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ORIGINAL ARTICLE

Tendon Transfer Outcome in Radial Nerve Injury: Our Experience

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ABSTRACT

Objective: The objective of the current study was evaluation of outcome of tendon transfers in high radial nerve palsy for restoration of power and function of wrist and hand in Karachi, Pakistan.

Methodology: A descriptive case series with clinical data of 17 patients was analyzed at the Department of Orthopedics Surgery at the Dr. Ruth K.M. Pfau Civil Hospital at Dow University of Health Sciences in Karachi, Pakistan, from January 2018 to December 2021. Patients who were diagnosed with high and low RNP were registered. Those with multiple injuries which might have caused considerable disability (polytrauma patients) or those suffering from brachial plexus lesions were excluded.

Results: Out of seventeen patients, 14 (85%) were male while 03 (15%) were femalewith mean age of 29.5 years. There were 65% right-sided injured patients. Mean of the Disabilities of the Arm, Shoulder and Hand (DASH) scores was 11.44 ± 3.35 with 94.1% patients in minimal disability category whereas 5.88% patients moderately disable.Motor power of wrist and finger extension was significantly improved between the preoperative period and three months post-operatively, between the pre-operative period and six months.

Conclusion: Tendon transfers treating radial nerve palsy have positive functional outcomes in terms of wrist extension, finger extension, and handgrip strength, as well as positive patient satisfaction as measured by Quick DASH ratings. Tendon transfers help restoring nonfunctional dangling wrist and hand into functional powerful wrist and hand.

Keywords: Radial nerve palsy, tendon transfers outcome, DASH scores

INTRODUCTION

The hand is both a grasping and a fine-movement organ. It is beneficial in day-to-day tasks. It can also be used in a variety of industries, from exact delicate work by designers to harsh labor by laborers. Because of its prehensile role, the hand is extremely important[1]. According to Riordan[2], grasp includes three phases: phase one involves opening the hand wide, phase two involves enclosing the object, and phase three involves clutching the object between such fingers and the palm[1].Muscles that are innervated by the radial nerve play a significant part in the initiation phase and phase three of the grip, as well as in the release of gripped objects [1].Peripheral nerve damage is a leading source of disability and morbidity today. Peripheral nerve damage affects 2 to 3% of patients hospitalized ina Level I Trauma Centre[3,4]. Fractures of the humeral shaft account for approximately 3-5% of all the fractures[5]. Radial nerve palsy (RNP) is among the most frequent nerve disorders concomitant with trauma, resulting in 2 to 17% of all the humeral shaft fractures (with a mean of 11%)[6,7]. RNP can be classified as partial or total[8]. In 50–68% of patients, motor function loss occurs[7]. The clinical manifestations of radial nerve injury are typically basic, with patients displaying a lack of wrist, thumb, and metacarpophalangeal (MCP) joint extension. When the radial nerve is injured, the wrist and finger extensors are lost, and the usual grasping and releasing pattern is compromised[1]. Radial nerve injury is characterized asprimary or secondary; the primary nerve palsies befall immediately after the injury, while 10-20% of nerve palsies are secondary, with loss of function occurring because of the conservative treatment or entrapmentof nerve in the fracture holes or broken parts of bone, as well as after surgery[9].

Damage to the trunk of the radial nerve, from its origin point on the posterior cord of the brachial plexus where it divides at the elbow, causes high RNP[10]. Together, motor and sensory impairments characterize RNP [10]. RNP, on the other hand, is frequently linked to a humeral shaft fracture (HSF), either caused by the initial injury (called primary RNP) or radial nerve lesion of iatrogenic nature (secondary RNP). Over 70% of RNP patients will recover on their own, making the choice between observing and surgical explorations (either primary or secondary RNP) difficult. Because most patients will recover on their own, surgical investigation is only recommended for open fractures or if ultrasonography reveals serious nerve injury. Between two weeks and six months, the first symptoms of nerve healing may show. Otherwise, the age of the patient, clinical examination, electroneuromyography, and ultrasound findings are used inthe determination of whether exploration of the nerve should be done or not. If recovery is not possible, an autograft is recommended only in pediatric people who are less than six months old and whose current conditions are adequate. Otherwise, nerve transfers conducted by a skilled team produce satisfying results and can be done up to ten months after an accident. Tendon transfers are indeed the gold standard and arethe only choice after 10 to 12 months. Outcomes are trustworthy as well as timely[10].

Although the results of radial nerve neurorrhaphy are favorable, functional restoration can be achieved with tendon transfers if this is not achievable. There are different types of tendon transfer procedureswith drawbacks and benefits. Merely just a few studies have compared the outcomes of various tendon transplants. Flexor carpi ulnaris (FCU) has double the wrist flexion power of flexor carpi radialis (FCR) with identical excursion, as is generally known. The openness of the MCP joint is found to bemore crucial than that of the strength of the extension for the grab and release function.The treatment plan is determined by the primary cause and severity of the injury. Before surgical exploration, humeral fractures with closed radial nerve damage are studied for three months[1]. The purpose of the intervention is to get the wrist, dexterous fingers, and thumb to extend again. The pronator teres (PT) is well acknowledged as a useful tool for reviving wrist extension. The ideal transfer for finger extension resuscitation is still debatable. A transfer of theflexor carpi radialis (FCR), flexor digitorum superficialis (FDS), or FCU to the extensor digitorum communis can help it recover.FDS or palmaris longus (PL) tendon can be redirected to extensor pollicis longus (EPL) for thumb extension and abduction [11]. Transferring to abductor pollicis longus or tenodesis of the latter can also assure abduction if such revived EPL is not retracted. The various possibilities of transfers have been selected per the classes, but most importantly with the patient and the clear and common objectives in mind; the choice of transfer is made based on the clinical evaluation of the patient (upper or lower radial paralysis, presence of transferable tendons such as PL, wrist mobility), as well as their expectations

and needs (activities that require FCU, the importance of the freedom to move fingers, as well as doing extension or abduction of thumb). Tendon transfers for radial paralysis frequently produce excellent results when the technical rules of execution and postoperative rehabilitation instructions are followed[11]. Therefore, to further explore about results of the tendon transfer procedure, the objective of the current study was the evaluation of the outcome of tendon transfers in high radial nerve palsy for restoration of power and function of the wrist and hand in Karachi, Pakistan.

MATERIAL AND METHOD

The current research was done as a case series of descriptive nature which was being conducted at the Department of Orthopedic Surgery, Dr. Ruth K.M. Pfau Civil Hospital, Dow University of Health Sciences in Karachi, Pakistan. The duration of the study was from January 2018 to December 2021. The number of patients enrolled in this research was 17 based on the inclusion criteria.

Patients who were diagnosed with high and low RNP were registered. Those with multiple injuries which might have caused considerable disability (polytrauma patients) or those suffering from brachial plexus lesions were excluded.

For power grip testing, we employed a hand dynamometer, and for muscle power testing, we used the grading system of the Modified Medical Research Council (MRC). To improvise wrist extension, all patients had to transfer of PT tendon to the tendon of extensor carpi radialis brevis (ECRB), and to improve thumb extension, the PL tendon was transferred to the tendon of EPL. Disabilities of the Arm, Shoulder and Hand (DASH) score was used to assess the function of the whole upper limb which is a score based on answers to 30 questions. It is scored in two sections, with symptom/disability section with 30 elements with scores from 1 (no difficulty) to 5 (extreme difficulty) and there is a high performance music/sports/work section too which is optional to fill with 4 elements scoring from 1 to 5. The total responses number is divided by completed responses number which is subtracted by one. Then the calculated value is multiplied by 25 and DASH disability score is attained according to which an interpretation is being made. Low scores showed that the activity was not challenging, whereas high scores suggested that the damaged hand could not be used. The instrument employed a 5-point scale to allow patients to choose a number that corresponded to their level of severity/function. The values that were assigned for the responses completed were added, yielding a score in between 0 to 20 (minimal disability) which was assigned as the lowest, and a score between 81 to 100 (crippled and patient bed bound, unable to use the injured hand) which was assigned as the highest score. Other values were 21 to 40 as moderately disable, 41 to 60 as severely disable, and 61 to 80 as crippled.

Figure 1: One of the patients showing wrist drop on presentation

Frequencies and percentages are used to define categorical variables and baseline demographic information. The symmetrical distribution of continuous variables is represented by means and standard deviations (SD), while the skewed distribution of the same variable is represented by median and inter-quartile range (IQR). Examination of data was done with the SPSS version 19 program, in which non-parametric tests were performed. Presentation of one of the patients on presentation, during the procedure and at final follow-up can be seen in figures 1-3.

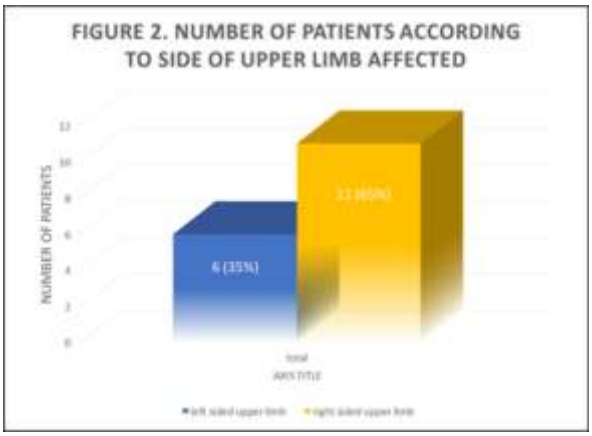
Figure 2: Perioperative images of one of the patients showing (A), Pronator Teres, Flexor carpi radialis, and Palmaris longus; (B), EDC and Extensor carpi radialis; (C), Extensor palmaris longus; (D), presentation after tendon transfer.

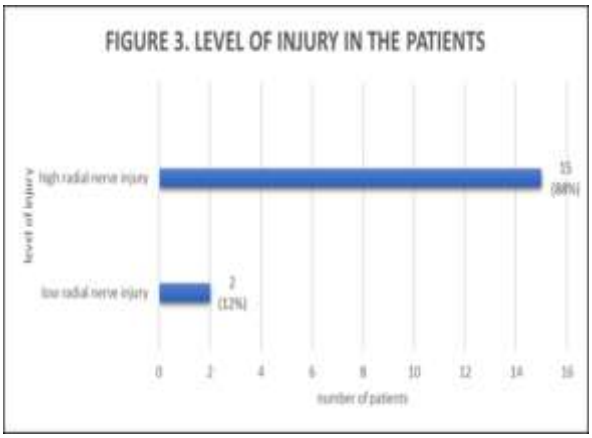
Figure 3: A patient showing all movements of the wrists on final follow-up

RESULT

Radial nerve injury was found in all 17 individuals who suffered upper extremity fractures and were on an average of 29.5 years old. They were between the ages of 18 and 48 years. There were 14 male patients (85%) and 3 female patients (15%) among the seventeen patients as displayed in figure 1.

11 of the 17 patients (65%) had a right-sided upper limb injury, while 6 (35%) had a left-sided injury. The graphical representation can be seen in figure 2. Out of seventeen patients, 15 (88%) had high radial nerve injury while 02 (12%) had low radial nerve injury as seen in figure 3. Grip strength, extension power of fingers and wrist, and DASH scores were used as outcome measures. Between the preoperative period and three months postoperatively, and between the preoperative period and six months, there was a significant improvement in wrist and finger extension motor power. DASH Scores along with interpretation is being elaborated in Table 1 where the mean of the scores was 11.44 ± 3.35. The highest DASH score obtained was 22.6 while 8.3 was the lowest. We understood after the interpretation of the DASH scores that 16 (94.1%) patients were in minimal disability category whereas 1 (5.88%) patient was moderately disable.





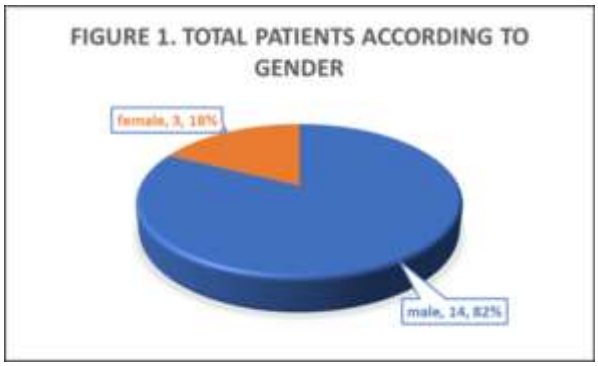


Table 1: Patients' DASH Scores outline

No	Name	gender	age	Side	Score	Interpratetion	Date
1	W.A	M	18	R	11.2	Minimal Disabilty	Feb 2018
2	W.K	M	22	L	8.3	Minimal Disabilty	April 2018
3	M.A	M	30	R	10.2	Minimal Disabilty	June 2018
4	A.M	M	20	R	11.8	Minimal Disabilty	Sep 2018
5	T.K	M	26	L	9	Minimal Disabilty	Jan 2019
6	A.B	F	19	L	10	Minimal Disabilty	Jan2019
7	M.R	M	32	R	14.4	Minimal Disabilty	May 2019
8	G.H	M	33	R	9.1	Minimal Disabilty	Aug 2019
9	H.N	M	36	L	9.6	Minimal Disabilty	Nov 2019
10	Z.I	M	26	R	10.6	Minimal Disabilty	Jan 2020
11	I.A	M	29	R	11.3	Minimal Disabilty	Oct 2020
12	S.H	F	21	R	14.6	Minimal Disabilty	Feb 2021
13	F.A	M	33	L	9.6	Minimal Disabilty	Mar 2021
14	S.K	M	38	R	22.6	Moderate Disabilty	Mar 2021
15	Z.N	F	48	R	9.8	Minimal Disabilty	May2021
16	H.R	M	44	R	10.4	Minimal Disabilty	June
17	S.A	M	27	L	12	Minimal Disabilty	Sep 2021

DISCUSSION

The current study evaluated the outcomes achieved through tendon transfer in high RNP to restore function and power of the wrist and hand. The DASH scores indicated that patients were in minimal disability zone. We noticed that there was an improvement in motor power of wrist and finger extension between three and six months postoperatively. Thereof, the results convey that through the tendon transfers in the radial nerve injury patients do get helped.

Multiple studies support the narrative that was being explored in the present study. For instance, in a study of 25 treated patients with split FCU for RNP, 68% had good to outstanding results, while 32% had fair results. Although wrist extension was reduced in individuals with significant RNP, most patients were able to regain independent hand use[12]. There were 13 people with high RNP who were studied in a level-II prospective, a comparative investigation[13]. PL, PT, ECRB, and FCR to extensor digiti communis were the tendons employed. From damage to treatment, it took somewhere between 1.5 and 9 months. Excellent to good outcomes were achieved[13]. Furthermore, there was a retrospective evaluation of 58 individuals with irreversible RNP who were treated by Brands transfer for15 years. The average postoperative follow-up was 10 years (ranging from 2 to 15 years). The Bincaz score revealed that six patients had outstanding outcomes, 49 patients had good results, and three patients experienced bad results. Those three patients exhibited wrist radial deviation, thumb abduction deficiency, and wrist flexion restriction.

After eight weeks, 55 patients (94.82%) became ready to commence their regular jobs[14].In another study done in Malaysia where for wrist and thumb extension, PT was rerouted to ECRB, while PL was redirected to EPL[15]. However, they used a variety of approaches to re-establish finger extension. The surgeries were carried out by two skilled hand surgeons, the first of whom used FCU and the second used FCR. Wrist and finger extension, as well as hand grasp, improved significantly. According to the authors, these results could be attributed to a comprehensive program of rehabilitation and effective intra-operative overtightening of the transplanted tendon near the damaged extensor tendon. Muscle-tendon component's reeducation is a key aspect of tendon transfer therapy. According to the authors of the study, patients should be encouraged to do wrist extension, forearm pronation, and wrist extension all at the same time[15]. Another study done in 2018 showed 69 patients with a follow-up period of 20 months ranging from 8 to 36 months. All the tendon transfers were seen to be in the good or excellent category in the majority of the cases. Though transferred tendon had less power but a significant improvement in function was displayed in all patients. Nevertheless, mild bowstringing of PL and radial deviation were noted[16]. A 2020 research study had 20 patients with radial and posterior interosseous nerve (PIN) palsy. Division of patients was into three groups and according to an objective evaluation; the FCR group with six patients (66.6%) who were excellent, two patients (22.2%) were good, and one (11.1%) was fair. FCU group included three patients (50%) who were excellent, two patients (33.3%) were good, and one (16.7%) was fair. The FDS group had three patients (60%) who were excellent, one patient (20%) was good, and one (20%) was fair[17]. After six months of nerve healing, two cases of drop hand were treated with jones and modified jones tendon transfer. The patient's tendon transfers were successful, and the outcome was positive. The wrist, finger, and thumb can all be extended by both patients[18].

We found a significant improvement in patients which was pretty much evident from the DASH Scores. A study done in Indonesia found results consistent to ours where they noticed 10 patients (90.9%) out of 11 who were in minimal disability range with 1 (9.1%) in moderately disable after tendon transfer[19]. There was a striking similarity between the mentioned study with ours as we also had 16 out of 17 patients minimally disable after surgery (94.1% vs 90.9%) and 1 patient moderately disable (5.88% vs 9.1%).Another study done in 2021 found improvised DASH scores after surgery (p value: 0.005) comparing nerve transfer with tendon transfer[20]. Altintas et al, got a mean DASH score of 16 with surgery success rate of 89%[21]. A 2017 study found a low 3.45 mean score of DASH scale which further supported this surgical intervention[22]. There were few studies that gave opposing DASH score results with mean DASH scores of 30, 38, and 35 which counts in moderate disability[23].

However, studies gave contrasting results for tendon transfer too. One of which revealed 14 patients with the radial nerve lesions treated with the nerve transfer and tendon transfer[24].The study inspected progress in recovery and found better results in nerve transfer than in tendon transfer[21].Limitations in wrist flexion were observed there in the tendon transfer group in 9 out of 13 patients, including persistent radial deviation in five individuals. While all patients after nerve transfer could extend their fingers with the wrist neutral or extended, only 50% of patients throughout the tendon transfer group required wrist flexion to do so. Extension at the first carpometacarpal joint was recovered after nerve transfer in 11 of the 14 patients, but only in four of the 13 patients after tendon transfer. The thumb metacarpophalangeal extension in both groups showed a 30° lag, which was indicative of a retarded EPL recovery[24].

This study had certain drawbacks. This was a single-center study which might not have given an overall idea about a large population. Assessments conducted over a longer period, maybe more than a year, could yield even better results. Large sample size and a longer period of follow-up should have been documented, as well as the time it took to return to work and the time it took to recover from medical leave. For a more objective improvement, clinical range of motion should be measured before and after surgery through goniometry. Before surgery, as well as one or two years afterward, an examination should be conducted.

CONCLUSION

Tendon transfers for radial nerve palsies produce good functional outcomes in wrist extension, finger extension, and handgrip power, as well as good patient satisfaction as measured by Quick DASH ratings. Tendon transfers assist in transforming a drooping wrist and hand into a functional, efficient wrist and hand.

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