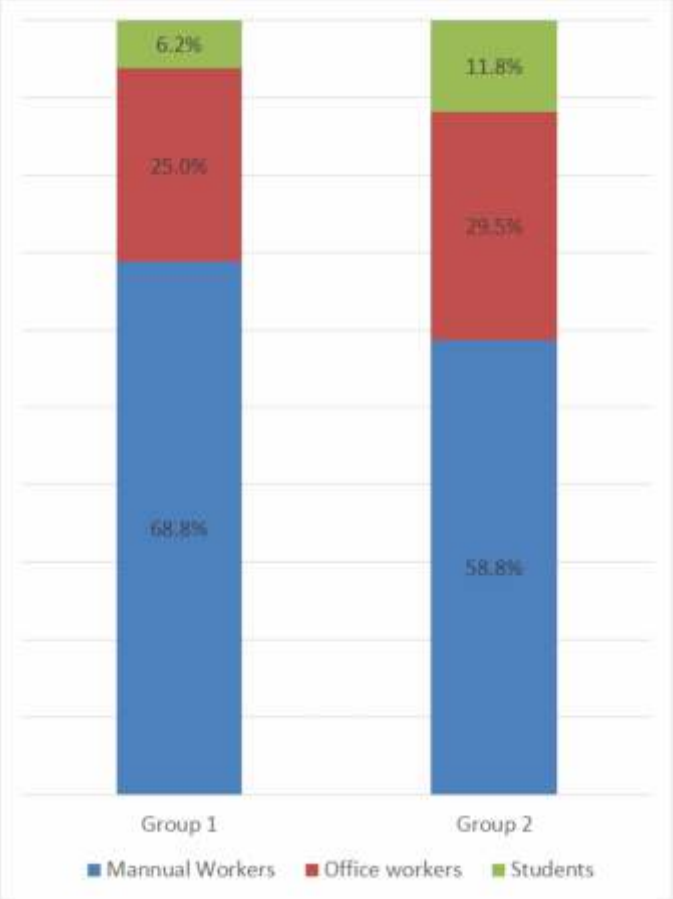

Figure 1- *Occupation of Patients in both Groups*

A Shapiro-Wilk test ($p > 0.05$) showed the age was normally distributed in group 1 patients (p-value - 0.791) with a mean of 30 ± 5.61 years (n=16), while it was not distributed normally in the group – 2 patients (p-

value - 0.034) with a mean of 29.18 ± 8.09 years (n=1).

Patients of Group-1 were satisfied with the procedure at the end of the 12th week and reported an overall enhancement in the quality of life after the procedure. The majority (95.8%) were not willing to wait until nerve recovery and were able to go back to their previous jobs. 15 out of 16 patients said they will opt for early tendon transfer if they fall in similar trauma to the other limb. Subjective assessment was done through a questionnaire. All the patients reported satisfactory improvement in activities of daily life that includes personal care, communication, and mobilization, while no patient from group 2 reported any sort of subjective improvement and were not satisfied with the procedure. The majority (93.7%) of them said they would not opt for the same procedure in future, if need be. None was able to return to their previous job after 3 months of the procedure as there was no improvement in terms of extension of wrist and finger, thumb abduction and extension, and grip strength. Table 2 compares activities of daily living between the 2 groups. Table 3 depicts subjective assessment of improvement in quality of life. All patients of group-1, showed improvement in terms of extension of wrist and fingers, and thumb abduction and extension. Significant improvement in grip strength with ulnar deviation of wrist was also noted while no improvement was noted in any patient of group 2 [Table 4]

Table 4: *Objective Assessment of Range of Motion*

		Group-1	Group - 2	p-value
Wrist Extension	Excellent	12 (75%)	00 (0.0%)	0.000
	Good	04 (25%)	00 (0.0%)	
	Fair	00 (0.0%)	00 (0.0%)	
	Poor	00 (0.0%)	17 (100%)	
Fingers Extension	Excellent	13(81.2%)	00 (0.0%)	0.000
	Good	03(18.8%)	00 (0.0%)	
	Fair	00 (0.0%)	00 (0.0%)	
	Poor	00 (0.0%)	17 (100%)	
Thumb Abduction	Excellent	09(56.3%)	00 (0.0%)	0.000
	Good	04 (25%)	00 (0.0%)	
	Fair	03(18.8%)	00 (0.0%)	
	Poor	00 (0.0%)	17 (100%)	
Thumb Extension	Excellent	14(87.5%)	00	0.000
	Good	02(12.5%)	00	
	Fair	00	00	
	Poor	00	17 (100%)	

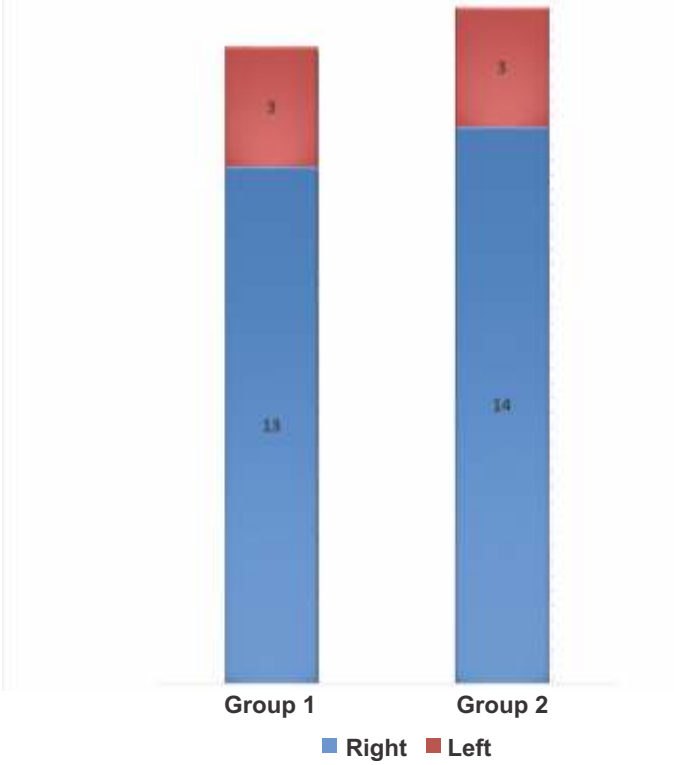

Figure 2 – *Hand Dominance*

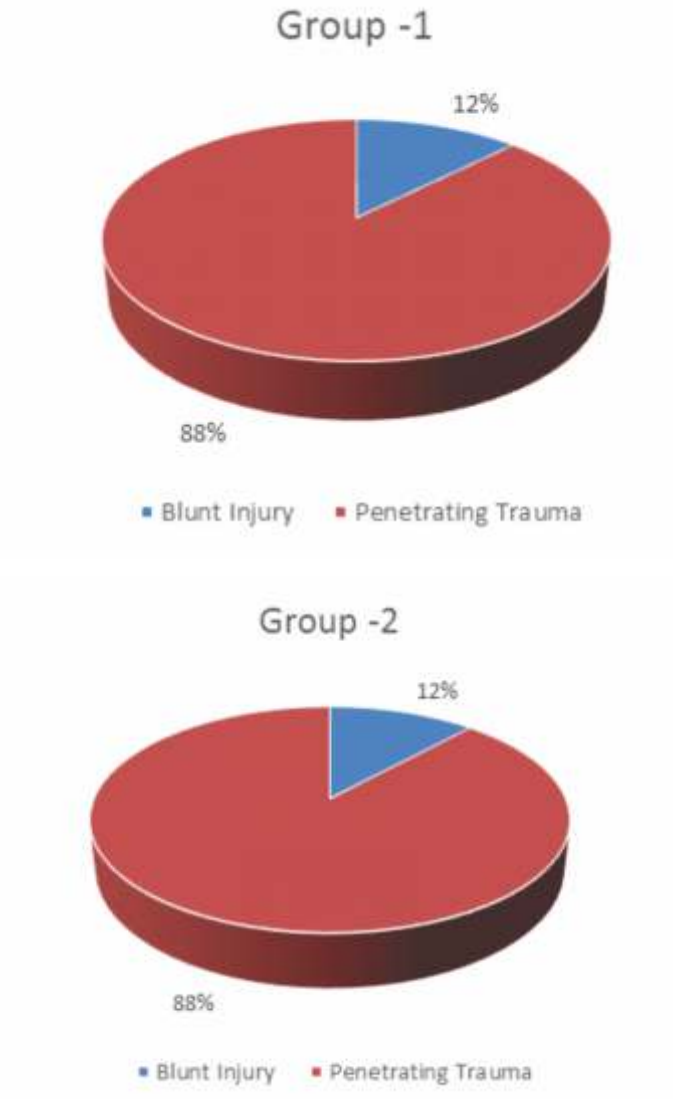

Figure 3 - *Mechanism of Injury*

Discussion

Peripheral nerve palsies depending on their various etiologies are known to have multiple management and treatment options. Classification of radial nerve palsy into primary or secondary nerve damage and according to the site of nerve transection into high and low radial nerve palsy is commonly used to determine surgical management options.[13] One systematic review comparing nerve recovery as per categorization by Shao et al according to management strategies showed 77.2% nerve recovery with expectant management, 68.1% nerve recovery in cases of late surgical intervention; that is 8 weeks post-injury with unsuccessful expectant management, and 89.8% nerve recovery with early surgical intervention (injury duration-within 3 weeks).[14] Surgical exploration and treatment commonly comprise neurolysis, neurorrhaphy, nerve repair by grafting, and/or tendon transfers, out of which tendon transfers are the preferred modality for reliable results.[13]

Tendon transfers have been in practice for many years and are currently indicated in high radial nerve palsy, irreparable nerve damage in high-energy trauma, failure to recover after primary repair or grafting, or in cases of late presentation with no expectation of nerve regeneration.[10] A study comparing tendon transfers versus nerve transfers for restoring wrist extension displayed similar outcomes, achieving a motor score of M3-M4 and degree of wrist extension to about 0°-70°. However, tendon transfer proved to be superior when comparing recovery times between the two aforementioned surgical options.[15] Current principles suggest mobilization of single joints between 4 and 6weeks post-operatively. At 6 weeks post-operatively strengthening exercises are normally initiated and splint is discontinued, and at 12 weeks patients are expected to have a complete restoration of wrist and hand function.[10]

At present, tendon transfers are performed after failed primary nerve repair/graft with a minimum waiting period of 1 year for recovery.[1] For this study, everyone who presented in the clinic with features suggesting a high radial nerve transaction was considered and those who fulfilled the criteria to undergo a successful nerve repair and/or tendon transfer were included. Patients were divided into two groups as described previously. In group 1 primary nerve repair plus a full set of tendon transfer was performed at the same time, thus omitting the standard waiting time for signs of nerve regeneration whereas group 2 underwent nerve repair alone. For radial nerve repairs an end-to-end repair with epineural micro sutures or if the gap between the two ends were ^{3} 3cm, an autologous nerve graft using sural nerve was preferred. Full set of tendon transfer surgery comprised of a transfer of pronator teres (PT) to extensor carpi radialis brevis (ECRB) to restore wrist extension and for thumb extension and abduction a palmaris Longus (PL) rerouted to extensor pollicis longus (EPL). For restoration of MCPJ or finger extension we preferred a Brand's flexor carpi radialis (FCR) to extensor digitorum communis (EDC) transfer as a flexor carpi ulnaris (FCU) transfer is often known to result in radial deviation of the wrist. All transfers were done in an end-to-side fashion except PL to EPL as some radial nerve recovery is still expected. The only drawback of the said transfer is that patients were unable to perform independent finger extension that will be a potential problem for typing and keyboard (piano) operators but was not an issue for manual workers.

All patients were followed up in the clinic at the 6th and 12th week post-operatively. The key step in rehabilitation of tendon transfer procedure is re-education of the muscle-tendon unit and was encouraged in all patients of group 1 starting 4th week post-operatively. Full range of motion was started after 12th week post-operatively.

It was found that by the 12th week, patients in group 1 were full weaned off the splint with complete restoration of wrist, fingers, and thumb extension and with many of them returning to their work with no difficulty and exemplary patient satisfaction. The only drawback reported was the inability to execute fine finger movement by a few patients as per their job demands. In group 2, none of the patients showed any signs of functional return at follow-up assessments. By the 12th week, except a few patients who were not manual workers, the majority showed immense dissatisfaction and wished to be splint-free.

This study affirms tendon transfers at the time of nerve exploration can be beneficial especially for manual workers who prefer avoiding long periods of disability and want to return to their work as soon as possible. Classically, the principle of a successful tendon transfer is based on transferred muscle unit reeducation through proper feedback information in achieving muscle functions that are completely different to their original function. However, performing a tendon transfer earlier has an added benefit as the transferred tendons also serve as a substitute during periods of nerve regeneration thus, providing internal splintage while simultaneously adding the bulk of normal muscle to the re-innervated muscle.[2,16]

Moreover, with mobilization of required joints indicated

as early as 4 weeks post-operatively and proper rehabilitation and reeducation of transferred muscle unit, complications like wrist flexion contractures can be avoided that is otherwise a threat with prolonged wrist bracing.[17]

The only drawback of the procedure of tendon transfer is that independent finger extension would be lost, which is more of a concern for certain professions such as musicians, keyboard operators etc. Another drawback is the additional scar marks on forearm.

Limitations of the study include small sample size and the generalizability of the study, as most of the subjects were manual workers that belong to low socioeconomic status and were the only breadwinners of the family and therefore cannot wait until the nerve recovery period.

Conclusion

Early tendon transfer at the time of nerve exploration and repair, in high radial nerve injury gives admirable results in terms of function and patient satisfaction, especially in manual workers. Patients don't have to wait for nerve recovery time that is psychologically disturbing to them. The author suggests performing tendon transfer in such cases.

Conflict of Interest

None

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