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Outcome of tendon transfer for radial nerve palsy in Misrata

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Abstract

Background: Radial nerve palsy can result in significant functional limitations, including wrist and finger drop, impairing daily activities and work capacity. Tendon transfer is a well-established surgical approach to restore motor function in patients with irreversible radial nerve injury.
Objective: To evaluate the short-term functional outcomes of tendon transfers in patients with high radial nerve palsy in northwest Libya using a comprehensive assessment protocol.
Methods: A prospective study was conducted between 2021 and 2024 including 20 patients (17 high, 3 low radial nerve palsy) with chronic radial nerve injuries. Tendon transfers performed included pronator teres to extensor carpi radialis brevis (wrist extension), palmaris longus to extensor pollicis longus (thumb extension/abduction), and flexor carpi radialis to extensor digitorum communis (finger extension). Postoperative rehabilitation included splinting and physiotherapy. Outcomes were evaluated using the modified DASH score and Bincaz scoring system.
Results: The mean age was 36 years (range 16–56). Postoperative DASH scores improved significantly (mean pre-op 48 → mean post-op 18 at 10 weeks). According to Bincaz scoring, 3 patients achieved excellent outcomes, 15 good, and 2 poor. Complications were minimal and included radial deviation of the wrist (n=2), restricted wrist flexion (n=2), and thumb abduction deficiency (n=2). Overall, 95% of patients returned to their normal daily activities within 8 weeks.
Conclusion: Tendon transfers for radial nerve palsy provide reliable restoration of wrist, finger, and thumb function, with high patient satisfaction and early return to daily activities. This surgical approach effectively transforms a drooping hand into a functional and efficient unit.

I) INTRODUCTION:

Radial nerve palsies represent a complex clinical condition that can lead to significant functional limitations and disability for affected patients [1]. The radial nerve plays a crucial role in the extension of the elbow, wrist and fingers, and is responsible for most of the strength and coordination required for a proper movement of the upper limbs [2].

The incidence of radial nerve palsy can vary depending on the etiology, with traumatic, compressive or idiopathic causes that can impair nerve function [3]. Patients with this condition often have

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	Excellent	Good	Fair	Poor
Wrist extension	0-80°	0	45° extension lag	70° extension lag
Fingers' extension	0-10°	0	45° extension lag	90° extension lag
Thumb abduction and extension	80- 99°	60-80°	30-59°	0-29°
Wrist flexion	Full	0-20°	0	Dorsiflexed

Thumb movements were measured in line of traction of the transferred tendon

difficulty performing essential daily actions, such as grasping and lifting objects, significantly limiting their quality of life and ability to perform work activities [4]. The management of radial nerve palsy has been the subject of ongoing research and development in hand and orthopaedics and Plastic surgery [5]. Among the various treatment options available, tendon transfers have proven to be an effective surgical strategy for restoring motor function in patients with radial nerve damage. Tendon transfer is a surgical procedure in which the tendon of a functioning muscle is moved from its original position to reattach it to a new position in order to restore impaired motor function

The main goal of tendon transfers in radial nerve palsies is to restore the ability to extend the elbow, wrist and fingers, allowing patients to perform essential daily activities and thus improving their quality of life. Some schemes have been developed for evaluating the results of tendon transfers in radial nerve palsy, the most logical and commonly used being the evaluation schemes that assess the range of active joint movements. The primary aim of our study is to present a new evaluation protocol, an original scheme for tendon transfer outcomes based on functional movements of the wrist and finger joints that includes all variables to be evaluated in the patients' outcome, considering objective and subjective parameters; with a unique, complete, reproducible and reliable scheme that minimizes the examiner's subjective error in the evaluation of all clinical cases.

The objective of this study was to evaluate the short-term outcome of tendon transfers in high radial nerve palsy in restoration of wrist in some north west Libyan cities.

II) Materials and Methods

A Prospective study conducted at a tertiary care center between 2021 and 2024 included 20 patients with radial nerve palsy. Of these, 17 patients had high radial nerve palsy, and 3 had low radial nerve palsy.

These patients had normal hand function prior to injury with supple hand/wrist joints, stable skeleton, good skin cover with no contracture at the time of ten don's transfer. Patients with absent Palmaris longus (PL) tendon or associated injuries of the median or ulnar nerves were excluded from the study. Three tendons were used to restore lost extension of wrist, fingers and thumb.The pronator teres (PT) was transferred to extensor carpi radialis brevis (ECRB) for wrist extension, PL to extensor pollicis longus (EPL) to restore thumb extension and some abduction and FCR to extensor digitorum communis (EDC) to restore fingers extension. After surgery patients were followed up every month during the first 3 months and then every 3 months for the next 6 months. Postoperatively functional results were assessed by modified dash score and Bincaz scoring system (Table 2).

According to this scoring system, results are judged to be excellent with a score above,or equal to,8points,good with a score of 6 or 7points, Fair with 4 or 5 points and poor with 3 or less points.5 Patients were asked about their return to normal activities of daily living/work. Mean post-operative follow-up was 10 (range 2e15) years. We evaluated these patients by Bincaz score (active range of movements at the wrist/metacarpo-phalangeal joints and radial/ palmar abduction of thumb at the CMC joint) by goniometer at minimumof8weeksfollow-up.Radial extension of the thumbwas measured in the plane of the palm, as the angle between the line along radial border of the first metacarpal with the IP joint in extension. The palmar abduction was measured in the plane

perpendicular to the flat palm, as the angle between the dorsal subcutaneous border of the proximal phalanx of the thumb and the palmar border of the index ray.

The inclusion criteria were patients with wrist and finger drop secondary to either high radial nerve injury with or without involvement of the posterior cord of the brachial plexus and those treated non-surgically for at least six months post-injury. Exclusion criteria were total brachial plexus injury (traumatic or congenital) affecting the flexor and pronator components (donor tendons) of the forearm and any musculoskeletal disorders affecting donor tendons such as cerebral palsy

*Quick*DASH-9

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer *every question*, based on your condition in the last week, by circling the appropriate number. If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* of which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

Rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	0	1	2	3	4
2. Do heavy household chores (e.g., wash walls, floors).	0	1	2	3	4
3. Carry a shopping bag or briefcase.	0	1	2	3	4
4. Wash your back.	0	1	2	3	4
5. Use a knife to cut food.	0	1	2	3	4
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	0	1	2	3	4

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	0	1	2	3	4

	NOT AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	0	1	2	3	

	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	0	1	2	3	4

A *Quick*DASH-9 score may not be calculated if there is greater than 1 missing item.

***Quick*DASH-9 SCORE = [(sum) x 1.1] x 5/2, a missing response is added as the average of the remaining.**

inclusion criteria	Exclusion criteria
patients with wrist and finger drop secondary to either high radial nerve injury or low radial palsy	total brachial plexus injury (traumatic or congenital)
Age between 16 – 56	Less than 16 yrs
Chronic Old injury (more than 6 months)	New trauma radial palsy

III) Surgical technique

Procedure The patient is positioned supine on a regular operating table with the operative extremity placed on a hand table. A non-sterile, well-padded brachial tourniquet is placed and set to 250mmHg. The operative extremity is prepped and draped in the usual sterile fashion. The limb is then exsanguinated with a sterile esmarch and tourniquet inflated to 250mmHg. The first incision is made

volarly over the FCR tendon. The tendon is identified and the subsheath is released the length of the tendon to accommodate further excursion and allow a more direct line of pull. Without this release, the tendon often makes more of a right angle turn to be transferred dorsally. The wrist is then flexed and the FCR tendon is cut at the level of the trapezium. Attention is then turned to dissection of the palmaris longus tendon, which will be found just ulnar to the FCR tendon. One must be vigilant preoperatively to make sure the patient has a palmaris longus tendon, as there have been cases where the median nerve was mistakenly harvested. We typically mark the exact location of the tendon at the wrist crease in the preoperative holding area with the patient actively flexing the PL. Once the PL has been identified, the median nerve is then visualized and protected. The palmaris longus is freed from its surrounding sheath using tenotomy scissors and cut at its insertion into the palmar fascia. Typically, there is abundant length of tendon for this transfer and dissection into the palmar fascia is not necessary. Dorsally, an incision is made just ulnar to Lister's tubercle to expose the recipient tendons. Dissection is taken down to the level of the fascia with subsequent release of the extensor retinaculum. The EPL tendon is transposed from its sheath and cut proximally at its musculotendinous junction. Next, the EDC tendons are identified just ulnar to the EPL tendon in the 4th extensor compartment. The extensor retinaculum is released as there is no risk of bowstringing after tendon transfer given the volar pull of the FCR. Prior to cutting the tendons, the wrist is placed in neutral and all f ingers are placed in full extension to set the tension of the 2nd-5th extensor tendons. In cases where there is not an EDC to the small finger, one can elect to use the extensor digiti minimi (EDM). Once the tension is set, all four slips are sutured together with 3-0 Ticron suture. The tendons are then cut just proximal to the suture. After the donor and recipient tendons are exposed, a plane is developed to pass the tendons superficial to the radial artery and deep to the superficial branch of the radial nerve, making sure the tendon transfer does not compress the nerve.

FCR to EDC (Finger Extension) The FCR tendon is passed from the volar wound to the dorsal wound. At this point, the wrist is placed in neutral, and all digits are extended by placing towels beneath them and having an assistant ensure that they remain extended. Once positioned, the tendon transfer is initiated. Using a sharp Pulvertaft weaver, the FCR is passed through each of the four EDC tendons. After the first pass, one must check to make sure tension is adequate. If satisfied, 2 more passes through the tendon are performed and sutured into place with 3-0 Ticron (Figure 1). PL to EPL (Thumb Extension) The EPL is then passed from the dorsal wound to the volar wound. Again, the thumb is positioned in full extension with the wrist in neutral. A pulvertaft weave between EPL and PL is performed with tension checked after the first pass. Two additional passes are performed, and the ends of each tendon are split and sutured so that they are flush on the sides of the other tendon. (Figure 2). At this point, tension is checked by testing the tenodesis. The wrist is flexed and extended to ensure adequate excursion and full extension of the thumb and digits. If the transfer appears loose, it is better to revise now than a later date. Once this is satisfied, the tourniquet is released and hemostasis achieved.

Postoperatively, the transfers were protected with a thermoplastic splint fabricated preoperatively. Re-education of muscle-tendon unit was an important part of the rehabilitation following the tendon transfers. Patients were motivated to perform combined motions for wrist extension, pronation of forearm and simultaneous wrist extension. All patients underwent standard physiotherapy care and rehabilitation regime by one dedicated physiotherapist and one occupational therapist until six months postoperatively. An integrated team approach between the surgeon and hand therapist was conducted

Figure 1 tendon transfer first step

Figure 2 tendon transfer second step

figure 3 tendon transfer third step

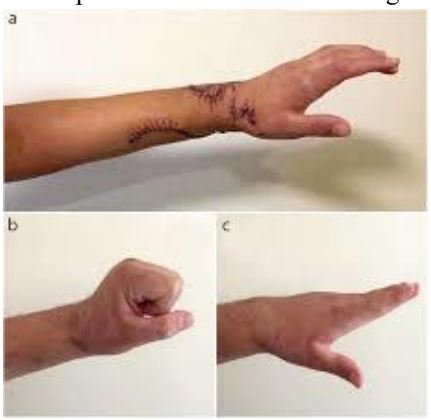


Figure 4 post operative radial palsy tendon transfer

in this study. All patients were protected by an above-elbow volar thermoplastic splint for six weeks in MCPJ, PIPJ and DIPJ full extension and wrist in 30° to 40° extension. Exercises were tailored between intermittent active flexion and passive extension according to the regime as shown in Table I. The splints were discontinued at six weeks.

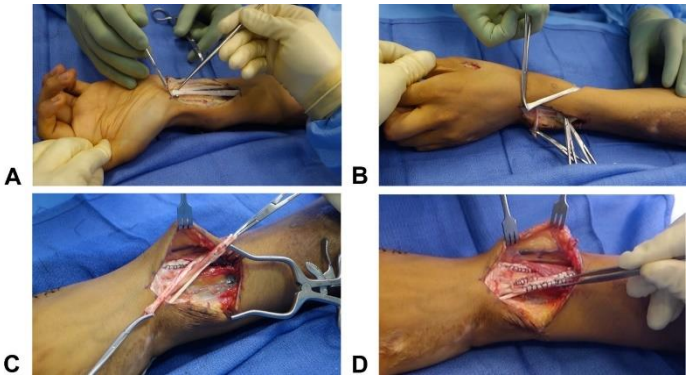


Figure 5 tendon transfer steps for radial nerve palsy

IV) Results

20 patients with irreversible radial nerve paralysis were included in the study, 13 were male and 7 female patients. Mean age was 36 years (range 16 and 56 years). 14 patients had radial nerve palsy on right side while 6 patients had on left side. 12 Patients had comminuted open humeral fracture, 4 patients had penetrating injuries with irreparable damage to radial nerve while 4 gun shoot damage . Mean duration of palsy was 8 months (range from 6 to 10 months). 15 patients underwent radial nerve exploration and repair but did not recover.

PATIENT NUMBER	SEX	AGE	PRE OPERATIVE SCORE	POST OPERATIVE SCORE AFTER 10 WKS
1	M	16	47	13
2	F	22	48	11
3	M	22	50	9
4	M	34	46	11
5	M	54	45	7
6	F	24	47	15
7	F	29	51	17
8	M	36	44	17
9	M	56	47	22
10	M	39	46	19
11	M	18	45	21
12	M	22	49	24
13	M	32	50	35
14	F	38	50	36
15	M	44	52	36
16	F	29	51	11
17	F	19	48	19
18	M	23	48	14
19	M	18	46	17
20	F	25	50	10

On evaluation with the Bincaz score, 3/20 patients had an excellent result, 15/20 patients had good results, (Fig. 5-8) and 2/20 patients had poor results (Table 1).

Bincaz score

excellent result	good results	poor results
3	15	2

There were 3 complications in 5 patients, radial deviation of wrist (n ¼ 1), inadequate abduction of thumb (n ¼2)and restricted wrist flexion (n ¼2).There were no adhesion, stiffness, lack of dexterity, and decreased muscle power. There was marginal necrosis of skin flap in two patients which go with conservative treatment. 2 patients with restricted wrist flexion became better with physiotherapy in 6 weeks time. 55/58 patients (94.82%) were able to return to their normal daily work after ~8 weeks. 3/58 patients with poor results had difficulty in their routine work.

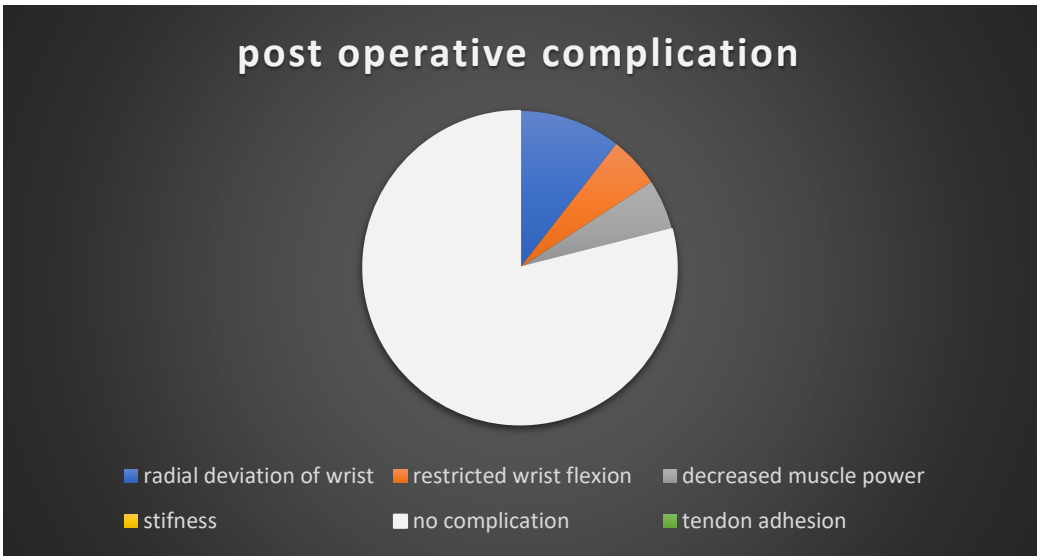
Complication pos operative tendon transfer of radial palsy

radial deviation of wrist	2
restricted wrist flexion	1
stiffness	0
decreased muscle power	1
Tendon adhesion	0

Discussion

It is well known by surgeons that tendon transfer is of critical importance in the restoration of lack of hand function and decreased limb performance [10, 18]. This is because once a nerve repair application has failed, bet ter results can be obtained via tendon transfer in pa tients with radial nerve palsy. In particular, if there is a low level of improvement in radial nerve injuries within a one-year period, tendon transfer should be recom mended for the treatment of such injuries [14, 19, 20]. Although many surgeons prefer different tendon transfer approaches to obtain the best treatment outcomes, in cluding restoration of the thumb, finger extension, and wrist extension, there are points of disagreement on the best tendon transfer approach in patients with radial nerve palsy [21, 22]. In this paper, the results were evalu ated for tendon transfer applied to many patients with drop-hand syndrome, and promising outcomes were obtained.

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 use12. There were 13 people with high RNP who were studied in a level-II prospective, a comparative investigation13. 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 achieved13. 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.

Comparison with Other Techniques and Clinical Implications The results of the Jones tendon transfer technique in this study demonstrate that it is an effective method for restoring wrist, finger, and thumb function in patients with radial nerve palsy. One of the key advantages of the Jones technique is the use of functional tendons that are already present in the forearm, reducing the need for complex muscle harvest or long incisions. Additionally, the ability to transfer the pronator teres for wrist extension and the flexor carpi radialis for finger extension allows for the restoration of both power grip and dexterity, which are crucial for activities of daily living. However, there are some limitations to the Jones tendon transfer technique. In some cases, the use of flexor carpi ulnaris (FCU) as a donor for finger extension can lead to a loss of wrist stability, resulting in radial deviation during wrist extension. This is particularly problematic in patients who require strong power grips or engage in manual labour. The loss of ulnar deviation during power grasp can also affect the patient's ability to perform certain tasks, such as opening jars or holding large objects. To mitigate these issues, it is important to carefully select the donor tendons based on the patient's occupation and functional needs. This finding is consistent with Thompson et al. (2017), who observed that high radial nerve palsy patients tended to recover better in terms of grip strength after tendon transfer compared to those with low radial nerve palsy. Sundaram et al. (2020) also noted that tendon transfer procedures provided better strength restoration in patients with high radial nerve palsy, possibly due to the preservation of some intrinsic muscle function that compensates for the loss of wrist extension. On the contrary, Kumar et al. (2018) found that patients with low radial nerve palsy had slower recovery of grip strength, possibly due to the more severe damage to nerve function at lower levels. This disparity may be attributed to the varying degree of nerve involvement and the extent of compensation available for tendon transfer in different types of radial nerve palsy.

Cunningham et al. (2016), who also found that patients with high radial nerve palsy exhibited better functional outcomes post-surgery. In their study, patients who underwent tendon transfer for high radial nerve palsy had improved scores on disability assessments, reflecting better hand function. However, Jain et al. (2019) reported that the Quick DASH score improvements in their study were less pronounced for low radial nerve palsy, which corroborates findings of lower Quick DASH scores in the low radial nerve palsy group.

In a study by Yavari et al. [30], a single tendon transfer from the flexor carpi ulnaris to the common extensor digitorum and extensor pollicis longus was per formed on 30 subjects. Ternary tendon transfer from the pronator teres to the extensor carpi radialis brevis, from the flexor carpi ulnaris to the common extensor digi torum and from the palmaris longus to the extensor pol licis longus was applied to another 17 patients. There was no significant difference between the results of sin gle tendon and ternary tendon transfer surgery after 1 month of postoperative splinting and physiotherapy. In the current study, ternary tendon transfer was used ra ther than single tendon transfer, so there was no com parison.

V) Conclusions:

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 and Bincaz score. Tendon transfers assist in transforming a drooping wrist and hand into a functional, efficient wrist and hand.

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