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Evaluation of Different Modalities of Tendon Transfer in Ulnar Nerve Palsy

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ABSTRACT

Background: Tendon transfer surgery is a type of hand surgery that is performed in order to improve lost hand function. A functioning tendon is shifted from its original attachment to a new one to restore the action that has been lost.

Aim of the study: the present study was performed to evaluate the different modalities of tendon transfer in management of clawing of little and ring fingers in ulnar nerve palsy.

Patients and Methods: Correction of clawing of ring and little fingers was done in 20 patients (with ulnar palsy whether high or low; age range: 5-60 years). Different techniques of tendon transfer were used including Zancolli-lasso procedure using flexor digitorum superficialis (FDS), Stiles Bunnel procedure using FDS and Brand procedure

Results: Anti-claw procedures were performed in 20 cases, 10 patients showed excellent results, 6 patients showed good results, 3 patients showed fair results, while 1 patient showed poor result according to MRC grading system.

Conclusion: It could be concluded that among many techniques of tendon transfer procedures prescribed for treatment of claw hand in ulnar nerve palsy, FDS transfer is the best reconstructive tendon transfer procedure for correction of ulnar claw hand especially in low ulnar palsy. In case of high ulnar palsy when FDS isn't available ECRL transfer is the next choice.

Keywords: tendon transfer, ulnar nerve palsy, claw hand.

INTRODUCTION

Tendon transfers follow a basic concept that nothing new is created but functional parts are rearranged into the best possible working combination, so it is the relocation of a tendon from a functioning muscle to replace an injured or nonfunctional muscle-tendon unit [(1)].

Paralysis of the ulnar nerve can be classified as either a high or low palsy. In the forearm, the ulnar nerve innervates the flexor carpi ulnaris (FCU), and the flexor digitorum profundus (FDP) of the little and ring fingers. Lesions at or proximal to this level are considered high ulnar nerve palsy. In the hand, the ulnar nerve innervates the hypothenar muscles, the ulnar lumbricals, the interossei, the adductor pollicis, and the deep head of the flexor pollicis brevis. The ulnar nerve also provides sensation to the little finger and the ulnar half of the ring finger. Lesions involving these latter motor and sensory deficits only are considered low ulnar nerve palsy [(2)].

Ulnar nerve palsy alters both the form and function of the hand. Claw hand deformity due to loss of active IPJ extension and MCPJ flexion, which prevents the patient from cupping the hand around objects, grip strength is diminished and key pinch is lost in most cases, Froment's sign, loss of thumb adduction and Wartenberg's sign are also presented in ulnar palsy [(3)].

Bouvier's test involves passively correction of the MCPJ hyperextension and checking for improved IPJ extension. If the patient's flexed IPJ posture improves, then Bouvier's test is positive, and clawing is defined as simple. If the IPJ's remain flexed, then Bouvier's test is negative, and the clawing is defined as complex [(4)].

Tendon transfer procedures used for correction of clawing included**:**

1-Zancolli lasso FDS transfer: It maintains the MP joint in flexion passively, commonly indicated in simple clawing with positive Bouvier's test. It isolates the FDS tendon for transfer and to be looped around the A1 pulley creating a dynamic flexion of the MP joint. and it corrects the clawing simply by preventing the MP joints hyperextension and allows simultaneous flexion of the IP joints [(5)].

2-Stiles-Bunnel FDS transfer: The FDS tendon is transected distal to the A2 pulley and split proximally. Each slip of the FDS tendon is tunneled along the lumbrical canal then looped around the lateral bands. The transfer is tensioned and secured with the wrist neutral and the MCPJ flexed at 45 degrees of flexion [(6)].

3-Brand procedure (ECRL with 4-tail tendon transfer): A transverse incision at the dorsal base of the index metacarpal is used to expose the insertion of the ECRL tendon. A palmaris longus tendon graft is harvested and secured to the ECRL tendon end, the two tendon graft ends are split to create four tendon ends,

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depending upon the number of fingers to be corrected then sutured to the lateral band [7].

PATIENTS AND METHODS

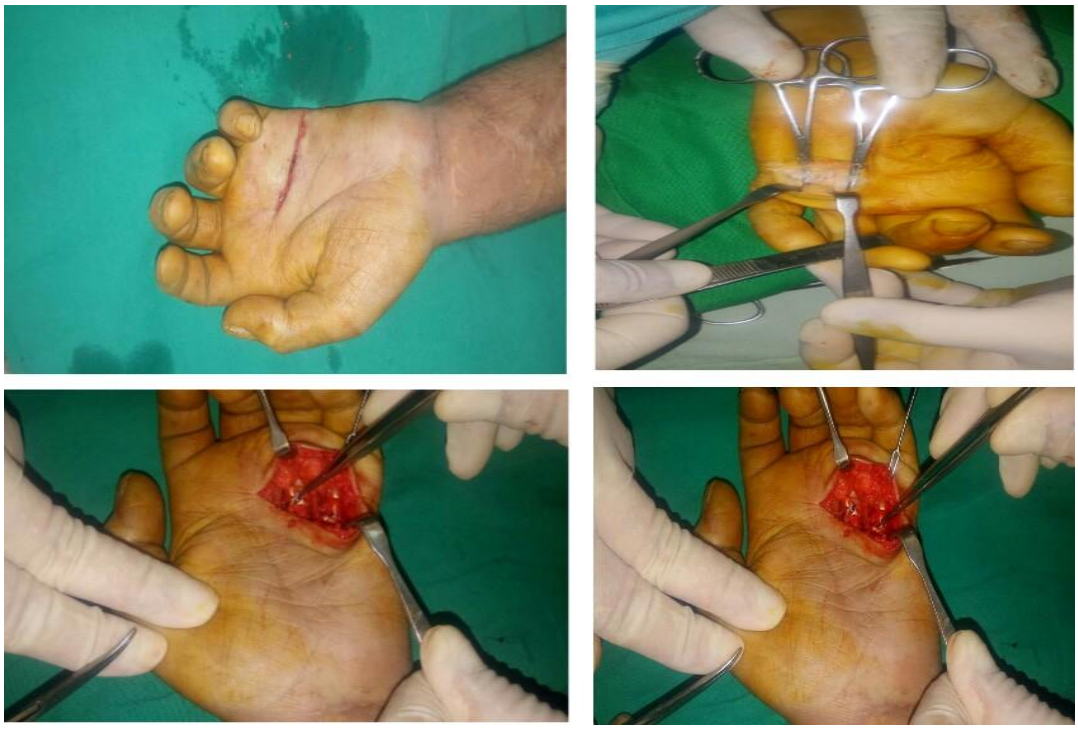
This study included a total of 20 patients with claw ring and little fingers following low or high ulnar nerve palsy attending at the outpatient clinics of plastic surgery at Al-Hussein and Bab al-Sharia; Al-Azhar University Hospitals. **Approval of the ethical committee and a written informed consent from all the subjects were obtained.** This study was conducted between November 2017 to April 2019.

15 (75%) of the patients were males, and 5 (25%) females. Average age was 32.08 years (range 22-48 years). 9 (45%) ulnar nerve injuries were at the dominant hand and 11 (55%) at the non-dominant hand, 3 (12.5%) high and 17 (87.5%) low ulnar nerve lesion. and the duration of paralyses ranged from 3 to 42 months (average 11months).

Preoperative assessment included: mobile PIP and MP joints and positive Bouvier's test, also the reconstruction requires good functioning flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP) muscles. Patients negative Bouvier's test or PIPJ contractures, combined upper limb nerve palsy or with extensor expansion damage were excluded from the study.

Surgical techniques:

1.Zancolli Lasso procedure (FDS transfer): (Fig. 1) This category included 11 cases. An incision was done at the distal palmar crease of the little and ring fingers with subcutaneous dissection the FDS tendon, A1 and A2 pullies were exposed, and the FDS tendon slips of the ring and little fingers divided distal to the A1 pulley approximately 2 cm distal to its separation. After division, the proximal part of the 2 FDS slips passed anteriorly between the A1 and A2 pulleys , then looped proximally anterior to the A1 pulley, and secured over the A1 pulley and sutured back to the FDS tendon itself proximal to A1 pulley, with the MPJ placed in about 30-50° of flexion during tightening (little finger tension was set tighter than the ring finger). A plaster splint was used to maintain fingers at 45° of flexion for 4 weeks followed by active physiotherapy for another 4 weeks.



(Fig. 1) intra-operative steps of Zancolli Lasso procedure.

2. Stiles-Bunnel procedure (FDS transfer): **(Fig. 2)**

This category included 6 cases. Midaxial incisions were made on the radial sides of each digit. A palmar incision was made at the distal palmar crease to retrieve the FDS donor tendons.

The ring finger FDS was harvested through a window between the A1 and A2 pulleys. It was splitted so that it could be used for two fingers. Each slip was passed through the lumbrical canal. With a positive Bouvier's test, the transfer was sutured to the flexor tendon sheath. (If the Bouvier's test was negative, the transfer should be sewn to the lateral band).

A dorsal blocking splint was used to maintain fingers at 45° of flexion with the little finger adducted to the ring finger for 4 weeks followed by active physiotherapy for another 4 weeks.

(Fig. 2) Fig. 4 in tra-operative steps of Stiles-Bunnel procedure.

3.Brand procedures (Simultaneous MCPJ flexion and IPJ extension): **(Fig. 3)**

This category included 3 cases. A longitudinal incision was made on the dorsoradial aspect of the hand to harvest the ECRL tendon proximal to the extensor retinaculum. Sufficient tendon grafts were harvested to allow extension of the wrist extensor to the level of the lateral bands of the ring and little fingers.

After harvesting, a palmaris longus tendon graft was split into two strands distally with the main tendon preserved without splitting proximally.

A dorsoradial incision was made over the proximal phalanx of the ring and little fingers. A mosquito was passed along the lateral band proximally along the path of the lumbrical through a tunnel between the two heads of 3^{rd}-4^{th} and 4^{th}-5^{th} metacarpals with the MCPJ flexed. The mosquito was then passed dorsally into the proximal incision.

Each division of the tendon graft is inserted to the lateral band of the extensor system then passed into the appropriate lumbrical canal through the tunnel to the dorsal aspect. The excurtion was adjusted with MCP joint flexed 45, with little finger slightly flexed more than the ring finger. The tendon grafts were secured with a non-absorbable suture to ECRL tendon. The hand was splinted with the wrist slightly extended, the MCPJ flexed, and the IPJ extended for 4 weeks

(Fig. 3) intra-operative steps of Brand procedure.

Statistical methods

Data entry and statistical analyses were performed using SPSS (statistical package of social sciences) version 21 (SPSS Inc., Chicago, IL, USA). Categorical data were expressed in number and percentage. Continuous normally distributed data were expressed in mean and standard deviation. Independent sample T test was used for continuous normally distributed data. To study the association between Categorical data chi square test was used. Statistical significance was considered when probability (P) value was less than or equal to 0.05.

RESULTS

This study included 20 patients. Their overall outcome was as follows: 'Excellent' results were obtained in 10 patients (50%); 'good' results were obtained in 6 patients (30%); 'fair' result was the outcome in 3 patients (15 %) and 'poor' results was the outcome in 1 patient (5%).

Result	Total (20)
Excellent	10 (50%)
Good	6 (30%)
Fair	3 (15%)
Poor	1 (5%)

Subjective evaluation:

Table (1): Subjective evaluation scale from 0 to 5 [8].

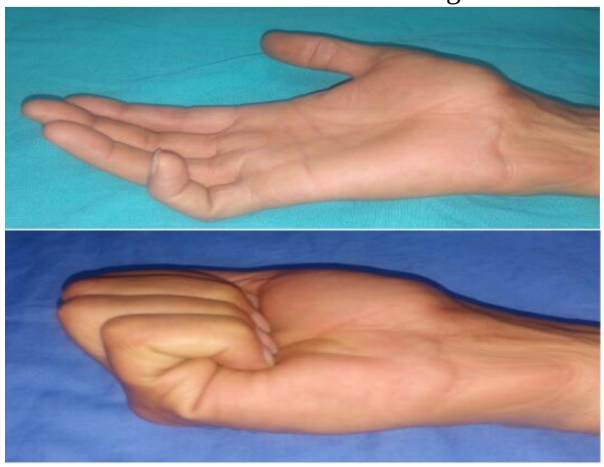
Grading	Clinically	Number	Percentage
0	Not improved in comparison to pre-operative state	0	**%**
1	Slightly improved; does not help in everyday activities	1	5%
2	Slightly improved; helps in everyday activities, but cannot tolerate workload	3	15%
3	Moderately improved; can be burdened with workload for 1–2 hours	5	25%
4	Greatly improved; can be burdened with workload for more than 2 hours	8	40%
5	Greatly improved; uses hand normally in all muscular activities with usual intensity; does not notice weakness	3	15%

Objective evaluation:

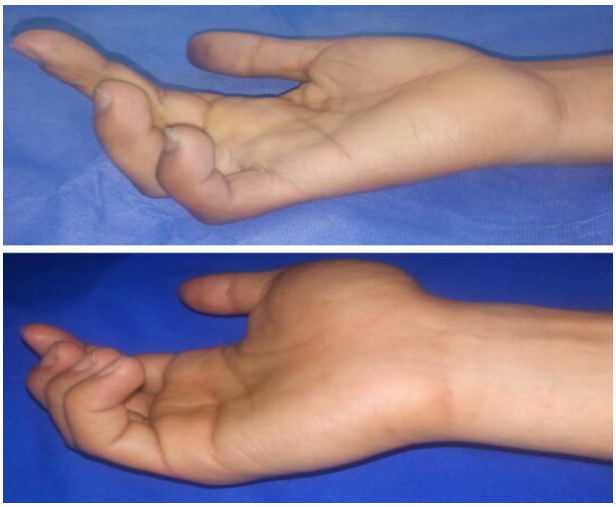
Table (2): the criteria closed fist analysis [9].

Grading	Closed Fist Analysis	Number	Percentage
Excellent	Fully tight fist	10	50%
Good	Finger closes fully, but not tightly enough to hold a hypodermic needle	6	30%
Fair	A visible gap between the base of the finger and the	3	15%
Poor	One fingerbreadth gap between the base of the finger and the tip	1	5%

(Fig. 4) pre-operative and 9 months post-operative after **ZLP** correction of clawing



(Fig. 5) pre-operative and 6 months post-operative after **Bunnel** procedure with fully tight fist.



(Fig. 6) pre-operative and 6 months post-operative after **Brand** procedure.

Complications:

1.**ZLP**: Most of the results were satisfactory according to patient compliance, only one patient complained of postoperative weak grip which improved gradually and by physiotherapy. 2.**Bunnel**: No complications were encountered. 3.**Brand**: One patient developed PIPJ hyperextension due to insertion of the the tendon graft to the lateral band in addition to difficult reeducation of the new transfer, the use of tendon graft increased the possibility of adhesions which required more aggressive post-operative physiotherapy.

Table (3): summary of results of 20 patients with anti-claw procedures

Case	Level of injury	*Surgical procedure*	*Subjective evaluation*	*Objective evaluation*
1	Low ulnar	ZLP	5	Excellent
2	Low ulnar	ZLP	4	Excellent
3	Low ulnar	ZLP	4	Excellent
4	Low ulnar	ZLP	4	Excellent
5	Low ulnar	ZLP	4	Excellent
6	Low ulnar	ZLP	5	Excellent
7	Low ulnar	ZLP	4	Good
8	Low ulnar	ZLP	4	Good
9	Low ulnar	ZLP	3	Good
10	Low ulnar	ZLP	3	Good
11	Low ulnar	ZLP	3	Fair
12	Low ulnar	Bunnel	5	Excellent
13	Low ulnar	Bunnel	4	Excellent
14	Low ulnar	Bunnel	4	Excellent
15	Low ulnar	Bunnel	3	Good
16	Low ulnar	Bunnel	2	Good
17	Low ulnar	Bunnel	2	Fair
18	High ulnar	Brand	3	Good
19	High ulnar	Brand	2	Fair
20	High ulnar	Brand	1	Poor

DISCUSSION

This series included 20 patients, 75% were males, while only 25% were females. This male predominance reflects the higher incidence of upper limb trauma in males**.**

The mean age of the patients included in this study was 32.08 years, which reflects the mean age of working youth population, who are more subjected to upper limb injury. This highlights the financial impact to society from such disabling injuries[(10)].

The ulnar nerve is the least favorable nerve in the upper limb in terms of recovery especially its most distal motor component, tendon transfer procedures were performed in in ulnar nerve palsy with established clawing, when recovery was no longer expected [(11)].

Timing of tendon transfers for ulnar nerve palsy primarily divided into (early, conventional and late) depending on the probability of motor function recovery after nerve repair. Because of the fact that the paralyzed intrinsic muscles rarely recover, early tendon transfer at the time or shortly after ulnar nerve repair were recommended , to prevent MPJ hyperextension and flexion contractures [(12)]. Clawing of the ring and little fingers showed marked improvement after tendon transfer surgeries, improved 8 major hand functions whether grip, pinch or even flat hand function rather than the aesthetic appearance which was the main complaint in some patients.

Multiple dynamic procedures have been described, to correct clawing and improve the pattern of digital flexion including Zancolli lasso, Modified Stiles-Bunnell and Brand procedures. The Zancolli lasso and to a less extent the modified Stiles-Bunnell tendon transfers are most commonly used because both are volar FDS transfers and do not require tendon grafting.

Zancolli lasso FDS transfer showed great results with marked improvement of hand grip with rare complications including swan neck deformity due to unopposed extensor action on PIPJ, also it can't be used in high ulnar palsy. **Bunnel** FDS transfer also showed good results in improvement of hand grip especially when there is associated little finger abduction (Wartenberg's deformity) and it also may be done for reconstruction of abduction and adduction of the lost introssei function which is a rare complaint of the ulnar palsy patient

Brand ECRL transfer is generally not preferred because the use of extensor muscle for replacement of flexor function, also the use of tendon graft disturbed the adjustment of tension and increased the possibility of adhesions, its value is limited to the cases of high ulnar palsy when the FDS should be preserved due to paralysis of FDP of little and ring fingers [(7)].

The 3 – 6 months timing for return to work or resumption of everyday life activities after tendon transfer procedures by ulnar palsy patients was achieved in this study.

CONCLUSION

It could be concluded that excellent outcomes are possible to achieve with tendon transfer in ulnar palsy whether high or low. This functional progress is achievable at negligible donor morbidity, and within a very acceptable time frame.

Finally, once available; FDS tendon transfer is the best reconstructive procedure for correction of ulnar claw hand especially in low ulnar palsy . In high ulnar palsy ECRL transfer is the best substitute.

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