

# Early Rehabilitation Outcome and Demographic and Clinical Features of Patients with Traumatic Tendon Injury

## Travmatik Tendon Yaralanmalı Hastaların Erken Rehabilitasyon Sonuçları ve Demografik, Klinik Özellikleri

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### Summary

**Objective:** Tendon injuries are among the most common forms of traumatic hand injuries. We aimed in this study to report the rehabilitation outcomes of flexor, extensor and combined tendon injuries.

**Materials and Methods:** Thirty-seven patients (110 digits) with traumatic hand injury who were treated by plastic and reconstructive surgery and attended our outpatient clinic for rehabilitation were included in the study. Twenty-five patients (67.6 %) with 78 tendons had flexor (FTI), 8 patients (21.6%) with 18 tendons had extensor (ETI), and 4 patients (10.8%) with 12 tendons had both flexor and extensor tendon injury (combined) (CTI). Patients with FTI were treated by the Kleinert protocol, and those with ETI and CTI were treated by the immobilization technique. Patients in all groups were assessed by the total active motion (TAM) scoring system of the American Society of Surgery of Hand (ASSH), distal palmar crease-finger tip distance (DPCFD), and wrist range of motion (ROM) at the 4th and 8th weeks of the rehabilitation protocol.

**Results:** Excellent and good results were obtained in 51.3% of FTI patients, 94.4% of ETI patients and 58.4% of CTI patients.

**Conclusion:** Even at the 8th week of the rehabilitation period ETI results of our patients were satisfactory. Both FTI and CTI patients had fewer excellent and good results at the 8th week and these injuries need close and longer follow up of the patients. *Türk J Phys Med Rehab 2009;55:19-24.*

**Key Words:** Rehabilitation outcome, traumatic tendon injury

### Özet

**Amaç:** Travmatik el yaralanmalarının en sık görülen şekillerinden biri tendon yaralanmalarıdır. Bu çalışmada fleksör, ekstensör ve kombine tendon yaralanmalarının rehabilitasyon sonuçlarını yayınlamayı amaçladık.

**Gereç ve Yöntem:** Plastik ve Rekonstrüktif Cerrahi kliniğimizde opere olmuş ve polikliniğimize rehabilitasyon amaçlı başvurmuş 37 travmatik el yaralanmalı hasta (110 parmak) çalışmaya alındı. Yetmişsekiz tendon ile 25 hastanın (%67,6) fleksör (FTY); 18 tendon ile 8 hastanın (%21,6) ekstensör (ETY) ve 12 tendon ile 4 hastanın (%10,8) hem fleksör hem de ekstensör tendon yaralanması (kombine) (KTY) mevcuttu. FTY olan hastalar Kleinert protokolü ile; ETY ve KTY olan hastalar immobilizasyon tekniği ile tedavi edildi. Tüm gruplardaki hastalar, Amerikan El Cerrahisi Birliğine ait total aktif hareket skorlama sistemine, distal palmar çizgi parmak ucu mesafesine ve el bileği eklem hareket açıklığına göre rehabilitasyon protokolünün 4. ve 8. haftalarında değerlendirildi.

**Bulgular:** FTY hastaların %51,3'ünde, ETY hastaların %94,4'ünde ve KTY hastaların %58,4'ünde iyi ve mükemmel sonuçlar sağlandı.

**Sonuç:** ETY hastaların rehabilitasyon sonuçları rehabilitasyonun 8. haftasında bile tatmin ediciydi. Hem FTY'lı hastalar hem de KTY hastalarda 8. haftada daha düşük iyi ve mükemmel sonuçlar elde edilmiştir ve bu yaralanmalar daha uzun ve daha yakından izlem gerektirir. *Türk Fiz Tıp Rehab Derg 2009;55:19-24.*

**Anahtar Kelimeler:** Rehabilitasyon sonuçları, travmatik tendon yaralanmaları

### Introduction

Restoring digital function after flexor tendon injuries continues to be one of the great challenges in hand surgery. Despite enhanced results after tendon repair, problems of stiffness, scarring, and functional impairment persist in hand surgery (1).

The effect of an injury on the extensor tendons is often regarded less seriously than a flexor tendon injury. The treatment and rehabilitation of the injury are often believed to be less time-consuming, and associated with a relatively favourable prognosis compared with flexor tendon injuries. However, experience demonstrates that injuries to the extensor tendons can be equally complex, time consuming, frustrating and disappointing (2).

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The purpose of this study was to evaluate the results of flexor and extensor tendon injuries together with complex tendon injuries where both of them were affected and to investigate the factors influencing the outcome.

## Materials and Methods

A hundred-ten patients attended the rehabilitation clinic after surgical treatment in the Reconstructive Surgery Department for traumatic tendon rupture of the hand. Of 110 patients, only 37 participated in the study, and the others failed to attend follow up visits. Twenty-five patients with 78 tendons had flexor (FTI); 8 patients with 18 tendons had extensor (ETI), and 4 patients with 12 tendons had both flexor and extensor tendon injury (combined) (CTI) in all zones of the hand.

Patients with fracture, finger implantation, burn injury and other non-traumatic tendon ruptures, and those with post-operative periods of more than 30 days were excluded from the study. Age, gender, occupation, dominant hand, affected hand, cause of trauma, number of affected fingers, associated nerve and vascular injury and zone of injury were recorded.

### Surgery Technique

All patients had been operated on in plastic and reconstructive surgery department at our hospital. Tendons were repaired by use of the modified Kessler technique with 4-0 prolene sutures.

### Postoperative Management

The modified Kleinert protocol was used to treat the patients with FTI. In the early stage (0-3 weeks), a modified Kleinert splint was used and passive flexion and active extension exercises were performed 10 times by the patients every hour at home. In the intermediate stage (3-6 weeks), the splint was discontinued depending on the quality of tendon glide and the wrist immobilized in the neutral position between exercise sessions. Isolated tendon gliding and tenodesis wrist exercises were initiated. In the late stage (6-8 weeks), resisted and blocking exercises were began.

The immobilization technique was used to treat the patients with ETI. During the first 3 postoperative weeks, injured hands were immobilized by splinting the wrist in 40-45° extension, metacarpophalangeal (MP) joint 0-20° flexion and IP joints in the neutral position. During this period, patients were seen weekly keeping the other joints in the extension position; passive proximal (PIP) and distal interphalangeal (DIP) range of motion (ROM) exercises and metacarpophalangeal (MP) flexion (less than 40°) exercises were performed by the same therapist. In the intermediate stage (3-6<sup>th</sup> weeks), home exercises including combined flexion with wrist extension, isolated finger extension, intrinsic plus position and claw hand position exercises were started. In the late stages (6-8<sup>th</sup> weeks), combined flexion with wrist flexion and resistive exercises were performed. All home exercises were prescribed 10 times every hour.

The immobilization protocol was preferred for the rehabilitation of patients with CTI as the exercises were performed more protectively.

### Assessment

All patients were assessed by the same author at the 4<sup>th</sup> and 8<sup>th</sup> weeks. Flexion and extension of each joint were

measured using a manual goniometry and the flexion and extension deficits were recorded. Outcome was analyzed using the total active motion (TAM) scoring system of The American Society of Surgery of Hand (ASSH). TAM was defined as the sum of the DIP, PIP and MP flexion minus the sum of the DIP, PIP, and MP extension deficits. For each finger (2-5) TAM is divided by 260° expressed as a percentage. The ASSH rating of the results was, excellent 100%, good 75 to 99%, fair 50 to 74% and poor below 50% (3). Wrist ROM in every direction and distal palmar crease- finger tip distance (DPCFD) of all the patients were also measured at the 4<sup>th</sup> and 8<sup>th</sup> weeks. Early participating in the rehabilitation protocol (first week postoperatively or not) and starting time of active motion of tendons after the early phase of rehabilitation protocol (3-4<sup>th</sup> week or 5-6<sup>th</sup> week) were recorded in all groups.

### Statistical Analysis

The mean TAM measurements, DPCFD and wrist ROM measurements of the 4<sup>th</sup> and 8<sup>th</sup> week were compared using the Wilcoxon ranked test with significance set at  $p < 0.05$ . The Mann Whitney U test was used for comparing TAM values of patients who were early participants in rehabilitation (at 1st week) and late participants, a having starting time of active motion at the 3-4<sup>th</sup> week and 5-6<sup>th</sup> week; and also the patients with and without nerve injury at the 8<sup>th</sup> week postoperatively.

## Results

Thirty-seven hand-injured patients with 110 ruptured tendons (mean aged 26.5±11.4 years) were admitted to the study and prospectively followed up for 63.4±19.8 days. The mean time after surgery was 15.1±12.5 days. The ratio of early participants was 17/37 (45.9%). 70.3% of injuries were the result of an accidental event mostly with a glass cut (Table 1). Twenty-six patients were right handed, 28 patients (75.7%) injured their dominant hand and 9 (24.3%) injured their non-dominant hand. FTI were mostly seen in zone 5 and ETI in zones 4 and above. Twenty-five (67.6%) patients had associated nerve injury. FTI and CTI had high nerve injury ratios, 88 and 75% respectively. Ulnar nerve injury was the most frequently observed injury in FTI. Table 1 and 2 summarize the clinical and demographic characteristics of the patients.

The patients with nerve injury had lower TAM values at both 4<sup>th</sup> and 8<sup>th</sup> week visits. ( $p=0.025$ ,  $p=0.022$  respectively). Early participants of FTI were 48% ( $n=12$ ) of all patients. There was no difference between TAM measurements of patients with early participants and late participants of FTI ( $p=0.423$ ), and ETI ( $p=0.536$ ) at the 8<sup>th</sup> week. Early participants of FTI had better DPCFD values at the 8<sup>th</sup> week when compared to late participants ( $p=0.026$ ). When TAM values of groups at the 8<sup>th</sup> week were compared according to the starting time of active motion (at 3-4<sup>th</sup> week or 5-6<sup>th</sup> week), the patients who started active motion at the 3<sup>th</sup>-4<sup>th</sup> weeks had higher TAM values than patients at the 5<sup>th</sup>-6<sup>th</sup> weeks in FTI, but this was not statistically significant.

At the end of the 8<sup>th</sup> week, there were statistically significant improvements in DPCFD and TAM values compared to the 4<sup>th</sup>

week visit values in all groups ( $p < 0.05$ ). However ETI group showed no improvement in palmar flexion and CTI group in all wrist ROMs on the 4<sup>th</sup> and 8<sup>th</sup> week visits (Table 3). Wrist dorsiflexion ( $17.7 \pm 31.8$  degrees) was found to be lowest in FTI patients at the 4<sup>th</sup> week visit and all mean wrist ROM measurements were found to be similar between groups at the 8<sup>th</sup> week visit, except the restriction of wrist dorsiflexion in FTI group.

Excellent and good results were obtained in 51.3% of FTI patients, 94.4% of ETI patients and 58.4% of CTI patients (Table 4).

## Discussion

We evaluated the rehabilitation results of FTI, ETI and CTI and found that ETI had better results than others. We preferred a static regime for ETI patients, as most of them were poorly compliant patients. Bulstrode NW et al. (4) also showed that the mobilization regime had no superiority on static regime at the 8<sup>th</sup> weeks and 12<sup>th</sup> weeks in TAM values of ETI patients, and recommended static regime for poorly compliant patients.

Table 1. Demographic characteristics of the patients.

	Flexor tendon injury (n=25)	Extensor tendon injury (n=8)	Combined tendon injury (n=4)
Female/Male	4/21	1/7	4/0
Age (Mean±SD)	24.4±11.5	29.63±12.6	31.3±5.9
Occupation			
Worker	10	2	2
Student	5	1	0
Unemployed	6	3	2
Teacher	2	1	0
Farmer	2	0	0
Housewife	2	1	0
Type of injury			
Glass cut	19	4	3
Sharp equipment	5	3	1
Traffic accident	1	1	0
Etiology of injury			
Accident	15	4	2
Work accident	2	1	1
Anger	8	3	1

Table 2. Clinical characteristics of the patients.

	Flexor tendon injury (n=25)	Extensor tendon injury (n=8)	Combined tendon injury (n=4)
Effected side (R/L)	18/7	5/3	3/1
Dominant side (R/L)	22/3	8/0	3/1
Type of repair			
Early primary	18	8	2
Late primary	6	0	2
Secondary	1	0	0
Number of digits	78	18	12
Zone V and above	21	8	3
Zone I - IV	4	0	1
Associated injury			
Vascular	10	0	1
Nerve	22	1	2
Median nerve	5	0	1
Ulnar nerve	12	0	1
Radial nerve	0	1	0
Median + ulnar nerve	5	0	0

Table 3. Distal palmar crease-finger tip distance, wrist range of motion, and total active motion results of the all groups.

		<b>4<sup>th</sup> week Mean±SD (Min/Max)</b>	<b>8<sup>th</sup> week Mean±SD (Min/Max)</b>	<b>p value</b>
Flexor tendon injury (n=25)	DPCFD (cm)	3.1±1.7 (0/6.5)	1.9±1.9 (0-6.5)	<0.001*
	Wrist ROM			
	DF	17.7±31.8 (-60/60)	37.7±25.3 (-25/60)	0.002*
	PF	52.1±13.5 (20-70)	57.3±14.1 (35-80)	0.05
	UD	26.3±12.2 (0/50)	33.5±10.9 (5/60)	0.029*
	RD	22.3±13.5 (-20/50)	26.9±7.9 (15/50)	0.006*
	TAM (n=78)	118.5±57.6 (20/240)	179.8±67.8 (45/275)	<0.001*
Extensor tendon injury (n=8)	DPCFD (cm)	2.1±1.8 (0/5)	0.5±1.1 (0/4.5)	<0.001*
	Wrist ROM			
	DF	48.4±16.0 (25/70)	58.8±8.4 (45/70)	0.017*
	PF	45.6±23.1 (0/70)	57.5±23.8 (0/75)	0.075
	UD	27.5±13.4 (10/50)	41.9±12.5 (20/60)	0.017*
	RD	25.3±10.1 (15/42)	29.4±7.8 (20/40)	0.348
	TAM (n=18)	183.9±47.7 (75/245)	237.0±42.8 (82/260)	<0.001*
Combined tendon injury (n=4)	DPCFD (cm)	3.2±1.9 (0/5.5)	0.7±1.0 (0/3)	0.003*
	Wrist ROM			
	DF	58.3±5.8 (55/65)	61.7±7.6 (55/70)	0.593
	PF	45.0±13.2 (30/55)	50.0±5.0 (45/55)	1
	UD	35.7±7.6 (27/40)	35.0±5.0 (30/40)	1
	RD	23.3±7.6 (15/30)	20.0±13.2 (10/35)	0.655
	TAM (n=12)	120.3±58.9 (60/250)	193.5±65.6 (90/270)	0.02*

\*p&lt;0.05

DPCFD: distal palmar crease- finger tip distance, ROM: range of motion, DF: dorsiflexion,  
PF: palmar flexion, UD: ulnar deviation, RD: radial deviation, TAM: total active motion, SD: standard deviation, Min: minimum, Max: maximum

Table 4. Functional results according to the scoring system of American Society of Surgery of Hand (ASSH) in all groups.

	Excellent	Good	Fair	Poor
Flexor tendon injury n (%)	8 (10.3)	32 (41)	16 (20.5)	22 (28.2)
Extensor tendon injury n (%)	4 (22.2)	13 (72.2)	0 (0)	1 (5.6)
Combined tendon injury n (%)	2 (16.7)	5 (41.7)	2 (16.7)	3 (25)

Most of our FTI were zone V injuries. In contrast to ETI, FTI were mostly accompanied with major nerve (median and ulnar) and artery (radial and ulnar) injuries in zone V. This type of injury is called as "spaghetti wrist, suicide wrist or full house syndrome" by various authors (5,6). Chin et al. (7) reported results of 60 patients with spaghetti wrist and obtained good to excellent results in only 19 of patients. In another study with a fewer number of patients, at the end of the rehabilitation only half of the fingers had a full active ROM while the others had significant fixed deformities (8). Hudson et al. (5) studied 15 patients with both median and ulnar nerve injury associated with zone V FTI and 54% of them had good and excellent results and 20% had poor results. In these studies poor results were attributed to inadequate compliance of the patients with the post-operative therapy programs. If patients with associated injuries were excluded, the outcome yielded better results in FTI. Thus, Çetin A et al. (9) found 73% excellent results according to Buck Gramcko classification. Hunk LK (10) achieved 77% excellent-good results in zones other than zone II, if the associated injury was only digital nerve in an active mobilization program.

Although not all of our patients with FTI had the spaghetti wrist, most of them had accompanying nerve injury. Our FTI patients had nerve or vascular injuries with a ratio of 22/25 and 10/25 respectively. Excellent and good results were obtained in only 50.3% of FTI patients. Poor compliance of the FTI patients with the rehabilitation program was observed during the follow-up period. In some patients starting active motion was delayed up to six weeks in our study. The patients started the active motion at the 3<sup>rd</sup>-4<sup>th</sup> weeks had higher TAM values than at 5<sup>th</sup>-6<sup>th</sup> weeks in FTI, but this was not statistically significant. Also follow-up period of the patients were shorter than most of the previous studies. Edinburg M (11) the modified Kleinert technique for flexor tendon divisions with associated injuries and had good-excellent results of 61% in 70 digits at the end of follow up period ranged from 2 to 8 months. All these factors might contribute to the poor outcome of patients with FTI in TAM values.

The patients with FTI also had lower wrist ROM compared to the other groups. Too much wrist flexion can make it difficult to regain extension with an injury so close to the wrist and to the flexor retinaculum, a prime source for flexor adhesions, and the authors recommended protection of the patient, with the wrist as close to a neutral position as possible (3). It is interesting to find higher wrist ROM in CTI patients who had immobilized wrist at the neutral position at the 4<sup>th</sup> week visit.

Excellent and good results were obtained in 94.4% of ETI patients in our study. We performed tenodesis exercises weekly at follow up visits of the mobilization period, very early in the rehabilitation period. Synergistic wrist and finger motion,

which provides for finger flexion with wrist extension and finger extension with wrist flexion, is considered to be a good postoperative therapy after tendon repair because force is relatively low and excursion is relatively high (12). Tenodesis exercises might result in less adhesions and better TAM values.

Russell RC found that ETI patients regained 80% or more of their hand function when assessed at 10 weeks in both static and dynamic splint groups (13). Bulstrode NW et al. reported good or excellent results in all of the patients with ETI randomized to three different rehabilitation regimes at the 12<sup>th</sup> week (4). Research on extensor lacerations has yielded a wide spectrum of results; excellent to good results ranged between 64%-to-92% in other studies (14-16). The ratios that were reported might be affected by the zone of the injury in ETI; immobilized distal ETI have serious gliding problems resulting in 50% loss of finger motion (17). Most of our ETI patients were in zones 4 and above. This might explain the higher excellent to good ratio in ETI.

In the literature, complex tendon injury (both flexor and extensor injury) was not studied sufficiently compared with other injuries. Newport et al. reported complex extensor tendon injury, but fracture, dislocation, joint capsule injury together with flexor tendon injury achieved only 45% good to excellent results (14).

## Conclusion

Even at the 8<sup>th</sup> week of the rehabilitation period, the ETI results of our patients were satisfactory. Both FTI and CTI patients had lower excellent and good results at the 8<sup>th</sup> week and these injuries need close and longer follow up of the patients. Having simultaneous nerve and/or combined tendon injury, beginning tenodesis exercises late, too much wrist flexion, and structural differences were considered to affect the rehabilitation results of FTI.

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