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The efficiency of Coban bandage on acute phase edema among patients undergoing a flexor tendon repair

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ABSTRACT

Introduction: To evaluate the efficiency of 3M Coban self-adherent wrap application on early (1-4 weeks) edema among patients undergoing surgery following a flexor tendon injury in Zone V or distal.

Material and Method: The study included 56 patients who had flexor tendon injuries. The patients were randomized into two groups by the computerized randomization method. Both groups were applied the "Modified Duran Protocol" (MDP) early passive mobilization exercises and "Retrograde Edema Massage". In addition, was applied 3M Coban self-adherent wrap to Group II. Finger circumferences was measured using a tape measure, and the pain intensity was evaluated with a visual analog scale (VAS). A goniometer was used to measure the joint range of motion (ROM), the Duruoz hand index (DHI) to evaluate functionality level, and the quality of life was investigated using the short form-36 (SF-36).

Results: The results showed that was statistically significant differences in both groups compared to pre-treatment ($p<0.05$). Edema, ROM, and all parameters of the DHI were found in both groups improved significantly ($p<0.05$). VAS pain scores at rest and activity were found significantly decreased in both groups compared to pre-treatment ($p<0.001$). In addition, pain at activity was found more significantly decreased in Group II (using bandage group). When it comes to the quality of life, there was a significant improvement in the SF-36 scores in both groups ($p<0.05$). In addition, increases in the scores on the "Physical Functioning" and "Physical Role" subscales were more significant in Group II ($p<0.05$).

Conclusion: In flexor tendon injuries, early rehabilitation and close follow-ups are likely to improve edema, upper extremity functions, and quality of life among patients. "Early Passive Mobilization Exercises (the Modified Duran Protocol)" and "Retrograde Edema Massage" are rather effective in edema treatment. Overall, we suggest that 3M Coban self-adherent wrap application also contributes to reducing pain at activity and improving physical functions following flexor tendon repairs.

Keywords: Flexor tendon injury, edema, 3M Coban self-adherent wrap

INTRODUCTION

When not treated early and correctly, flexor tendon injuries - prevalent among males of working age - may significantly restrict one's activities of daily living and cause lifelong problems (1,2). Surgeons may adopt different techniques in flexor tendon repairs. Yet, the shared purpose is to minimize the gap between tendon ends in the repair region, accelerate recovery, and increase tendon gliding and excursion (3). In the literature, surgical techniques applying 4 knots with 4-0 and 5-0 prolene suture materials and the Kessler technique are encouraged, as well as epitendinous repair (4). The easy-to-apply and practical nature (consuming less time) is the distinctive feature of the modified Kessler + epitendinous suture technique (5).

Many rehabilitation methods come to mind in flexor tendon injuries. Postoperative active or passive motion programs are often cited to improve postoperative outcomes for repaired tendons (6,7). The Modified Duran Protocol is among these programs. This protocol suggests that 3-5 mm of passive motion of the tendon anastomosis would effectively prevent tendon adhesions (8). The passive, controlled motions may protect the newly repaired tendon and help control the tension in the repaired area (9). For this purpose, a dorsal splint is used by limiting the wrist to 20° and MCP joints to 40-50° of flexion and keeping fingers extended. A splint allows passive flexion of the fingers but hinders the extension beyond its boundaries (10). Unlike the Duran and Houser protocol, a splint is not

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supplemented with a tape, and the interphalangeal joints are kept extended between exercises or overnight. Patients individually perform passive flexion-extension exercises.

Edema may occur in hands secondary to injury and surgery in the early period or due to venous return insufficiency caused by decreased motion after local trauma. It is quite common in flexor tendon injuries and adversely affects the rehabilitation process (11). Extremity elevation, exercises, retrograde massage, and elastic compressions are used to treat edema (12). As a kind of compression method, Coban bandages will be effective in dealing with edema and improving hand functionality when used in the early period, especially in patients with flexor tendon injuries with excessive soft tissue edema.

The relevant literature shows not much interest in hand edema and Coban bandage after flexor tendon injuries. In our literature review, we could unfortunately not encounter any study evaluating the efficiency of this bandage in the rehabilitation program applied following flexor tendon repairs. Therefore, we aimed to investigate the effectiveness of 3M Coban self-adherent wrap involved in the early period (1-4 weeks) on edematous hands and fingers repaired with the modified Kessler surgical technique after flexor tendon injuries in zone V or its distal.

MATERIAL AND METHOD

The Ethics Committee of Kırıkkale University granted ethical approval to our study (Date: 11/03/2021, Decision No: 2021/05-2021.03.02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The study was carried out with the permission of Ankara City Hospital Department of Physical Therapy and Rehabilitation Traumatic Hand Rehabilitation Clinic.

This study included 56 patients (40 males and 16 females) aged 18 years and over who applied to the traumatic hand outpatient clinic between April 2021 and September 2021, underwent a zone V or distal flexor tendon surgery with the modified Kessler suture technique, who were in the acute period (1-4 weeks) with edema on the volar or dorsal surface of the finger-hand. All patients were informed about the study the study and signed the informed consent form. Those with infection, malignancy, circulatory problems, steroid-nonsteroid medication, cognitive dysfunction, and open wounds were excluded from the study.

After recording their demographic characteristics, the patients were randomized into two groups by the computerized randomization method. Group I included 19 males (mean age: 30.05±10.45 years) and 9 females (mean age: 31.22±15.10 years), while Group II was composed of 21 males (mean age: 36.85±12.31 years) and 7 females (mean age: 28.85±8.49 years).

During the postoperative rehabilitation phase, both groups were applied the "Modified Duran Protocol" (MDP) early passive mobilization exercises(13) and "Retrograde Edema Massage". In addition, was applied 3M Coban Self-Adherent Wrap to Group II for their edematous fingers-hands. All patients were provided the treatment for 4 weeks and was called them for control examinations in the 1st, 2nd, and 4th weeks.

According to the Modified Duran Protocol, a dorsal blocking splint was used in all patients for 4 weeks in all patients for 4 weeks, keeping the wrist at 20° flexion, MCP joints 40-50° flexion, and fingers extended. Interphalangeal (IF) joints were taped in extension between exercises and at night (14). The patients were advised to perform early passive mobilization exercises as passive flexion and extension for the distal interphalangeal (DIP), proximal interphalangeal (PIF), and metacarpophalangeal (MCP) joints ten times every hour and hold them for five seconds in each position (14). In addition, the patients were explained how to do retrograde edema massage for edema control: retrograde edema massage refers to effleurage motions with slight pressure from the fingertip to the palm (from distal to proximal) in the plaster cast (15,16). The patients were warned to perform exercises and massage without removing the splint. Rehabilitation practices were taught to each patient by the same physiotherapist, and were asked to do them every hour during the day.

It is well-known that edema caused by surgery or trauma severely limits movements, slows down recovery, and prolongs the return to daily life. Therefore, edema treatment should be included in a rehabilitation program (17). In addition to the rehabilitation program, 3M Self-Adherent Wrap, which is considered helpful in postoperative edema, was applied to the patients in Group II. Each bandage was wrapped circularly (on its own stretch) from distal to proximal, covering the wrist, edematous finger, and the volar and dorsal parts of the hand (**Figure**). The patients were advised to use it between exercises and remove it at night and during exercises (12).

Environmental and volumetric measurements are utilized to determine edema severity (19). Peripheral measurement refers to measuring the circumference of the IF and MCF joints with a tape measure, which is a valid, reliable, widely adopted method (20). This method is usually helpful if there is edema in one or both fingers since a small amount of edema cannot be identified with a

volumetric measurement. In a volumetric measurement, one's hand and wrist are placed vertically in a volüme meter, and the volume of fluid overflowed by the hand is calculated. In this study was preferred the tape measure method due to the pandemic. The patients' hand and wrist circumferences were measured using a tape measure in a way of completely surrounding joints and not squeezing soft tissues (21). DIP, PIP, MCP, and wrist circumferences were evaluated at different stages of the treatment (pre-treatment (PT), 1st week (T1), 2nd week (T2), and 4th week (T4) control examinations) and results were compared.

Figure. Coban self-adhesive bandage (3M) application

Range of Motion (ROM) of all joints of the injured hand was measured passively with a goniometer at PT, T1, T2, and T4 control examinations. ROM is one of the most commonly used outcome variables after hand tendon injuries and can be measured on the dorsum or lateral of the hand (22).

The patients' functionality levels were determined using the Duruoz Hand Index (DHI) at PT and T4 examination. The index consists of 18 items on the ability to do some basic hand movements in Daily life activities and is scored on a scale ranging between 0 (no difficulty) and 5 (impossible to do); a higher score refers to greater activity restriction and difficulty (23).

The pain severity at rest and activity was assessed using a Visual Analog Scale (VAS) at PT and T4 examination. For the VAS assessments, the patients were told about the meanings of the numbers 0 (no pain)-10 (severe pain) placed on a 10 cm line, and we asked them to mark their pain severity on this 10 cm line. Pain severity was identified considering the distance between the marked number and the starting point (24).

Finally, quality of life among the patients was evaluated using the Short Form-36 (SF-36) at PT and T4 examination. It is a 36-item scale consisting of the social functioning, physical functioning, physical role, emotional role, bodily pain, vitality, general health, and mental health subscales. Each subscale is scored on a scale ranging from 0 (poorest quality of life) and 100 (greatest quality of life) (25).

Statistical Analysis

Statistical Analysis were carried out using the Statistical Package for the Social Sciences (SPSS, version 23.0; Inc, Chicago, IL, USA). The patients were assigned to the groups using the computerized randomization method to balance their prognostic factors. The normality of distribution was checked using the Shapiro-Wilks test. Continuous variables were presented as mean±standard deviation and median (minimum-maximum) and categorical variables as numbers and percentages. Groups were compared by Independent Sample t-test in terms of normally distributed numerical variables. In contrast, groups were compared by Mann-Whitney U test for numerical variables that were not normally distributed. Multiple comparisons of the repeated measured between groups were performed using parametric a mixed-design analysis of variance tests (mixed-design ANOVA) or non-parametric two-way Friedman's tests depending on the normality of distribution. All statistically analysis was performed at the 95% confidence interval and p-value <0.05 was accepted as statistically significant.

RESULTS

The study was carried out with 56 patients [40 males (71.4%), 16 females (28.6%)] with a mean age of 32.64±11.96 years. **Table 1** presents the demographic, injury, and pain characteristics of the participants.

The results revealed that edema in both groups improved significantly from PT to T1 examination, from T1 to T2 examination compared to the baseline parameters ($p<0.05$). Comparing the circumference measurements in the T2 and T4 examination, edema decreased significantly in Group I ($p<0.05$); however not significantly in Group II ($p>0.05$). The differences between the groups were not significant ($p>0.05$) (**Table 2**).

The degree of joint range of motion (passive) increased statistically in both groups compared to pre-treatment (p<0.001); nevertheless, the difference was not significant between the groups (p>0.05) (**Table 3**). Although there were significant differences within the groups by all parameters of the Duruoz Hand Index compared to pre-treatment, between-group differences were not significant (p>0.05). VAS pain scores at rest and activity showed significant decreases in both groups compared to pre-treatment (p<0.05). In addition, pain at activity was found more significantly decreased in Group II (using bandage group) (p<0.001), but improvement in pain at rest was similar between the groups (p>0.05). Within and between-group comparisons for functional status and pain severity are shown in **Table 4**.

Table 1. Patients' demographic, injury, and pain characteristics

Variables	All groups n=56	Group I n=28	Group II n=28	p value
Age, (year)				0.111
Mean±SD	32.64±11.96	30.42±11.86	34.85±11.86	
Med (min-max)	29.50 (18.00-61.00)	26.50 (18.00-55.00)	32.50 (18.00-61.00)	
Sex, n (%)				0.554
Male	40 (71.4)	19 (67.9)	21 (75)	
Female	16 (28.6)	9 (32.1)	7 (25)	
Educational attainment, n (%)				0.507
Primary school	14 (25)	6 (21.4)	8 (28.6)	
High school	32 (57.1)	18 (64.3)	14 (50)	
Undergraduate or above	10 (17.9)	4 (14.3)	6 (21.4)	
Smoking, n (%)				0.592
Yes	30 (53.6)	16 (57.1)	14 (50)	
No	26 (46.4)	12 (42.9)	14 (50)	
Occupation, n (%)				0.165
Worker	31 (55.4)	15 (53.6)	16 (57.1)	
Civil servant	4 (7.1)	2 (7.1)	2 (7.1)	
Retired	6 (10.7)	1 (3.6)	5 (17.9)	
Student	10 (17.9)	8 (28.6)	2 (7.1)	
Housewife	5 (8.9)	2 (7.1)	3 (10.7)	
Dominant hand, n (%)				0.388
Right	50 (89.3)	24 (85.7)	26 (92.9)	
Left	6 (10.7)	4 (14.3)	2 (7.1)	
Injured hand, n (%)				0.422
Dominant	29 (51.8)	16 (57.1)	13 (46.4)	
Non-dominant	27 (48.2)	12 (42.9)	15 (53.6)	
Type of injury, n (%)				0.378
Knife	30 (53.6)	12 (42.9)	18 (64.3)	
Glass	18 (32.1)	11 (39.3)	7 (25)	
Spiral stone	4 (7.1)	3 (10.7)	1 (3.6)	
Metal	4 (7.1)	2 (7.1)	2 (7.1)	
Number of injured fingers, n (%)				0.073
1 finger	36 (64.3)	14 (50)	22 (78.6)	
2 fingers	15 (26.8)	10 (35.7)	5 (17.9)	
3 fingers and more	5 (8.9)	4 (14.3)	1 (3.6)	
Treatment initiation, n (%)				0.607
1. week	12 (21.4)	6 (21.4)	6 (21.4)	
2. week	29 (51.8)	16 (57.1)	13 (46.4)	
3. week	13 (23.2)	5 (17.9)	8 (28.6)	
4. week	2 (3.6)	1 (3.6)	1 (3.6)	
Comorbidity, n (%)				0.716
No	47 (83.9)	24 (85.7)	23 (82.1)	
Yes	9 (16.1)	4 (14.3)	5 (17.9)	
VAS at rest, (cm)				0.398
Mean±SD	3.50±2.19	3.75±2.22	3.25±2.17	
Med (min-max)	3.00 (1.00-9.00)	3.50 (1.00-8.00)	3.00 (1.00-9.00)	
VAS on movement, (cm)				0.144
Mean±SD	3.73±1.91	3.35±1.78	4.10±1.98	
Med (min-max)	3.00 (1.00-8.00)	3.00 (1.00-7.00)	3.00 (1.00-8.00)	

* p<0.05. SD: Standard deviation. Min: Minimum. Max: Maximum. VAS: Visual Analog Scale. cm: centimeter

Table 2. Within and between-group comparisons for edema reduction between the patients with a flexor tendon injuries

Variables	Group I n=28 Mean±SD (centimeter)	p	Group II n=28 Mean±SD (centimeter)	p	p value
1DIP					
PT-T1	6.92±0.65-6.76±0.64	<0.001*	7.10±0.60-6.91±0.59	<0.001*	0.553
T1-T2	6.76±0.64-6.58±0.64	<0.001*	6.91±0.59-6.76±0.51	0.003*	0.602
T2-T4	6.58±0.64-6.47±0.61	0.007*	6.76±0.51-6.66±0.55	0.002*	0.943
PT-T4	6.92±0.65-6.47±0.61	<0.001*	7.10±0.60-6.66±0.55	<0.001*	0.957
2DIP					
PT-T1	5.66±0.43-5.48±0.44	<0.001*	5.85±0.72-5.62±0.57	<0.001*	0.562
T1-T2	5.48±0.44-5.36±0.45	<0.001*	5.62±0.57-5.42±0.55	<0.001*	0.071
T2-T4	5.36±0.45-5.24±0.40	0.019*	5.42±0.55-5.37±0.55	0.143	0.244
PT-T4	5.66±0.43-5.24±0.40	<0.001*	5.85±0.72-5.37±0.55	<0.001*	0.578
3DIP					
PT-T1	5.62±0.48-5.50±0.47	0.007*	5.99±0.64-5.74±0.50	<0.001*	0.084
T1-T2	5.50±0.47-5.32±0.49	<0.001*	5.74±0.50-5.59±0.54	<0.001*	0.587
T2-T4	5.32±0.49-5.22±0.49	0.015*	5.59±0.54-5.50±0.59	0.038*	0.804
PT-T4	5.62±0.48-5.22±0.49	<0.001*	5.99±0.64-5.50±0.59	<0.001*	0.294
4DIP					
PT-T1	5.37±0.51-5.22±0.49	<0.001*	5.60±0.54-5.36±0.49	<0.001*	0.145
T1-T2	5.22±0.49-5.08±0.48	0.001*	5.36±0.49-5.25±0.50	0.002*	0.605
T2-T4	5.08±0.48-4.97±0.48	0.011*	5.25±0.50-5.13±0.50	<0.001*	1.000
PT-T4	5.37±0.51-4.97±0.48	<0.001*	5.60±0.54-5.13±0.50	<0.001*	0.439
5DIP					
PT-T1	5.01±0.48-4.78±0.46	<0.001*	5.32±0.56-5.06±0.52	<0.001*	0.664
T1-T2	4.78±0.46-4.68±0.41	0.004*	5.06±0.52-4.94±0.53	0.001*	0.633
T2-T4	4.68±0.41-4.59±0.45	0.026*	4.94±0.53-4.87±0.52	0.092	0.695
PT-T4	5.01±0.48-4.59±0.45	<0.001*	5.32±0.56-4.87±0.52	<0.001*	0.676
2PIP					
PT-T1	6.82±0.51-6.63±0.57	<0.001*	7.07±0.70-6.81±0.56	<0.001*	0.310
T1-T2	6.63±0.57-6.55±0.60	0.001*	6.81±0.56-6.65±0.58	0.001*	0.218
T2-T4	6.55±0.60-6.43±0.57	0.016*	6.65±0.58-6.58±0.54	0.227	0.443
PT-T4	6.82±0.51-6.43±0.57	<0.001*	7.07±0.70-6.58±0.54	<0.001*	0.262
3PIP					
PT-T1	6.88±0.63-6.70±0.59	0.003*	7.19±0.64-6.94±0.54	0.001*	0.459
T1-T2	6.70±0.59-6.57±0.62	0.001*	6.94±0.54-6.78±0.55	0.001*	0.552
T2-T4	6.57±0.62-6.44±0.59	0.001*	6.78±0.55-6.75±0.60	0.417	0.081
PT-T4	6.88±0.63-6.44±0.59	<0.001*	7.19±0.64-6.75±0.60	<0.001*	0.908
4PIP					
PT-T1	6.68±0.72-6.45±0.66	<0.001*	6.83±0.70-6.48±0.57	<0.001*	0.093
T1-T2	6.45±0.66-6.31±0.63	0.001*	6.48±0.57-6.32±0.61	0.005*	0.775
T2-T4	6.31±0.63-6.17±0.68	0.003*	6.32±0.61-6.29±0.57	0.062	0.147
PT-T4	6.68±0.72-6.17±0.68	<0.001*	6.83±0.70-6.29±0.57	<0.001*	0.790
5PIP					
PT-T1	5.92±0.63-5.69±0.60	<0.001*	6.28±0.71-6.03±0.71	<0.001*	0.765
T1-T2	5.69±0.60-5.55±0.55	0.002*	6.03±0.71-5.85±0.64	<0.001*	0.488
T2-T4	5.55±0.55-5.45±0.58	0.003*	5.85±0.64-5.80±0.64	0.240	0.289
PT-T4	5.92±0.63-5.45±0.58	<0.001*	6.28±0.71-5.80±0.64	<0.001*	0.964
MCP					
PT-T1	20.65±1.56-20.33±1.70	<0.001*	21.30±1.65-20.88±1.64	<0.001*	0.408
T1-T2	20.33±1.70-20.11±1.68	0.020*	20.88±1.64-20.62±1.67	<0.001*	0.704
T2-T4	20.11±1.68-19.90±1.69	0.004*	20.62±1.67-20.57±1.78	0.444	0.124
PT-T4	20.65±1.56-19.90±1.69	<0.001*	21.30±1.65-20.57±1.78	<0.001*	0.898
WRIST					
PT-T1	17.63±1.35-17.49±1.35	0.020*	17.72±1.32-17.47±1.35	0.001*	0.241
T1-T2	17.49±1.35-17.35±1.31	0.002*	17.47±1.35-17.29±1.34	0.002*	0.555
T2-T4	17.35±1.31-17.17±1.36	0.010*	17.29±1.34-17.30±1.47	0.918	0.051
PT-T4	17.63±1.35-17.17±1.36	<0.001*	17.72±1.32-17.30±1.47	<0.001*	0.699

* p<0.05. SD: Standard deviation. PT: Pre-treatment. T1: first-week treatment. T2: second-week treatment. T4: fourth-week treatment DIP: Distal interphalangeal joint. PIP: Proximal interphalangeal joint MCP: metacarpophalangeal joint

When it comes to quality of life, there were significant differences in Group I all scores except "Physical Role" and "Emotional Role" subscales, and in Group II all scores except "Emotional Role" subscale compared to pre-treatment in the SF-36 scores (p<0.05). In addition, increases in the scores on the "Physical Functioning" and "Physical Role" subscales were more significant in Group II (using bandage group) than in Group I (p<0.05). No statistically significant difference was found between groups other subscales (p>0.05) (**Table 5**).

DISCUSSION

The present study explored the efficiency of 3M Coban Self-Adherent Wrap application on edema and rehabilitation in flexor tendon injuries. The study was found Coban bandage application, along with other conventional treatments, to be significantly helpful in reducing pain at the activity. In addition, the improvements in some parameters of quality of life (e.g, physical function and physical role) were significantly greater in those using Coban bandages.

Table 3. Within and between-group comparisons for joint range of motion (passive) values between the patients with flexor tendon injuries

Variables		Group I n=28		Group II n=28		p value
		Mean±SD (degree)	p	Mean±SD (degree)	p	
1DIP	PT-T4	50.53±13.07-75.35±9.80	<0.001*	54.82±13.15-77.50±10.22	<0.001*	0.505
2DIP	PT-T4	40.17±11.09-64.28±8.68	<0.001*	42.67±12.72-65.17±8.10	<0.001*	0.573
3DIP	PT-T4	42.32±8.86-65.00±8.81	<0.001*	44.28±11.84-64.28±9.30	<0.001*	0.341
4DIP	PT-T4	42.32±12.20-66.07±10.57	<0.001*	44.82±10.58-65.17±10.13	<0.001*	0.302
5DIP	PT-T4	44.46±10.99-66.42±10.61	<0.001*	40.89±10.27-63.39±10.97	<0.001*	0.877
2PIP	PT-T4	68.75±14.82-95.00-10.18	<0.001*	70.35±19.90-96.78±9.54	<0.001*	0.963
3PIP	PT-T4	70.00±13.47-95.53±9.46	<0.001*	71.25±16.30-94.64±10.17	<0.001*	0.519
4PIP	PT-T4	70.35±18.50-94.10±10.54	<0.001*	75.17±15.66-96.42±9.70	<0.001*	0.517
5PIP	PT-T4	71.78±14.09-95.35±10.26	<0.001*	67.50±15.42-93.03±12.49	<0.001*	0.616
MCPfl	PT-T4	40.53±12.93-71.42±11.61	<0.001*	46.25±11.51-70.53±11.08	<0.001*	0.138
WRISTfl	PT-T4	37.85±16.01-70.17±15.30	<0.001*	43.21±13.20-70.53±9.65	<0.001*	0.171
WRISTex	PT-T4	11.78±15.22-42.67±20.65	<0.001*	20.17±13.43-53.92±14.74	<0.001*	0.541

* p<0.05. SD: Standard deviation. PT: Pre-treatment. T4: fourth-week treatment DIP: Distal interphalangeal joint. PIP: Proximal interphalangeal joint MCP: metacarpophalangeal joint. Fl: Flexion. Ex: Extension

Table 4. Within and between-group comparisons for functional status and pain scores between the patients with flexor tendon injuries

Variables		Group I n=28		Group II n=28		p value
		Mean±SD	p	Mean±SD	p	
DHI kitchen	PT-T4	40.00±0.00-13.78±5.06	<0.001*	39.32±2.49-11.75±4.39	<0.001*	0.282
DHI dressing	PT-T4	10.00±0.00-2.71±1.24	<0.001*	9.57±1.59-2.50±0.88	<0.001*	0.569
DHI hygiene	PT-T4	10.00±0.00-2.50±1.20	<0.001*	9.53±1.75-2.32±1.05	<0.001*	0.515
DHI at the office	PT-T4	10.00±0.00-3.14±1.38	<0.001*	9.92±0.37-2.53±1.10	<0.001*	0.118
DHI other	PT-T4	20.00±0.00-5.42±2.21	<0.001*	19.53±1.71-4.75±1.99	<0.001*	0.716
DHI tota	PT-T4	90.00±0.00-27.57±9.10	<0.001*	87.89±7.74-23.85±7.88	<0.001*	0.510
VAS at rest (cm)	PT-T4	3.75±2.22-0.96±0.92	<0.001*	3.25±2.17-0.60±0.91	<0.001*	0.735
VAS on movement (cm)	PT-T4	3.35±1.78-1.46±1.26	0.004	4.10±1.98-0.92±1.01	<0.001*	<0.001*

* p<0.05. SD: Standard deviation. PT: Pre-treatment. T4: fourth-week treatment. DHI: Duruoz Hand Index. VAS: Visual Analog Scale. Cm: Centimeter

Table 5. Within and between-group comparisons for sf-36 scores between the patients with flexor tendon injuries

Variables		Group I n=28		Group II n=28		p value
		Mean±SD	p	Mean±SD	p	
SF36 Physical functioning	PT-T4	61.96±4.15-81.42±4.48	<0.001*	60.17±0.94-83.03±4.37	<0.001*	0.002*
SF36 Role physical	PT-T4	33.92±23.77-34.82±22.91	0.326	25.00±24.53-30.35±20.81	0.011*	0.044*
SF36 Bodily pain	PT-T4	54.10±25.73-86.07±16.05	<0.001*	50.08±26.07-84.64±16.86	<0.001*	0.692
SF36 General health	PT-T4	76.78±13.62-83.39±10.71	0.001*	73.57±14.06-81.42±12.75	<0.001*	0.570
SF36 Vitality	PT-T4	38.39±24.57-61.96±20.69	<0.001*	40.71±23.04-68.39±22.40	<0.001*	0.545
SF36 Social functioning	PT-T4	55.35±19.37-76.33±14.16	<0.001*	57.58±21.33-76.78±18.85	<0.001*	0.716
SF36 Role emotional	PT-T4	27.37±24.10-28.56±23.51	0.326	32.13±23.10-35.71±25.56	0.083	0.307
SF36 Mental health	PT-T4	53.85±25.70-67.85±21.37	0.004*	44.85±24.13-70.00±22.82	<0.001*	0.075

* p<0.05. SD: Standard deviation. PT: Pre-treatment. T4: fourth-week treatment. SF-36: Short Form 36 Health Questionnaire

The mean age of 56 patients (40 male, 16 female) was 32.64±11.96 years. Fifty patients presented with a right-hand injury, 6 with a left-hand injury. Among them, 29 patients (51.8%) had a dominant hand injury. Seven (12.5%) patients had a zone I flexor tendon injury, 29 (51.8%) had a zone II injury, 9 (16.1%) had a zone III injury, 6 (10.7%) had a zone IV injury, and 5 (8.9%). In their study, Manninen et al. (2) examined the epidemiology of hand flexor tendon injuries in the northern Finnish population. The mean age of the sample (106 patients) was 39±16 years, and flexor tendon injuries were more common in males than females, especially among those of working age. More than half of the patients (n=59, 56%) had a right-hand injury, 47 (44%) had a left-hand injury. Thirty-five (33%) patients had a zone I flexor tendon injury, 59 (56%) had a zone II injury, 1 (0.9%) had a zone III injury, 3 (2.8%) had a zone IV injury, and 7 (6.6%) had a zone V injury. The reported rates were similar to those in our study.

The available data on the edema-reducing effect of 3M Coban Self-Adherent Wrap application are quite limited. Moreover, we could not encounter any study evaluating the efficiency of Coban bandage application within a rehabilitation program after flexor tendon repairs. Lowell et al. (21) investigated the efficiency of 3M Coban Self-Adherent Wrap application on burned hand edema and followed up a 59-year-old male patient for four weeks. The results revealed that the treated hand had less edema, greater range of motion (active), more increased grip strength, and more improved dexterity compared to the other hand. In their randomized controlled study, Moffatt et al. (26) evaluated 82 patients to compare the effects of shortstretch bandage and 3M Coban Self-Adherent Wrap application on upper-extremity volume (edema) and their use at different frequencies in lymphedema patients. The patients were divided into four groups and followed up for 19 days. Group I (22 patients) had a short-stretch bandage five times a week; Group II (22 patients), Group III (20 patients), and Group IV (18 patients) had a Coban bandage twice a week, three times a week, and five times a week, respectively. The results showed that 3M Coban Self-Adherent Wrap application decreased upperextremity volume (edema), which was greater in Group III than in the other groups.

In flexor tendon injuries, a limited motion protocol is adopted after surgery in most cases. Early tendon motion reduces adhesion, increases gliding, and promotes healing (27). In a study comparing early active and passive mobilization protocols, Frueh et al. (28) divided 159 fingers (132 patients) undergoing flexor tendon repairs into two groups and found no significant differences between the group with early passive mobilization protocol (138 fingers) and the group with early active mobilization protocol (21 fingers). In another study, Kitis et al. (29) recruited 192 patients (263 fingers) and divided those with a zone II flexor tendon injury into two groups. They applied the modified Kleinert protocol to one group (97 patients; 137 fingers) and controlled passive motion protocol to the other group (94 patients; 126 fingers). Using the Buck-Gramcko scale at the end of the 12th week, the researchers found that total active motion was 87% excellent in the modified Kleinert protocol group and 75% excellent in the controlled passive motion protocol group. In our study, early passive mobilization exercises were applied to both groups following the Modified Duran Protocol. At the end of the fourth week, the groups had significant improvements in the range of motion and functional use of the hand and finger joints compared to the baseline parameters.

Bircan et al. (30) applied the Modified Kleinert and Modified Duran Protocols to 18 patients with a zone V flexor tendon injury and evaluated rehabilitation outcomes using the Buck-Gramcko scale. The researchers reached excellent results in 92.8% of the fingers after the rehabilitation program, which lasted for an average of 20 months. Besides, Chan et al. (31) evaluated 16 patients (21 fingers) with a zone II flexor tendon injury repaired with the modified Kessler suture technique. After an average of 130-day rehabilitation program consisting of active extension against band resistance, band-aided passive flexion, and controlled passive flexion-extension exercises, the functional results were excellent and good in 81% of the fingers according to the Buck-Gramcko scale.

Strickland and Glogovac (32) divided 37 patients (50 fingers) undergoing flexor tendon repairs into two groups and applied immobilization to one group (25 fingers) and early passive motion (a slight modification of the Duran and Houser protocols) to the other group (25 fingers). They observed that joint motion was significantly better in the second group and reported early passive motion might be an effective technique after flexor tendon repairs in the postoperative period.

In a study, Turan et al. (33) attempted to validate the DHI in diabetic hand dysfunction and concluded it to be a reliable, practical scale to assess hand dysfunction in diabetic patients accurately. Moreover, Erçalık et al. (34) explored the reliability and validity of the DHI among 65 patients (140 fingers) undergoing flexor tendon repairs. They concluded the DHI to be a reliable and valid questionnaire to evaluate the dexterity restrictions and clinical course of patients with traumatic hand injuries. In this study, all DHI parameters improved significantly in both groups compared to PT, but the differences between the groups were similar.

It seems there is a lack of interest in the literature regarding the relationship between 3M Coban Self-Adherent Wrap application and the VAS pain at activity in traumatic hand injuries. In their randomized controlled study, Jonker et al. (35) explored the impacts of 3M Coban self-adherent wrap application on the pain profile after osteotomy and evaluated patients using a 10 cm descriptive pain scale at PT and during the fourth-week control examination. The results showed bandage application altered the pain profile among the patients, supporting our study. Lee et al. (36) scrutinized the mechanism and treatment of trigger finger secondary to neglected partial flexor tendon rupture. They performed debridement and repair of the ruptured tendon and discovered the postoperative VAS pain scores significantly decreased compared to PT. In this study, there were found the VAS pain at rest and activity significantly decreased in both groups compared to PT, while pain at actvity decreased more in Group II (bandage using group) at the fourth week compared to Group I. Such findings may imply that 3M Coban Self-Adherent Wrap application is an effective treatment method in reducing pain at activity in flexor tendon injuries.

On the other hand, Galasso et al. (37) assessed quality of life among patients with carpal tunnel syndrome and found a significant improvement in most of the SF-36 subscales (excluding general health, vitality, and mental health) when compared to baseline measurement. In a study by Oktayoğlu et al. (38) to evaluate hand functions in patients with idiopathic cervical dystonia, quality of life was assessed with SF-36. The results revealed significant differences between the groups by all SF-36 subscales. In this study, both groups significantly had increased scores on all SF- 36 subscales compared to the baseline measurements. Yet, improvements in "Physical Functioning" and "Physical Role" subscales were more significant in Group II (bandage using group) after treatment. Hence, 3M Coban self-adherent wrap application may contribute to the improvements in physical functions of patients with flexor tendon injuries.

CONCLUSION

In flexor tendon injuries, early rehabilitation and close follow-ups help improve edema, upper extremity functions, and quality of life among patients. "Modified Duran Protocol" early passive mobilization exercises and "Retrograde Edema Massage" are efficient in edema treatment. Besides, 3M Coban self-adherent wrap application offers an extra advantage in reducing pain at activity and improving physical functions in flexor tendon injuries.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Kırıkkale University Medical Faculty Non-interventional Clinical Researchs Ethics Committee (Date: 11/03/2021, Decision No: 2021/05-2021.03.02).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Referee Evaluation Process: Externally peer-reviewed.

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