



## RESULT OF STANDARD TENDON TRANSFER FOR IRREPAIRABLE RADIAL NERVE INJURY

SA Jalil

### ABSTRACT:

**Objectives:** The purpose of this study was to evaluate the results of tendon transfers in patients with irreparable radial nerve palsy.

**Place and Duration of Study:** Abbasi Shaheed Hospital from 2006 to 2007 Calendar Year  
**Study Design:** Retrospective case series

**Patients and Methods:** The study included 15 patients (4 females, 11 males; mean age 28.60 years; range 15 to 55 years) who underwent tendon transfers for radial nerve palsy. Three patients had low and 12 patients had high-level radial nerve palsy. The average followup time was 14.66 months (range 6 months to 28 months).

**Results:** According to the Chuiard criteria, the results were excellent in two patients (13.33%), good in eight patients (56%), and fair in five patients (33.33%). Two patients (13.33%) had radial deviation deformity and two patients (13.33%) had extension wrist contracture.

**Conclusion:** Treatment of irreparable radial nerve palsy with tendon transfers yields successful results. Radial deviation deformity occurs in patients receiving FCU transfer for finger extension.

**Keywords:** Radial nerve injury, Tendon transfer

### INTRODUCTION:

Radial nerve palsy results in a lack of extrinsic extensors of the wrist, fingers and thumb. The degree of dysfunction depends on the level of trauma to the radial nerve. If the wrist is not stable there is a loss of prehensile grip. Patients have great difficulty picking up large or heavy objects<sup>1</sup>.

Operative attempts for the restoration of wrist extension in radial nerve palsy dates

back to over 100 years. Scuderi<sup>2</sup>, Raskin<sup>3</sup> had performed tendon transfers for radial nerve palsy.

In Robert Jones<sup>4</sup> established a milestone in the method of treatment of radial nerve palsy. He transplanted the pronator teres (PT) into the extensor carpi radialis longus (ECRL), the flexor carpi radialis (FCR) into the extensor pollicis longus (EPL) and the extensor indicis proprius (EIP), and the

**Correspondence:** Syed Amir Jalil Associate Professor Dept Of Orthopaedic Surgery, Karachi Medical & Dental College, & Abbasi Shaheed Hospital. Cell #: +92300-2173560, EMAIL: [dramirjalil@yahoo.com](mailto:dramirjalil@yahoo.com)



flexor carpi ulnaris (FCU) into the extensor tendons of the third, fourth, and fifth fingers. He made further modifications in 1921<sup>5</sup>. Zachary<sup>6</sup>, in 1946, reported that the FCR should be preserved for wrist control. Many modifications of tendon transfers for radial nerve palsy are available.

Three major groups of transfers are popular: the superficialis transfer described by Boyes<sup>7,8</sup>, the FCR transfer advocated by Brand<sup>9,10,11</sup> and the FCU transfer (standard)<sup>12,13</sup>. The most widely accepted combination for irreparable radial nerve injury is standard transfer: the PT to the extensor carpi radialis brevis (ECRB), FCU to the extensor digitorum communis (EDC), and the Palmaris longus (PL) to the rerouted EPL<sup>3</sup>.

The purpose of this study is to evaluate the result of standard tendon transfer in irreparable radial nerve injury.

#### MATERIALS AND METHODS:

This is a retrospective and prospective study, conducted in the Department of Orthopaedic Surgery Abbasi Shaheed Hospital Karachi. Fifteen patients of isolated irreparable radial nerve injury were treated by transferring the standard tendon transfer: FCU to EDC, the PT to the ECRB (in high radial nerve injury) and PL to the rerouted EPL.

The arm was immobilized in plaster cast for 4 weeks. The elbow flexed to 90 degrees, forearm pronated maximally, and the wrist extended from 30 - 45 degree. The MP joints of the fingers were extended to neutral. The thumb was immobilized with the IP and MP joints are extended

completely, and the thumb is abducted and extended at the carpometacarpal joint. Only the IP joints of the fingers remain free. The splint was removed at 10 - 14 days, to examine the wound and remove stitches and a long arm cast was applied in the same position as noted above. The cast is removed at 4 weeks postoperatively, and removable short arm splint to hold the wrist, fingers and thumb in extension are made, which the patient wear for an additional 2 weeks, removing them only for exercise.

A planned exercise program started at 4 weeks, to achieve the optimal results from this procedure.

#### RESULTS:

A total of 15 patients were studied. Out of which 11(73%) were male and 4(27%) were female and the mean age was  $28.60 \pm 11.29$  years. The mean age for females was  $28.25 \pm 8.65$  years, and the mean age for males was  $28.72 \pm 12.49$  years. There is no significant mean age difference between sexes and the age range was between 15 55years. As shown in Table I.

The mean follow up time was 14.66 months, range from 6 to 28 months.

Most of patients involved their dominant hand. Right hand was principally involved in 80%(12) of cases and the left hand which was not dominant hand in any case were involved in 20%(3) of cases.

Twelve (80%) patients had high radial nerve palsy. The remaining three (20%) spare the wrist, they had low radial nerve palsy.

The mechanism of injury is shown in Table-II



Our result is based on the assessment described by the Robert G.Chuinard and their colleagues, as shown in Table-III.

By examination, 2 patients obtained an excellent result, 8 patients obtained good and 5 patients have fair result. All patients improved.

**Table I: Age and Sex Distribution:**

SEX	AGE (years)	
	MEAN ± S.D	AGE RANGE
FEMALE (n=4)	28.25 ± 8.65	20 – 38 years
MALE (n=11)	28.72 ± 12.49	15 – 55 years
TOTAL (n=15)	28.60 ± 11.29	Female : Male Ratio 1 : 2.75

Mean age difference among sex: P>0.94 (non- significant) t0.07.

**Table II: Mode of injury**

CAUSES	NO. OF CASES	PERCENTAGE
Road traffic accident	7	46.7%
Intramuscular injection	3	20.0%
Gun shot injury	2	13.3%
Nerve entrapment	1	6.7%
Stab wound	1	6.7%
Axe injury	1	6.7%

**Table III: Assessments Criteria**

CAUSES	NO. OF CASES	PERCENTAGE
Road traffic accident	7	46.7%
Intramuscular injection	3	20.0%
Gun shot injury	2	13.3%
Nerve entrapment	1	6.7%
Stab wound	1	6.7%
Axe injury	1	6.7%

DF, dorsiflexion. PF, palmar flexion. ABD, abduction. IP EXT, interphalangeal extension MP EXT, metacarpophalangeal extension

**DISCUSSION:**

Radial nerve is not an uncommon injury. It usually affects young and active people predominantly male in their prime working life.

The commonest age group affected is 20-40 years as reported by most studies<sup>14,15,16,17</sup>. Our study also had a similar pattern of age group involvement. The mean age of patients in our study was 28.60±11.29 years.

The motor deficit following radial nerve palsy is enormous as it supplies whole of the extensor compartment accounting for forty-two percent of total tension at wrist. As such only fifty eight percent is left for any possible transfer. Hence the ultimate strength will be fifty eight percent even after best effort<sup>18</sup>. The functional deficit after the radial nerve palsy is divided into three subgroups.



1. Loss of wrist extension.
2. Loss of thumb extension/abduction.
3. Loss of finger extension.

This is a good generalization as it allows us to propose/ design tendon transfers for restoration of different functions. The most important function to restore is wrist extension so as to allow long finger flexors to work under optimum conditions<sup>18</sup>. This is followed by the restoration of thumb extension / abduction. The last is restoration of metacarpophalangeal joint extension. After extension/ abduction. The last is restoration of metacarpophalangeal joint extension. After having quantified the functional deficit, the second stage is to find suitable muscle donors with adequate power/ excursion/ length. There are several modifications of tendon transfer described in literature for radial nerve palsy.<sup>3,19</sup>

The most widely accepted combination for radial nerve palsy is the Standard transfer<sup>12,13</sup>. The use of Pronator teres is widely accepted and least controversial. The length of pronator teres is slightly short to reach ECRB tendon therefore the tendon is detached with 2-3cm long strip of periosteum<sup>8,12</sup>. In the standard transfer, there are no residual flexor or extensor muscle-tendon units on the ulnar side of the wrist. This can lead to the deformity of excessive radial deviation and an inability to correct it actively. This is likely to be further aggravated if the pronator teres is inserted into the ECRL. Therefore we transfer the pronator teres to more centrally located ECRB then ECRL. Brand<sup>18</sup> also recommended the pronator teres transferred to the extensor carpi radialis brevis to maintain a more centralized pull

At the level of the wrist joint. Chuinard R G<sup>8</sup> insert pronator teres in both ECRB and ECRL. By maintaining the FCU intact, radial deviation has not been encountered in his series.

Pronator teres overtakes this essential hand function in all widely performed tendon transfer methods for radial nerve palsy<sup>7,9</sup>. Two of our patients(13.33%) had radial deviation on wrist extension. These patients also didn't had problem in daily life activities after the condition corrected by physiotherapy. The choice of transfer for digital extension is much more controversial. Options included the Flexor carpi ulnaris, Flexor carpi radialis, Palmaris longus or one or more Flexor digitorum superficialis tendons (FDS).

Jones<sup>4</sup> used the combination of the FCU and the FCR for extension of the fingers. Contrary to that Zachary<sup>6</sup> stated in 1946 that one wrist Flexor should be left intact. Influenced by these studies, Goldner et al<sup>20</sup>, Boyes<sup>7</sup>, and Chuinard et al<sup>8</sup>, favored the FDS to middle or ring finger for finger extension<sup>16</sup>. Critics of the FCU transfer reported that it produce significant loss of ulnar deviation, flexion, grip strength, and wrist stability.

Boyes<sup>7</sup> reported in 1960 that the FCU should be retained to maintain better balance of the wrist. He felt that the axis of the wrist from dorsal radial to anterior ulnar is the most important functional plane and should not be disturbed by sacrificing the Flexor carpi ulnaris for transfer.

In a follow up study, Chuinard and colleagues<sup>8</sup> reviewed twenty-one patients treated with the FDS transfer for finger extension. They felt that a combination of Superficialis and Flexor carpi radialis transfers best preserve a more normal wrist flexor function.



Tsuge<sup>11</sup> changed to FCR transfer after being disappointed with the radial deviation and restricted wrist flexion obtained with the FCU transfer. Kruft<sup>16</sup> and colleagues thought that transferring flexor tendons of the fingers yield more disadvantages than advantages:

- \* The length of the second or fourth finger flexors results in loss of strength.
- \* The risk of operative complication increased, and due to complex motions the patient has difficulties in coping with the new motor functions.
- \* The balance of the finger motion is disturbed.

This finding is supported by Riordan<sup>13</sup>, who found that the rehabilitation time after having transferred the FDS is longer because learning to switch from flexion to extension is more difficult.

In our opinion too much strength is lost after a transfer of the flexor tendons of the fingers. It is of primary importance to restore flexor function of the hand. To achieve this, good wrist extension is necessary. Boyes<sup>7</sup> suggested that the FCU is a more important wrist flexor to be left intact than the FCR. He also stated that its excursion is too short to fully extend the fingers. The patient is only able to extend the fingers fully while the wrist is held in flexed position. Kruft<sup>16</sup> stated that in his series, their patients are able to extend the wrist and the fingers simultaneously after the FCU transfer. In our series the patients are also able to extend the fingers when the wrist is dorsiflexed.

Green<sup>12</sup> has criticized FCU transfer as its results in radial deviation of the hand. Kruft<sup>16</sup> described in his series that the ulnar stabilization stays intact and the FCU continues to work against the radial deviation. Application of FCU causes only minor imbalance because the muscle's

The capacity to ulnarly deviate after FCU transfer has been researched through cadaveric study by Raskin KB<sup>3</sup> they found that the Flexor digitorum superficialis and Profundus not only assist in stabilizing the wrist after FCU tendon transfer, but also produce significant ulnar deviation. Our study revealed that FCU transfer achieved good finger extension and didn't disturb overall functional activity. However further work needs to be done in patients required active ulnar deviation and palmar flexion such as jewelers, carpenters, cobblers, soldiers and etc.

True abduction of the thumb is a function of the median nerve via the Abductor pollicis brevis (APB). The three extensors; the extensor pollicis longus (EPL), the extensor pollicis brevis (EPB), and the abductor pollicis longus (APL) supplied by the radial nerve. Their role is one of opening and not of prehension. The simplest solution is to use the same transfer for the extensor digitorum communis and pollicis longus. However, the thumb loses some of its independence. While reposition is adequate, the opening obtained in the first web space is limited. In order to correct this deficiency, another transfer on the abductor pollicis longus and extensor pollicis brevis may be required. This was the solution adopted by Merle d' Aubigné<sup>19</sup> but this has a risk of inadequate reposition of the thumb and radial deviation of the hand. For this reason, we have adopted Scuderi's<sup>2</sup> technique which consist of transferring the PL to EPL, rerouted lateral to the Lister's tubercle. In this manner, producing abduction and extension of the thumb. Under these circumstances, another transfer for the abductor longus and the extensor brevis does not seem to be necessary.



### CONCLUSION:

Standard tendon transfer is a good option for the treatment of irreparable radial nerve injury. Controversy persists over the use of the FCU for transfer to the EDC. Our study revealed that FCU transfer achieved good finger extension and didn't disturb overall functional activity. However further work needs to be done in patients required active ulnar deviation and palmar flexion such as jewelers, carpenters, cobblers, soldiers and etc.

### REFERENCES:

1. P Hahn, U Lanz. Replacement operation in radial paralysis. *Orthopade* 1997;26(8):666-72.
2. Scuderi, C. Tendon transplants for irreparable radial nerve paralysis. *Surg Gynecol Obstet.* 1949;88: 643-651.
3. Raskin KB., Wilgis EF. Flexor carpi ulnaris transfer for radial nerve palsy: functional testing and long term results. *J. Hand Surg[Am].* 1995 Sep; 20(5): 737-42.
4. Jones R. On suture of nerves, and alternative methods of treatment by transplantation of tendon. *BMJ* 1916; 1: 641-43.
5. Jones R. Tendon transplantation in cases of musculospiral injuries not amenable to suture. *Am. J. Surg* 1921; 35: 333-35.
6. Zachary RB. Tendon transplantation for radial paralysis. *Br. J. Surg* 1946; 23: 350-64.
7. Boyes JH. Tendon transfers for radial palsy. *Bull Hosps Jt Dis (NY)*, 1960;21:97-105
8. Chuinard RG, Boyes JH, Stark HH, and Ashworth CR. Tendon transfers for radial nerve palsy. *J Hand Surg* 1978;3:560-570.
9. Brand PW. Tendon transfers in the forearm. In: Flynn JE ed. *Hand surgery, 2<sup>nd</sup> ed.* Baltimore: Williams & Wilkins 1979.
10. Starr CL. Army experiences with tendon transference. *JBJS* 1922;4:3-21.
11. Tsuge K., and Adachi N. Tendon transfer for extensor palsy of forearm. *Hiroshima J Med Sci* 1969;18:219-232.
12. Green DP. Radial nerve palsy. In: Green DP, ed. *Operative hand surgery. 2<sup>nd</sup> Ed.* New York: Churchill Livingstone, 1988; 1479-98.
13. Riordan DC. Radial nerve paralysis. *Orthop Clin North Am* 1974;5:283-87.
14. Masmajan. Injuries of the radial nerve. *JBJS [Br]* 1997;79-B Suppl I:59.
15. Bellemere. Traumatic lesion of the radial nerve. *JBJS [B]* 1999;81-B :361.
16. Krufft. Treatment of irreversible lesion of the radial nerve by tendon transfer. *Plast Reconstr Surg* 1997; 100(3):610-616.
17. Brand PW. *Clinical mechanics of the hand. 2<sup>nd</sup> edition.* St. Louis; Mosby 1993 179-187.
18. Tubiana R. Our experience in tendon transfer for radial nerve palsy. *Ann Chir Main* 1985;4(3):197-210.
19. Goldner J.L., and Kelley, J. M. Radial nerve injuries. *South. Med. J.* 1958, 51:873.