J. Phys. Ther. Sci. 28: 2214–2219, 2016

The Journal of Physical Therapy Science

Original Article

Rehabilitation outcomes in patients with early and two-stage reconstruction of flexor tendon injuries

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Abstract. [Purpose] The primary aim of this study was to assess rehabilitation outcomes for early and two-stage repair of hand flexor tendon injuries. The secondary purpose of this study was to compare the findings between treatment groups. [Subjects and Methods] Twenty-three patients were included in this study. Early repair (n=14) and two-stage repair (n=9) groups were included in a rehabilitation program that used hand splints. This retrospective evaluated patients according to their demographic characteristics, including age, gender, injured hand, dominant hand, cause of injury, zone of injury, number of affected fingers, and accompanying injuries. Pain, range of motion, and grip strength were evaluated using a visual analog scale, goniometer, and dynamometer, respectively. [Results] Both groups showed significant improvements in pain and finger flexion after treatment compared with baseline measurements. However, no significant differences were observed between the two treatment groups. Similar results were obtained for grip strength and pinch grip, whereas gross grip was better in the early tendon repair group. [Conclusion] Early and two-stage reconstruction of patients with flexor tendon injuries can be performed with similarly favorable responses and effective rehabilitation programs.

Key words: Hand rehabilitation, Flexor tendon, Two-stage repair

(This article was submitted Feb. 9, 2016, and was accepted May 7, 2016)

INTRODUCTION

With its wide functional capability, the hand plays an important role in independent daily living and in communication with the environment. As the most mobile part of the upper extremity, the hand is actively used in everyday life and professional fields[1–4]. Due to functional losses, hand injuries frequently result in disability and workforce losses. Approximately 20–24% of traumatic injuries treated by emergency services are hand and wrist injuries[5, 6]. Among these, flexor tendon injuries are the most common[7, 8]. Delayed surgical repair can lead to increased chance of infection, tendon rupture, adhesion, and scarring, and delayed rehabilitation after tendon injuries can negatively affect functional status. Previous studies have shown that early surgical repairs following tendon injuries, early mobilization techniques, and comprehensive rehabilitation applications may increase the functional independence of patients with hand injuries[9–11]. The current study assessed the results of a rehabilitation program for patients with flexor tendon injuries who underwent early tendon repair or two-stage (silicon bar and free tendon graft) tendon repair, and compared the rehabilitation results between these two groups.

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Table 1. Buck-Gramcko score (BGS) and thumb function classification

Interphalangeal joint		Extension loss		Overall movement	
50–70˚	6 points	0–10˚	3 points	≥40˚	6 points
30–49˚	4 points	11–20˚	2 points	30–39˚	4 points
10–29˚	2 points	21–30˚	1 point	20–29˚	2 points
<10˚	0 point	>30˚	0 point	<20˚	0 point

Scoring: Perfect 14–15 points Good 11–13 points Moderate 7–10 points Bad 0–6 points

Table 2. Buck-Gramcko score (BGS) and classification for second through fifth fingers

Free nail palm crease distance		Extension loss		Total active movement	
0–2.5 cm (≥200˚)	6 points	0–30˚	3 points	≥160˚	6 points
2.5–4 cm (≥180˚)	5 points	31–50˚	2 points	≥140˚	4 points
4–6 cm (≥150˚)	2 points	51–70˚	1 points	≥120˚	2 points
>6 cm (<150˚)	0 point	>70˚	0 point	<120˚	0 point

Scoring: Perfect 14–15 points Good 11–13 points Moderate 7–10 points Bad 0–6 points

SUBJECTS AND METHODS

Data from nine patients with flexor tendon injury who underwent repair with a two-stage tendon graft operation and 14 patients who underwent early tendon repair were obtained from our hand rehabilitation unit. Patients with zone II–III flexor tendon injuries were included in the study. Data on patient, age, gender, profession, etiology, injured hand, dominant hand, affected finger, number of cut tendons and zones, date of the event, repair type, postoperative admission time, and complications in the follow-up period were collected. The injury zones and repair types for the tendons that underwent repair were classified according to criteria from the International Federation of Hand Surgery.

The rehabilitation protocol for each patient was determined based on the patient's age, socio-economic status, treatment adherence, examination findings, and postoperative period. While patients were wearing a splint, edema, pain, infection, adhesions, scar formation, tendon rupture and joint contractures were evaluated at an outpatient clinic twice weekly. The presence and severity of pain in patients were determined using a visual analog scale (VAS) (0=no pain, 10=the most severe pain). After the sutures were removed two weeks after surgery, deep friction massage was started with the splint to prevent scar formation. Additionally, patients with edema underwent decongestive massage and Coban bandages. A silicon layer and elastic bandage was used for patients who failed to show sufficient improvement with deep friction massage and who had dense scar tissue.

In patients who underwent early tendon repair, an early passive mobilization protocol was performed for all zones. In patients who underwent tendon repair, an early controlled passive motion protocol was performed in the dorsal protective dynamic splint beginning in the first week after the second operation. Apart from passive flexion exercises with the metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints, which included 10 repetitions three times daily, active extension against rubber band resistance was recommended 10 times per hour for patients in a dorsal-blocking dynamic splint. These exercises were discontinued in the sixth week following the operation. Extension exercises, with the fingers in a fist and extended to a neutral position, were also performed 10 times daily for 3 weeks. Tendon-gliding exercises were started in both groups in postoperative week four. Starting in the eighth week, light resistance and strengthening exercises were added to the treatment program. Remedial bracing was used in patients with flexion deformities. Physical and occupational therapy were performed on patients with restricted joint motion. The fingertip-distal palmar crease distance and the active and passive range of motion (ROM) for the MCP, PIP, and DIP joints were measured for all patients. ROM was evaluated by placing a standard finger goniometer on the dorsal surface of the joint. These data were evaluated using the Buck-Gramcko evaluation system (BGES) (Tables 1 and 2).

All patients were evaluated before treatment (first visit), in postoperative week 8 (second visit), and after the treatment program (postoperative week 12 / third visit). Only the BGES and VAS results were evaluated in the first and second visits, whereas grip strength and both fine and gross grip were evaluated in the third visit. Grip strength was measured using a Jamar hand dynamometer. Measurements were made with the patients in sitting position, with the elbow flexed at 90° and the forearm resting on the table in a neutral position. Patients were asked to perform a maximal and robust voluntarily grip three times in row with the injured hand. The average of the measured values was converted to kilograms (kg). Gross and fine grip were evaluated for the injured hand in threes categories (none 0, poor 1, acceptable 2). All patients in the two-stage tendon repair group were monitored and treated at the clinic before each of the two operations. After confirming that ROM was maintained in the fingers of the nine patients who underwent surgery, the second phase of the operation (tendon-grafting operation) was performed. Ethical approval for the study was received from the ethical committee of the Kocaeli University

Table 3. Patient demographics

	Overall	Early repair (n=14)	Two-stage repair (n=9)
Age	30.7 ± 13.3 (6–59 yrs)	33.1 ± 14.8	27.1 ± 10.1
Gender			
Female	4 (17.3%)	1 (7.1%)	3 (33.3%)
Male	19 (82.6%)	13 (92.9%)	6 (66.6%)
Profession			
Worker	10 (43.4%)	4 (44.4%)	6 (42.8%)
Student	3 (13.0%)	1 (11.1%)	2 (14.2%)
Housewife	2 (8.6%)	2 (22.2%)	-
Tradesman	5 (21.7%)	1 (11.1%)	4 (28.5%)
Officer	1 (4.3%)	-	1 (7.1%)
Retired	1 (4.3%)	-	1 (7.1%)
Farmer	-	-	-
Child	1 (4.3%)	1 (11.1%)	-
Etiology			
Work accident	7 (30.4%)	5 (35.7%)	2 (22.2%)
Home accident	5 (21.7%)	2 (14.3%)	3 (33.3%)
Impulse control disorders	4 (17.3%)	4 (28.6%)	-
Glass injury	3 (13.0%)	-	3 (33.3%)
Other (traffic accident etc.)	4 (17.3%)	3 (21.4%)	1 (11.1%)
Injured hand			
Left	15 (65.2%)	9 (64.2%)	6 (66.6%)
Right	8 (34.8%)	5 (35.7%)	3 (33.3%)
Dominant hand	13 (56.5%)	7 (50.0%)	6 (66.6%)
Non-dominant hand	10 (43.5%)	7 (50.0%)	3 (33.3%)

Faculty of Medicine (KOU KAEK 2014/320). Informed consent was obtained from every participant and from the parents or guardians of the children included in the study.

All data were analyzed using SPSS 13.0 statistical software program for Windows. Descriptive statistics (mean, median, standard deviation, and standard error) were examined first. As the data did not show a normal distribution, the Mann-Whitney U test was used for all comparisons between the two groups, and the Friedman test was used for three or more repeated intra-group measurements. The Wilcoxon marked magnitude test was performed for within-group comparisons to determine differences in measurements. In all hypothesis testing, $p<0.05$ was considered significant. To avoid type I errors in multiple comparisons, Bonferroni correction was used (0.05 / analysis number).

RESULTS

The average age of the patients was 30.7 ± 13.3 years (6–59 years). The patient group included 4 (17.3%) females and 19 (82.6%) males. The demographic characteristics of the patients are shown in Table 3. Between the two groups, there were no differences in age, gender, occupation, etiology, or injured or dominant hands. A total of 12 tendon injuries were observed in 12 fingers from nine patients who underwent two-stage flexor tendon repair; a total of 44 tendon injuries were observed in 24 fingers from 14 patients who underwent early tendon repair.

The distribution of finger injuries in the two-stage repair group included the following: the first finger, two (16.6%); the second finger, two (16.6%); the third finger, three (25.0%), the fourth finger, two (16.6%), and the fifth finger, three (25.0%).

Zone II and III injuries were present in seven (77.7%) and two (22.2%) patients, respectively. The distribution of finger injuries in the early repair group included the following: the first finger, four (16.6%); the second finger, 6 (25%); the third finger, four (16.6%); the fourth finger, five (20.8%); and the fifth finger, five (20.8%). Nine patients (64.2%) had zone II injuries and five (35.7%) had zone III injuries. There were no statistically significant differences between the two groups in terms of the number of affected fingers and tendons ($p=0.332$ and $p=0.469$, respectively). All patients who are included in the early repair group, has scheduled for an appointment to the clinic in the first week of the postoperative term. But from the two stage group, just seven of the patients has gone for an appointment to the clinic in the first week of postoperative term. One patient was detected to have applied in postoperative week 2, whereas one patient was detected at a later period in a two stage tendon repair group. Among patients in the two-stage repair group, the period between injury and the first opera-

tion was an average of 41 months (41.00 ± 54.76; with range: 4–144 months). Among all evaluated patients, tendon repair could not be performed in the early stages after injury. Scar tissue (n=5, 21.7%) and adhesions (n=6, 26.8%) were the most common complications in the two groups in the post-operative rehabilitation process. There were no statistically significant differences in complications between groups (p=0.317).

There were no statistically significant differences in VAS values between the two groups before the study. However, there was a statistically significant improvement in VAS values in both groups in the first and second visits compared to the pre-treatment visit ($p<0.05$), but there was no statistically significant difference between the two groups. Although there were no significant differences in VAS values between the first and second visits in the two-stage tendon repair group, there was a statistically significant improvement in the third visit compared to the second visit and in the third visit compared to the first (Bonferroni correction 0.05/3=0.017, p=0.038, p=0.011, and p=0.012, respectively). There was a significant improvement in VAS values in the second visit compared to the first, in the third visit compared to the second, and in the third visit compared to the first (p=0.001, p=0.001, and p=0.001, respectively). Table 4 shows VAS values for the early and two-stage repair groups. In both groups, there was a statistically significant improvement in BGES results during the rehabilitation process. While there were no statistically significant differences in BGES scores between the second visit and pre-treatment and between the second and third visits in the two-stage repair group (Bonferroni correction 0.05/3=0.17, respectively p=0.157, and p=0.023), there was a statistically significant increase between the first and third visits (p=0.014). There were also statistically significant improvements in the early repair group, including BGES scores in the second visit compared to the first visit and in the third visit compared to the first and second visits ($p<0.001$, $p<0.001$, and $p<0.001$, respectively). BGES scores for both groups are shown in Table 5.

Examination of grip strength and both fine and gross grip in the third visit revealed no statistically significant distinction between fine grip and grip strength ($p>0.05$ for both). However, a statistically significant difference was observed for gross grip, which included controlled grasping in the early repair group ($p<0.05$) (Table 6).

DISCUSSION

The primary aim of our study was to assess the rehabilitation results of patients with flexor tendon injuries who underwent either early or two-stage flexor tendon repair. The second aim was to compare rehabilitation results between the two groups. For this purpose, patient BGES, VAS, grip strength, and gross and fine grip were evaluated. Previous studies have indicated that hand injuries more often occur in males[12, 13]. In our study, 19 of the patients were male (82.6%). Traumatic hand injury also occurs more frequently in the second and third decades of life. This is consistent with the patients in our study, who were an average of 30.7 ± 13.3 years of age commonly included injuries in the second and third decades. The average age was 27 years in the gradual repair group and 33 years in the early repair group. In the literature, 60–82% of people who present to emergency services for hand or wrist injuries are males, and their average age is between 26 and 47 years[8,12–16], and 53–60% of injuries are to the dominant hand. In the present study, 66.6% and 50% of injuries were to the dominant hand in the two-stage and early repair groups, respectively.

In our study, tendon injuries occurred most often in industry workers (43.4%). A previous study on hand injuries reported that hand injuries were more common (38.4%) in workers than non-workers[11]. This observation suggests that tendon injuries are more common in the working class, which could be related to the fact that our clinic is located in an industrial area. An important part of hand and wrist injuries included tendon cuts.

The aims of rehabilitation programs for tendon injuries include providing active and passive finger ROM, preventing flexion contractures and extension loss, hindering tendon breakaway, reducing scar texture, providing pain control, and achieving the best possible hand condition and functionality[17, 18]. In the previous 30 years, an improved understanding of tendon anatomy and physiology has improved suturing techniques and has enabled early mobilization of repaired tendons, advances that have underscored the importance and necessity of early postoperative mobilization[19–21].

Following tendon repair, complications that can prevent tendon lapse, such as scar tissue and adhesion, can cause functional loss in the hand[7, 20]. In our study, scar tissue and cohesion were the most common complications. There were no differences in complications between the two groups.

Rehabilitation programs that include early movement techniques are important in order to prevent complications and preserve the functional capacity of the hand[21, 22]. After tendon injury, the best outcomes are obtained with surgical repair and during the earliest period of early rehabilitation. However, in patients with delayed surgical repair or with no effective rehabilitation after repair, scar texture and adhesion may limit ROM that can lead to loss of hand function.

The present study assessed the results of early and gradual tendon repair rehabilitations. There were no differences in BGES scores among patients who underwent gradual repair, between the second visit and pre-repair, or between the second and third visits. Better results were obtained in the third visit compared to the pre-repair visits, suggesting the necessity of proceeding with the rehabilitation program for 12 weeks. The significant recovery observed in the first visits of the group that underwent early rehabilitation led us to consider whether a rehabilitation program with an earlier start would provide better results. Previous studies have reported great or good functional recovery in 60–98% of patients following rehabilitation programs that began in early the period of flexor tendon repair[8, 14, 23–25]. Furthermore, early mobilization after tendon repair

Table 4. Patient visual analog scale (VAS) scores

		1. Control	2. Control	3. Control
Two Stage repair group	VAS score	6.1 ± 1.7	4.6 ± 1.6	1.3 ± 1.0*
Early repair group	VAS score	6.5 ± 2.5	5.0 ± 2.3	1.3 ± 2.0*

*Statistically significant ($p<0.05$) by Friedman test

Table 5. Patient Buck-Gramcko scores (BGS)

		Perfect	Good	Moderate	Bad
Two Stage repair	1. control	-	2 (16.6%)	5 (41.6%)	5 (41.6%)
BGS	2. control	1 (8.3%)	2 (16.6%)	5 (41.6%)	4 (33.3%)
(n=12)	3. control	4 (33.3%)	4 (33.3%)	3 (25.0%)	1 (8.3%)
Early repair	1. control	-	8 (33.3%)	16 (66.6%)	-
BGS	2. visit	1 (4.2%)	12 (50.0%)	11 (45.8%)	-
(n=24)	3. visit	12 (50.0%)	10 (41.6%)	2 (8.3%)	-

Table 6. Post-treatment patient grip strength and gross and fine grip

	Two Stage repair (n=9) n (%), mean ± SD Median (min–max)	Early repair (n=14) mean ± SD Median (min–max)
Grip strength (kg)	26.6 ± 12.5	33.1 ± 9.4
	28.0 (5–45)	33.5 (15–55)
Gross grip		
None (0)	3 (33.3%)	-
Poor (1)	6 (66.6%)	4 (28.5%)
Acceptable (2)	-	10 (71.4%)
Fine grip		
None (0)	2 (22.2%)	-
Poor (1)	7 (77.7%)	6 (42.8%)*
Acceptable (2)	-	8 (57.1%)

*Statistically significant ($p<0.05$) by χ^2 test

has a positive impact on tendon recovery, offering reduced contracture and improved function[26].

Similarly, immobilization increased cohesion and contracture[27]. However, the positive results observed in the gradual repair group along with the limited complications supports the idea that these patients benefited from an effective rehabilitation program following successful surgery. The decrease in VAS scores at the second and third visits compared to the pre-treatment in the early repair group indicates that early rehabilitation programs may successfully control pain. In the two-stage tendon repair group, the pain typically started to decrease after the second visit and was significantly decreased at the third visit. These results suggest that rehabilitation may also help control pain in complicated cases.

After tendon injuries, evaluating the functional capacity of the hand has great importance. In our study, we assessed patient gross and fine grasping skills in order to evaluate the functional capacity of the hand[28]. There were no differences in grip strength or gross grip parameters between groups, indicating that gradual tendon repair can also be successful. However, fine grip was better in the early repair group; therefore, it is necessary to proceed with a rehabilitation program to further improve fine grasping. The lack of specific tests for evaluating the functional skills of the hand and for evaluating gross and fine grasping is a weakness of our study. Additional studies that include in longer rehabilitation programs could make further contributions to the literature.

Previous studies have reported positive results in functional recovery after effective rehabilitation programs and early surgical repair[23, 29, 30]. Successful tendon repair has also been reported in cases in which repair was delayed[31]. Thus, effective and long-term rehabilitation may provide successful results.

REFERENCES

1) Chen CC, Chen YL, Chen SC: Application of RFID technology-upper extremity rehabilitation training. J Phys Ther Sci, 2016, 28: 519–524. [Medline] [CrossRef]
2) Jung HY, Chang M, Kım KM, et al.: Effect of wrist joint restriction on forearm and shoulder movement during upper extremity functional activities. J Phys Ther Sci, 2013, 25: 1411–1414. [Medline] [CrossRef]
3) Kım SD: Efficacy of tendon and nerve gliding exercises for carpal tunnel syndrome: a systematic review of randomized controlled trials. J Phys Ther Sci, 2015, 27: 2645–2648. [Medline] [CrossRef]
4) Shim J, Kim H, Lee S, et al.: Comparison of hand power and muscle activation during power grip and pinch grip. J Phys Ther Sci, 2011, 23: 459–461. [CrossRef]
5) Kenesi C, Masmejean E: [Emergency treatment of hand trauma in France, an important public health challenge]. Bull Acad Natl Med, 2004, 188: 793–800, discussion 800–801. [Medline]
6) Schöffl V, Heid A, Küpper T: Tendon injuries of the hand. World J Orthod, 2012, 3: 62–69. [Medline] [CrossRef]
7) Ahmad M, Hussain SS, Tariq F, et al.: Flexor tendon injuries of hand: experience at Pakistan Institute of Medical Sciences, Islamabad, Pakistan. J Ayub Med Coll Abbottabad, 2007, 19: 6–9. [Medline]
8) Çetin A, Dinçer F, Keçik A, et al.: Rehabilitation of flexor tendon injuries by use of a combined regimen of modified Kleinert and modified Duran techniques. Am J Phys Med Rehabil, 2001, 80: 721–728. [Medline] [CrossRef]
9) Strickland JW: Biologic rationale, clinical application and results of early motion following flexor tendon repair. J Hand Ther, 1989, 2: 71–82. [CrossRef]
10) Pettengill KM, Strien GV: Postoperative management of flexor tendon injuries. In: Mackin EJ, Callahan AD, Skirven TM, et al. (eds.), Rehabilitation of the Hand and Upper Extremity, 5th ed. St. Louis: Mosby, 2002, pp 431–456.
11) Evans RB: Clinical management of extensor tendon injuries. In: Mackin EJ, Callahan AD, Skirven TM, et al. (eds.), Rehabilitation of the Hand and Upper Extremity, 5th ed. St. Louis: Mosby, 2002, pp 542–579.
12) Keskin D, Seçkin Ü, Bodur H, et al.: Tendon yaralanmalı hastalarımızın klinik özellikleri. Turk Fiz Tip Rehab Derg, 2005, 51: 94–97.
13) Altan L, Bingöl Ü, Selçuk A, et al.: El yaralanmalı hastaların sosyodemografik özellikleri ve yaralanmanın karakteristik özelliklerinin rehabilitasyon sonuçlarına etkisi. Romatol Tip Rehab, 2002, 13: 236–242.
14) Kitiş PT, Buker N, Kara IG: Comparison of two methods of controlled mobilisation of repaired flexor tendons in zone 2. Scand J Plast Reconstr Surg Hand Surg, 2009, 43: 160–165. [Medline] [CrossRef]
15) Karasoy A, Sakinsel A, Gözü A, et al.: Acil el yaralanmalarında deneyimlerimiz. Ulus Travma Derg, 1998, 4: 265–269.
16) Çeliker R, İnanıcı F, Dinçer F: Classification and etiological evaluation of hand problems. Romatol Tib Rehab, 1995, 6: 67–71.
17) Graf V, Papaloïzos M, Borisch N, et al.: [Interest in early active controlled mobilization and flexion following flexor tendon repair in zone 2]. Chir Main, 2001, 20: 458–465. [Medline] [CrossRef]
18) Schneider LH: Flexor tendons-Late reconstruction. In: Green D, Hotchkiss RN, Pederson WC (eds.), In: Green's Operative Hand Surgery, 4th ed. Philadelphia: Livingstone, 1998, pp 1898–1949.
19) Küçükdeveci A: El rehabilitasyonu. In: Beyazova M, Gökçe-Kutsal Y (eds.), Fiziksel Tıp ve Rehabilitasyon, 1st ed. Ankara: Güneş Kitabevi, 2000, pp 1122–1241.
20) Stewart KM: Review and comparison of current trends in the postoperative management of tendon repair. Hand Clin, 1991, 7: 447–460. [Medline]
21) Dovelle S, Heeter PK: The Washington Regimen: rehabilitation of the hand following flexor tendon injuries. Phys Ther, 1989, 69: 1034–1040. [Medline]
22) Hung LK, Chan A, Chang J, et al.: Early controlled active mobilization with dynamic splintage for treatment of extensor tendon injuries. J Hand Surg Am, 1990, 15: 251–257. [Medline] [CrossRef]
23) Altan L, Bingöl Ü, Özbek S, et al.: Eldeki fleksör tendon yaralanmalarının rehabilitasyonunda immobilizasyon ve erken mobilizasyon tekniklerinin karşılaştırılması. Turk Fiz Tip Rehab Derg, 2000, 1: 73–76.
24) Chan TK, Ho CO, Lee WK, et al.: Functional outcome of the hand following flexor tendon repair at the 'no man's land'. J Orthop Surg (Hong Kong), 2006, 14: 178–183. [Medline]
25) Keskin D, Seçkin Ü, Bodur H: El fleksör tendon yaralanmalı hastalarımızın rehabilitasyon sonuçları. Romatol Tip Rehab, 2008, 19: 35–39.
26) Seçkin Ü, Borman P, Akyüz M, et al.: Elin fleksör ve ekstensör yaralanmaları sonrası uygulanan rehabilitasyon programı sonuçları. Romatizma, 2000, 3: 155–160.
27) Ingari JV, Pederson WC: Update on tendon repair. Clin Plast Surg, 1997, 24: 161–173. [Medline]
28) Villafañe JH, Valdes K: Reliability of pinch strenght testing in elderly subjects with unilateral thumb carpometacarpal osteoarthritis. Phys Ther Sci, 2014, 26: 993–995. [CrossRef]
29) Umay E, Gürçay E, Çevikol A, et al.: El tendon yaralanmalarının rehabilitasyonunda erken ve geç mobilizasyon sonuçlarının karşılaştırılması. Turk Fiz Tip Rehab Derg, 2009, 55: 147–152.
30) Öz B, Bal S, Demirdöven C, et al.: Early rehabilitation outcome and demographic and clinical features of patients with traumatic tendon injury. Turk Fiz Tip Rehab Derg, 2009, 55: 19–24.
31) Çiloğlu NS, Öncel A, Tercan M: İki aşamalı tendon rekonstrüksiyonu: 31 hastanın retrospektif değerlendirilmesi. Turk Plast Surg, 2012, 20: 10–13.