Journal of Hand Therapy 37 (2024) 479–488

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.elsevier.com/locate/jht

Research Paper

Effect of Kinesio taping on edema and wrist functions in patients with distal radius fracture followed conservatively with a cast: A randomized controlled single-blinded study

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ARTICLE INFO

Article history:
Received 10 September 2023
Revised 6 April 2024
Accepted 16 May 2024
Available online 5 July 2024

Keywords:
Wrist fractures
Kinesio tape
Taping
Edema
Pain
Joint range of motion

ABSTRACT

Background: Data in the literature on the results of Kinesio taping (KT) application after cast removal in patients with distal radius fracture (DRF) are quite limited.
Purpose: It was aimed to evaluate the effectiveness of KT applied immediately after cast removal in addition to the exercise program on edema, functionality, range of motion, and muscle strength in patients with conservatively followed DRF.
Study Design: Randomized controlled single-blinded clinical study.
Methods: This study was conducted with 64 patients with a diagnosis of DRF. The patients were randomized as Kinesio taping group (KTG) and control group. Both groups received a conventional home exercise program. KT was applied to patients in KTG for 10 days. Circumference and volume measurements were taken at baseline and day 10. Arm, Shoulder, and Hand Questionnaire for Disability, Visual Analog Scale, grip strength, and wrist joint range of motion measurements were taken at baseline, day 5, and day 10.
Results: The circumference difference between the affected extremity and the healthy extremity was statistically greater in the control group on the fifth day at the wrist level (<0.001) and 6 cm proximal to the wrist ($p = 0.001$). The circumference difference between the affected extremity and the healthy extremity was statistically greater in the control group on the 10th day at the wrist level ($p < 0.05$) and 6 cm proximal to the wrist ($p = 0.01$). Wrist extension angle (<0.001), wrist flexion angle ($p = 0.001$), and supination angle ($p = 0.001$) were higher in KTG on the 10th day. On the 10th day, the grip strength ($p < 0.05$) was higher in the KTG, while the Visual Analog Scale value ($p < 0.01$), Arm, Shoulder, and Hand Questionnaire for Disability score ($p < 0.01$), and the percentage of strength loss in the healthy arm ($p < 0.01$) were lower in the KTG.
Conclusions: In patients with DRF who were treated conservatively with a cast, the inclusion of Kinesio taping (KT) in the rehabilitation program was found to be effective in reducing edema and pain, as well as improving functionality, strength, and range of motion.

Introduction

Distal radius fractures (DRF) are one of the most common fractures of the upper extremity. It has been reported that DRF accounts for 26%-46% of all fractures.[1,2] The treatment of a DRF includes immobilization with a cast and percutaneous surgical fixation.[3] Successful treatment results of DRF are possible with early rehabilitation combined with surgery or conservative treatment. Edema management is important in early rehabilitation. Edema is frequently seen in DRF, and it has been reported that the incidence of edema is higher in patients who have been applied cast.[4] During the rehabilitation process, the presence of edema reduces function,

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0894-1130/
https://doi.org/10.1016/j.jht.2024.05.003

restricts the range of motion, reduces strength, and increases pain. Therefore, in DRF rehabilitation, the focus is on the evaluation and management of pain, functionality, and joint range of motion along with edema[5,6] The aim of DRF rehabilitation is to improve mobilization, control pain, and increase functionality. During rehabilitation, it is crucial to concentrate on the patient's functional limitations and assess their symptoms during activities.[6] The development of edema in the hand and wrist has a detrimental impact on the patient's functionality. It is well-established that prolonged edema in extremities leads to the development of fibrosis and adhesions in soft tissues.[7,8] Conventional approaches, such as elevation, cold application, and range of motion exercises, are used for edema control in DRF rehabilitation.[9] In addition, current studies have focused on the effectiveness of methods, such as manual lymphatic drainage and mobilization techniques on edema and functionality in the rehabilitation of DRF.[10] Methods, such as compression suits, have also been investigated for the rehabilitation of edema after DRF.[11] Although the effectiveness of manual lymphatic drainage and mobilization techniques has been proven, their application requires a physiotherapist and more time. In addition, compression gloves that are personalized can be costly and not easily accessible.[8,9]

Another complementary method used in edema management is Kinesio taping (KT). KT are drug-free, flexible cotton tapes developed by Kase.[12] After KT is applied to the skin, it is effective by opening the distance between the skin and subcutaneous tissues and increasing lymphatic drainage. In addition, the micromassage effect of the tape is also mentioned.[12,13] There is increasing evidence regarding the effect of KT on edema. Recent meta-analyses have shown its effectiveness in upper extremity lymphedema due to mastectomy performed for breast cancer surgery.[14] KT has been used for antiedema efficacy in orthopedic rehabilitation after total knee prosthesis surgery,[15,16] anterior cruciate ligament surgery,[17,18] after arthroscopic meniscus surgery.[19] It has been reported that more evidence is needed regarding the use of KT for treating postoperative edema.[20]

As far as we know, there is only one study on the application of KT in DRF. In this study, KT was applied within the cast, and the study protocol was published, but the results were not reported.[4] There is no study in the literature about the results of KT application in the early rehabilitation period after cast removal in patients with DRF. KT stands out with its antiedema activity and its structure that allows stretching between 130% and 145%.[12]

The aim of the study was to evaluate the effectiveness of KT applied immediately after cast removal with lymphedema technique on edema, functionality, range of motion, and muscle strength in patients with conservatively followed DRF, in addition to the exercise program. The hypothesis of this study is that by applying KT in the early period after cast removal in conservatively treated patients with DRF, KT will allow the effectiveness of exercise with its flexible structure, will not limit the range of motion of the joint, and will be effective in reducing edema.

Patient and method

Study population

This study was conducted between November 15, 2022 and August 1, 2023 in the Orthopedics and Traumatology Clinic of the Research and Training Hospital, with 64 patients who were managed conservatively for DRF.

Patients who were diagnosed with a distal radius fracture according to the AO classification on the two-way forearm radiograph taken at the entrance to the emergency department of the Training and Research Hospital and who were followed up with a cast because there was no indication for surgical intervention were included in the study.

All reduction and cast applications and follow-up of the patients were performed by the same orthopedist (L.H.) who has 7 years of experience in trauma surgery.

Bilateral DRF, previous surgery related to the same extremity, pathological fractures, open fractures, presence of active infection in the relevant extremity, having cognitive dysfunction (Mini Mental Test Score < 23),[21] having been treated with the diagnosis of upper extremity lymphedema, having a history of operation due to breast malignity, and presence of active infection in the relevant extremity were determined as exclusion criteria of the study.

Fracture reduction parameters were evaluated on X-ray images, where complete fracture healing was observed the day before cast removal.[22] After the cast was removed, the "time in the cast" was recorded. Randomization was performed on all patients on the day the cast was removed. Assessments taken after the cast was removed were considered baseline measurements. The next day, patients were referred to the Department of Physical Therapy and Rehabilitation for intervention applications. The evaluation and treatment procedures to be applied to the patients in the study were collaboratively developed by the Orthopedic Surgery Specialist (L.H.) and the Physical Therapy and Rehabilitation Specialist (B.C.K.) before the study.

Randomization and blinding

All patients were informed about the study, and a written consent form was obtained. Sixty-four patients who agreed to participate in the study were randomized into two groups, Kinesio taping group (KTG) and control group (CG) with computer-assisted numerator. One patient from CG was excluded from the study due to lack of follow-up, one patient from KTG due to lack of adherence, and one patient from the KTG due to lack of follow-up (Fig. 1).

The investigator who made the measurements (M.F.C.) and the investigator who made the interventions (B.C.K.) were different from each other. In addition, the tape was removed before the measurements and the skin was cleaned with alcohol. Thus, the evaluator was blinded to the groups.

Intervention

All patients participating in the study received home exercise program treatment. Cold application and elevation for 20 minutes three times a day are recommended. Home exercises were individualized as finger, wrist, and elbow range of motion exercises and active, active-assistive, and passive stretching exercises. The number of exercise repetitions and sets was increased periodically. All of the exercises were shown by the same physiatrist (B.C.K.) and illustrated exercise forms were given. The patients were given a 10-day chart and were asked to mark the chart when they performed exercises. Exercise compliance of the patients was evaluated according to the chart when the patients came for control. Patients who were missing more than 10% (less than 9 days) of the exercise program were excluded from the study because of exercise incompatibility.

Patients in KTG were tested for allergy with a band of approximately 5 × 5 cm in the palmar region of the wrist of the unaffected extremity before taping. Skin sensitivity testing for KT was performed after the cast was removed. The tape remained on the patients' skins for 24 hours. No allergic reaction or skin irritation was observed in any of the patients in this study. In KTG, KT was applied to the affected extremities of the patients using the lymphedema and epidermis, dermis, fascia (EDF) technique after skin sensitivity testing. All of the applications were made by a physiatrist (B.C.K.)

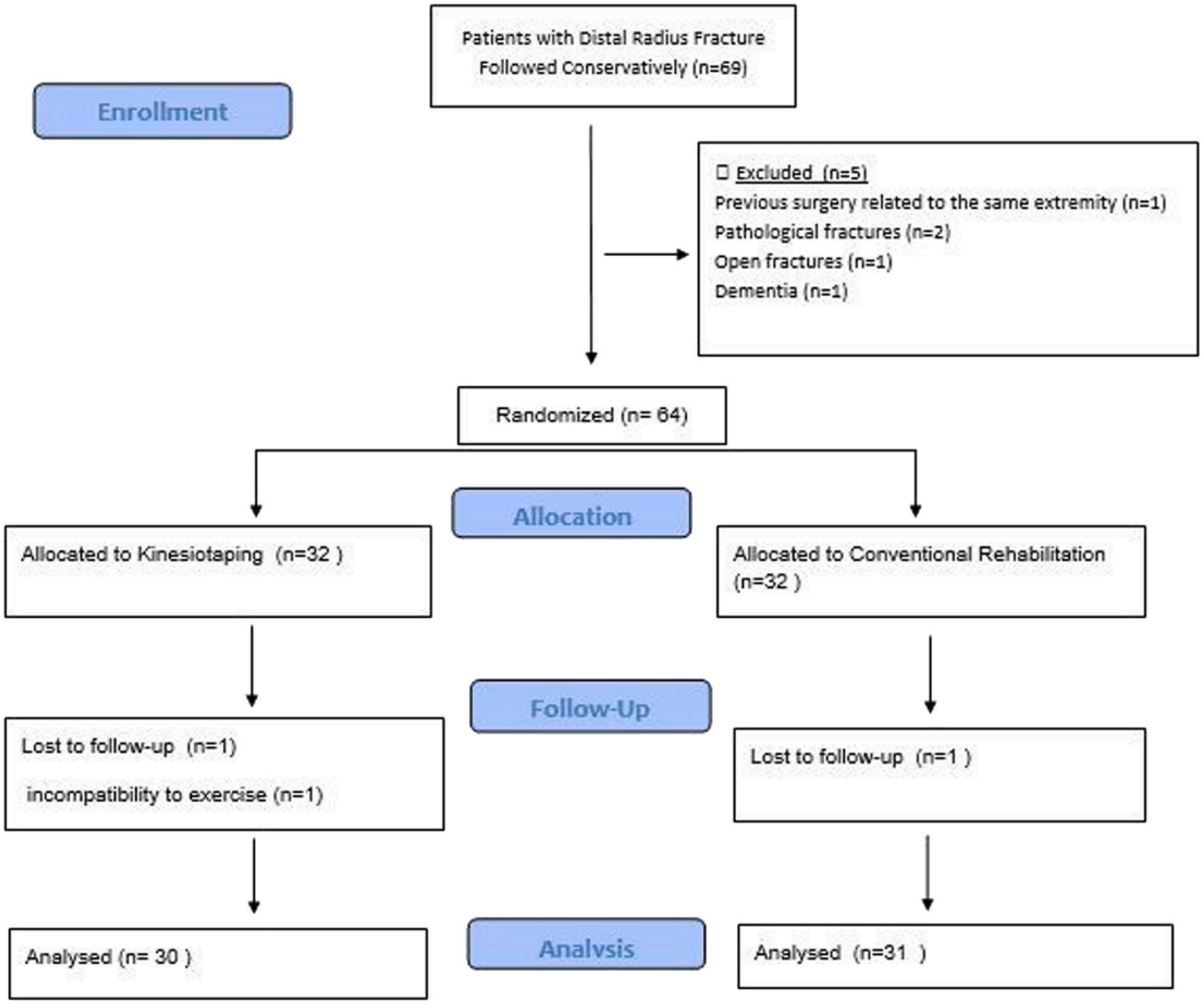

Fig. 1. CONSORT flowchart.

who has a KT certificate and has about 5 years of experience in this field.

In the EDF technique, the tape is divided into thinner pieces and adhered. Thus, it is aimed to reduce edema by affecting the skin and subcutaneous tissues. In this study, this method was preferred because it was aimed to regress the edema of the wrist that developed after the cast was removed. KT was applied while the patient was in the supine position and the forearm was in extension and supination. Accordingly, considering the arm and forearm length of the patient, three pieces of KT were cut and each band was divided into four equal strips. One of these three cut tapes was attached to the arm and the remaining two to the forearm.

Proximal of the band applied to the arm was adhered to approximately 1 cm below the lymph node between the pectoralis major and deltoid muscles without applying tension. Then, 5%-10% tension was applied to each of the four strips at the distal end of the tape, and it was adhered to the elbow area in a wavy manner. The other two bands were applied to the forearm. Two separate bands were applied, one starting 1 cm below the medial epicondyle, and the other 1 cm below the lateral epicondyle. The proximal part of the tape was adhered without tension. Distally, each strip was adhered to the back of the hand and fingers in a wavy form by applying 10%-15% tension. Care was taken to cross the two bands applied to the forearm at the level of the wrist and the back of the hand (Figs. 2 and 3). The patients were evaluated on the fifth day after the bands were applied. On the day of the control, the patient was asked to remove the tape. The patient's measurements were made and taped again in the same procedure.

Outcome measurements

Circumference measurements were made at the level of both hands and wrists using a tape measure according to the figure of eight method.[23] In addition, circumference was measured at the wrist level, at the level of the metacarpophalangeal joint (MCP), 6 cm proximal to the wrist with the help of a tape measure, and the difference between both upper extremities was recorded in centimeters. Measurements were made from both extremity and the difference between the affected extremity and the healthy extremity was statistically analyzed.

Upper extremity volumetric measurement was performed using a volumetric measurement device (Fig. 4). The volume of both extremities was measured while the patient was standing at room temperature. Before taking volumetric measurements, a mark 5 cm proximal to the styloid process of the ulna was made with a pencil on both hands. The patient was instructed to slowly immerse their hands up to the marked point without making a fist. This process

Fig. 2. Kinesio taping application, dorsal.

Fig. 3. Kinesio taping application, volar.

was carried out on both hands to obtain measurements. The volume of water overflowing into the overflow container during measurement was recorded separately for each hand. To minimize the changes caused by room temperature, the volume difference between the healthy extremity and the affected extremity was calculated in milliliters.

The joint range of motion was evaluated passively in all directions (wrist flexion, wrist and extension, forearm supination and pronation, MCP flexion and extension) with the help of a goniometer according to the neutral zero method.

In this study, hand grip strength was measured. The measurement was made in kilograms using the Jamar hydraulic dynamometer (Sammons Preston Incorporated, Bolingbrook, IL) in the position recommended by the American Association of Hand Therapists. As a standard position, the upper extremity was positioned in shoulder adduction, elbow 90 degrees flexion, wrist 0-30 degrees extension, and 0-15 degrees ulnar deviation, and measurement was made.[24] Trial measurements were performed before each measurement. The trial measurement focused on the patient's recognition of the device and its correct positioning. The measurements were repeated three times and the arithmetic mean was taken. Both hands were measured in this way. Patients were verbally motivated during the measurements. When the measurement of one hand was finished and the measurement of the other hand was started, a 30-second rest break was taken.

The short version of the Arm, Shoulder, and Hand Questionnaire for Disability (Quick-DASH) was used to assess patients' functional status. Quick-DASH is a self-reporting upper extremity questionnaire designed to measure functional limitations and symptoms during activities. A lower Quick-DASH score is associated with a higher level of functionality.[25] This scale has been culturally adapted.[26] Since the patient's dominant hand may be affected and patient's literacy may be limited, the questionnaire was filled out by the evaluator face to face with the patient.

Patients' pain was assessed using the Visual Analog Scale (VAS), which is a 10-point Likert scale. According to this scale, 0 points were reported as no pain and 10 points as unbearable pain. Patients were asked to rate the pain they experienced with wrist movements based on this score.

Circumference and volume measurements were taken at baseline (immediately after removing the cast) and on day 10 (10 days after the first KT application), Quick-DASH, VAS, hand grip strength, and wrist joint range of motions measurements were taken at baseline (immediately after removing the cast), on day 5 (5 days after the first KT application) and day 10.

Ethical approval

The Clinical Research Ethics Committee was consulted before the start of the study. This trial was approved by the Ethics Committee under number 2022-20/172. In addition, the trial was registered on ClinicalTrials.gov before the start of the patient recruitment. This study was registered on ClinicalTrials.gov as NCT05623865.

Sample size calculation

In this study, there was no reference study to be used to calculate the required number of patients to make comparisons between the groups. The effect size according to the group mean and standard deviations of the Quick-DASH score (first group mean 29.93, second group mean 18.55) was calculated as 0.8212266. To obtain the sample size, G-Power analysis was performed and it was calculated that at least 28 samples from each group would be sufficient, assuming that there would be a difference between the variables as a result of the evaluation process for the alpha error of 5% and the test power of 85%. According to this power analysis, around 30 cases were included in each group, considering case and/or data loss during the follow-up process.

Statistical analysis

Research data were evaluated in a computer environment using IBM SPSS 22 (IBM Statistical Package for Social Sciences). Descriptive statistics of categorical variables are presented as numbers and percentages. Cross tables were used to compare categorical variables and "Pearson Chi-Square Test" and "Fisher Precision Test" were applied. Descriptive statistics of numerical variables are presented as

Table 1
Demographic data and baseline parameters

	KTG (n = 30)	CG (n = 31)	p
Gender, F/M (%F)	26/4 (86.7%)	27/4 (87.1%)	0.628*
Age, years	58.7 ± 9.7	58 ± 9.9	0.791†
Hypertension, yes/no (%yes)	15/15 (50%)	16/15 (51.6%)	0.900‡
Diabetes mellitus, yes/no (%yes)	3/27 (10%)	2/29 (6.5%)	0.484*
Coronary artery disease, yes/no (%yes)	3/27 (10%)	3/28 (9.7%)	0.648*
Smoker, yes/no (%yes)	3/27 (10%)	4/27 (12.9%)	0.519*
Dominant hand			
Right	26 (86.7%)	27 (87.1%)	0.628*
Left	4 (13.3%)	4 (12.9%)	
Injured hand			
Right	20 (66.7%)	18 (58.1%)	0.488‡
Left	10 (33.3%)	13 (41.9%)	
Fracture type			
Type A	13 (43.3%)	16 (51.6%)	0.809‡
Type B	7 (23.3%)	6 (19.4%)	
Type C	10 (33.3%)	9 (29%)	
Time in cast, days	36 (31%-45%)	37 (30%-45%)	0.259§
Voler tilt			
−10 dorsal	2 (6.7%)	2 (6.5%)	0.775*
Nötral	25 (83.3%)	24 (77.4%)	
+10 voler	3 (10%)	5 (16.1%)	
Radial inclination angle	18 (15-21)	18 (9-23)	0.240§
Ulnar variances, mm			
−2	4 (13.3%)	7 (22.6%)	0.699*
−1	5 (16.7%)	3 (9.7%)	
0	15 (50%)	14 (45.2%)	
+1	0 (0%)	0 (0%)	
+2	6 (20%)	7 (22.6%)	
Radial height, mm	9 (6-12)	9 (6-18)	0.673§

KTG = Kinesio taping group; CG = control group.
* Fisher's Exact Chi-square test.
† Independent samples-t test.
‡ Pearson Chi-square test.
§ Mann-Whitney U test.

mean ± standard deviation for normally distributed variables, and median (min-max) for non-normally distributed variables. The normality distribution of the numerical variables was evaluated with the "Kolmogorov Smirnov" or "Shapiro Wilk" tests. In the comparison of numerical variables with two independent groups, "T" for normally distributed variables and "Mann-Whitney U" tests for non-normally distributed variables were used. "Repeated Measures ANOVA" was used for repeated measures (in measurements on day 0, day 5, and day 10) analysis in terms of normally distributed variables. While the results were obtained by analyzing the groups with the Friedman test in terms of repetitive measurements that were not normally distributed, the Wilcoxon test was used for pairwise comparison. Bonferroni correction was applied for the p-value obtained in the pairwise comparisons of the three groups (because it included repeated measurements). Statistical significance levels were accepted as $p < 0.05$ and interpreted as $p < 0.01$ and $p < 0.001$.

Results

Demographic and clinical characteristics of KTG and CG patients were compared, and no statistically significant difference was found between the groups (Table 1). There was no difference between the groups in terms of lack of adherence values ($p = 0.12$).

At baseline (day 0), the difference in circumference between the two arms measured by the figure of eight method ($p < 0.05$) and the difference in circumference between the two arms measured at the MCP level ($p < 0.05$) were found to be higher in the KG group than in the CG group. There was no statistically significant difference between the groups in the volumetric measurements at baseline (day 0) and in the circumference measurements taken at the wrist ($p = 0.648$) and 6 cm proximal to the wrist ($p = 0.291$). The circumference difference between the affected extremity and the healthy extremity was statistically greater in the CG on the fifth day at the wrist level ($p < 0.001$) and 6 cm proximal to the wrist ($p = 0.001$). The circumference difference between the affected extremity and the healthy extremity was statistically greater in the CG on the 10th day at the wrist level ($p < 0.05$) and 6 cm proximal to the wrist ($p = 0.01$) (Table 2 and Fig. 5).

Table 2
Comparison of the edema and volume measurements according to the groups

Variables		Group	Baseline[1]	p-value	Fifth day[2] Mean ± SD	p-value	Tenth day[3] Mean ± SD	p-value	p-value (intergroup)	Difference post hoc** p-value[4]
Edema	Figure of eight (cm)	KTG	1.5 (−1/+5)	**0.026***	2.2 ± 1.25	0.693†	3 (+1/+6.5)	0.689*	**< 0.001**‡	1 < 2 1 < 3
		CG	1 (−3/+3)		2.4 ± 1.44		3 (0/+6.5)		**< 0.001**‡	1 < 2 2 < 3 1 < 3
	Metacarpophalangeal (cm)	KTG	0.5 (−0.5/+2)	**0.039***	1 (−0.5/+2.5)	0.400*	1.5 (−0.5/+2.5)	0.948*	**< 0.001**‡	1 < 2 2 < 3 1 < 3
		CG	0 (−1.5/2)		1.5 (−0.5/+8)		1.5 (−1/+6)		**< 0.001**‡	1 < 2 1 < 3
	Wrist (cm)	KTG	0.5 (−2/+4)	0.648*	0.8 ± 1.02	**< 0.001**†	1.5 (−0.5/+3.5)	**0.019***	**< 0.001**‡	2 < 3 1 < 3
		CG	0.5 (−2/+3.5)		2.1 ± 1.29		2 (0/+5)		**< 0.001**‡	1 < 2 1 < 3
	Six cm proximal of wrist (cm)	KTG	0 (−1.5/+2)	0.291*	0.5 (−1/+3)	**0.001***	0.6 ± 0.94	**0.010**†	**< 0.001**‡	1 < 2 1 < 3
		CG	0 (−2/+3.5)		0.6 ± 0.94		1.5 ± 1.73		**< 0.001**‡	1 < 2 1 < 3
Volume	Volume	KTG	45.3 ± 35.6	0.5931*	59 ± 39.1	**0.045***	75.8 ± 39	0.058*	**< 0.001**‡	1 < 2
		CG	40.2 ± 39.3		80.3 ± 42		97.6 ± 48.2		**< 0.001**‡	2 < 3 1 < 3

KTG = Kinesio taping group; CG = control group. [1]Baseline measurements; [2]Measurements on the fifth day; [3]Measurements on tenth day; [4]Wilcoxon test. ** Difference: the numbers refer to superscripts on repeat measurements and indicate which measurements differ in repeated.
P values with p < 0.05, which is considered the level of statistical significance, are expressed in bold.
* Mann-Whitney U test.
† Independent samples-t test.
‡ Friedman test.

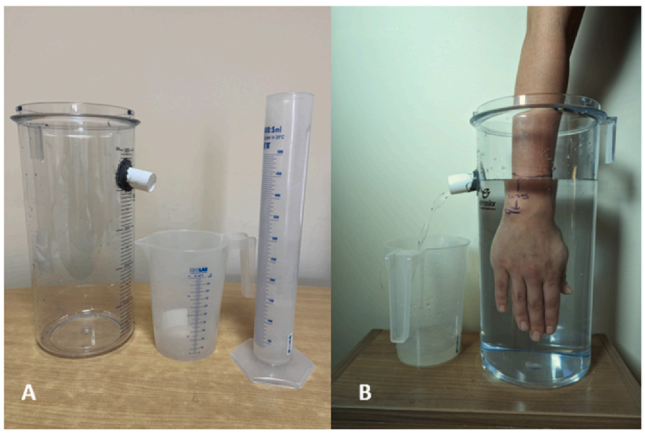

Fig. 4. Volumetric measuring device.

While the pronation angle was smaller in CG in baseline measurements $p < 0.001$, VAS, grip strength, and percentage of strength loss in the arm compared to the healthy arm were similar in both groups. The wrist extension angle ($p < 0.001$), wrist flexion angle ($p = 0.001$), and supination angle ($p = 0.001$) were higher in KG on the 10th day measurements. On the 10th day, the KTG group showed a significant improvement in grip strength ($p < 0.05$). The percentage loss of grip strength compared to the healthy side was 20.3% lower in the KTG compared to the CG group on day 10 ($p = 0.028$). VAS ratings were 50% lower for the KTG compared to the CG group on day 10 ($p < 0.001$). Quick-DASH ratings were 22.4% lower for the KTG compared to the CG group on day 10 ($p < 0.001$) (Table 3; Fig. 6).

The analysis was performed by calculating the difference between the 10th day and baseline values of the joint range of motion measurements of the patients. Accordingly, the increase in wrist extension angle ($p < 0.001$), in wrist flexion angle ($p < 0.001$), in wrist supination angle ($p < 0.001$), in wrist pronation angle ($p < 0.001$), in MCP flexion angle ($p < 0.001$), and in MCP extension angle ($p < 0.05$) were more in KTG. When the analysis was performed by calculating the VAS score difference between the day measurement and the baseline measurement, the decrease in VAS scores was lower in the CG ($p < 0.001$). The decrease in Quick-DASH score was lower in CG ($p < 0.001$). The increase in grip strength was greater in KTG ($p < 0.05$) (Table 3).

Table 3
Comparison of the range of motion, functions, pain, and strength measurements according to the groups

Variables		Group	Baseline*	*p*-value	Tenth day† Mean ± SD	*p*-value	*p*-value (intragroup)
Range of motion	Wrist flexion	KTG	40 (20-60)	0.784*	70 (50-80)	**0.005***	**< 0.001**
		CG	30 (20-80)		60 (40-80)		**< 0.001**
	Wrist extension	KTG	30 (10-50)	0.102*	60 (40-80)	**< 0.001***	**< 0.001**
		CG	20 (10-50)		40 (10-70)		**< 0.001**
	Forearm supination	KTG	50 (30-70)	0.988	70 (40-80)	**0.001***	**< 0.001**
		CG	50 (20-70)		60 (30-80)		**< 0.001**
	Forearm pronation	KTG	60 (40-90)	**0.003***	80 (40-90)	0.855*	**0.031**
		CG	70 (30-90)		80 (50-80)		**< 0.001**
	MCP flexion	KTG	58 ± 18	0.058‡	80 (60-90)	0.078*	**< 0.001**
		CG	60 ± 18		80 (40-90)		**< 0.001**
	MCP extension	KTG	0 (−10/0)	0.482*	0 (−10/0)	0.981*	**0.046**
		CG	0 (−10/0)		0 (−10/0)		0.157
Pain	VAS	KTG	6 (4-8)	0.892*	2 (0-6)	**0.004***	**< 0.001**
		CG	6 (4-8)		4 (0-8)		**< 0.001**
Functions	Q-DASH	KTG	70.5 ± 15.7	0.990‡	20 (2-42)	**0.003***	**< 0.001**
		CG	70.5 ± 15		34 (0-55)		**< 0.001**
Strength	Grip strength	KTG	0.4 (0-1.4)	0.770*	5.9 (1.5-11.5)	**0.028***	**< 0.001**
		CG	0.6 (0-2)		3.2 (1.2-17.8)		**< 0.001**
	Persentage loss§	KTG	96.7 ± 2.5	0.707‡	62.3 (37.7-79.7)	**0.005***	-
		CG	96.4 ± 2.8		78.2 (15.2-89.7)		-
Difference‖ pain	VAS	KTG	-	-	−4 (−8/0)	**< 0.001***	-
		CG	-	-	−2 (−4/0)		-
Difference‖ functions	Q-DASH	KTG	-	-	−51.8 ± 9.3	**< 0.001‡**	-
		CG	-	-	−40.2 ± 8.2		-
Difference‖ strength	Grip strength	KTG	-	-	5.3 (1.5-10.3)	**0.012***	-
		CG	-	-	2.8 (1.2-15.8)		-
Difference‖ range of motion	Wrist flexion	KTG	-	-	30 (10/60)	**< 0.001†**	-
		CG	-		20 (0/50)		-
	Wrist extension	KTG	-	-	30 (20/50)	**< 0.001†**	-
		CG	-		20 (−10/50)		-
	Forearm supination	KTG	-	-	20 (0/40)	< **0.001†**	-
		CG	-		10 (−10/30)		-
	Forearm pronation	KTG	-	-	12.5 (−10/30)	< **0.001†**	-
		CG	-		0 (−20/20)		-
	MCP flexion	KTG	-	-	20 (−20/70)	**< 0.001†**	-
		CG			20 (−10/50)		-
	MCP extension	KTG	-	-	0 (0/10)	**0.014†**	-
		CG	-		0 (0/10)		-

Q-DASH = Quick-Arm, Shoulder, and Hand Questionnaire for Disability; MCP = metacarpophalangeal joint; VAS = Visual Analog Scale; KTG = Kinesio taping group; CG = control group.
P values with p < 0.05, which is considered the level of statistical significance, are expressed in bold.
* Mann-Whitney U test
† Wilcoxon test.
‡ Independent samples-t test.
§ Percentage of strength loss relative to the healthy arm.
‖ Analysis of the difference between the measurements on the 10th day and the baseline.

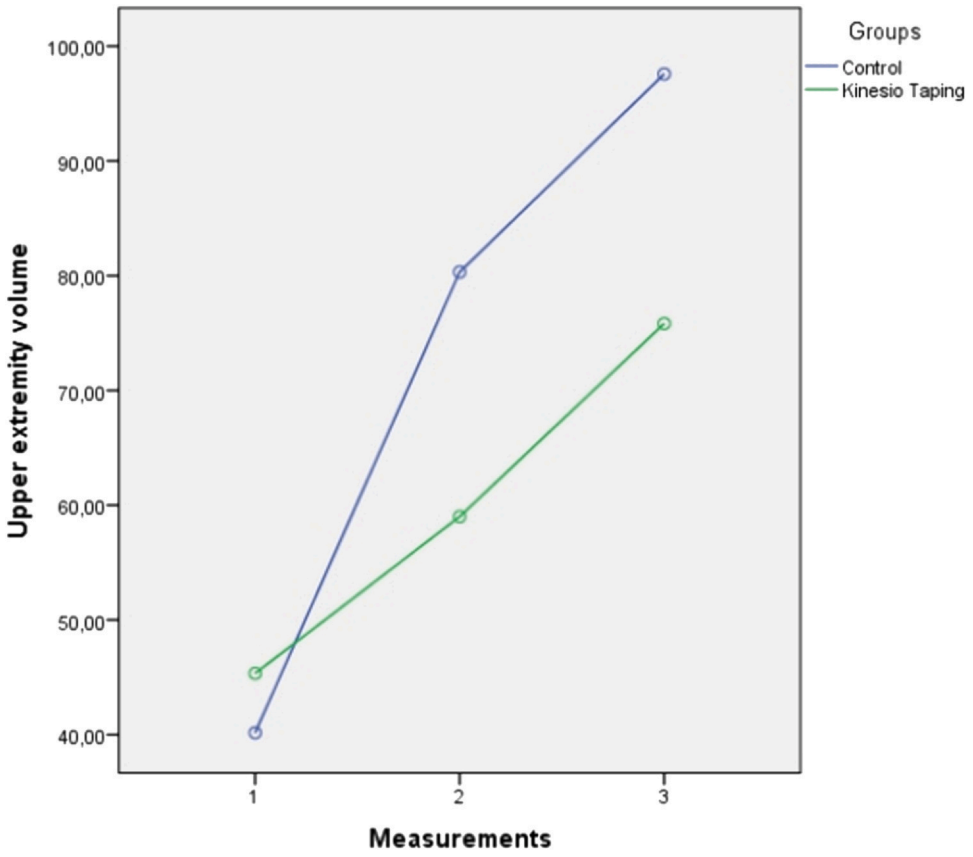

Fig. 5. Upper extremity volumes of the CG and KTG over time. CG = control group; KTG = Kinesio taping group.

Discussion

The results show that KT, added to the conventional home exercise program after cast removal in patients with a diagnosis of DRF, is effective in controlling edema in the subacute period. In addition, KT application is effective at increasing the range of motion available for wrist flexion, extension, and supination range of motion. KT used in the subacute period in this patient population is also effective in controlling pain and improving function and muscle strength. "KT application is associated with decreased edema around the forearm and lower Quick-DASH scores. Consistent with the literature, the results of this study suggest that edema in the forearm significantly impacts functionality during DRF rehabilitation.[5,6]

Although there are no studies in the literature on the efficacy of KT in patients with DRF, there is a growing body of literature on the additive effect of KT on range of motion, pain, and edema in patients undergoing orthopedic rehabilitation.[20,27] KT has different application techniques, such as analgesic, antiedema, and muscle inhibition. Studies in the literature use the EDP method to investigate its effectiveness on edema in postoperative patients.[27–29] In this study, KT was performed using the EDP technique, which also focuses on edema reduction. Edema is an important problem in the subacute rehabilitation of patients with conservatively treated DRF.[10] In the patients in this study, there was an increase in volumetric measurements and circumference increase over time after the cast was removed. However, this study showed that this increase was significantly less in the KTG. According to the results of this study, KT applied with the EDF technique is effective in edema that develops on the 5th and 10th days, that is, in the subacute period, in this patient population. In the literature, current studies have frequently applied manual massage techniques for edema management and their effectiveness has been demonstrated.[10] KT is another preferred method in edema management in different diseases.[4,14,17,20]

Manual massage is applied daily and requires experienced staff and longer periods of time. Kinesio taping also requires experienced personnel but is relatively inexpensive and does not require a daily application. It allows the follow-up of patients by being integrated into the home exercise program. All these data suggest that adding KT to the rehabilitation program immediately after the cast is removed may be an inexpensive, safe, and effective method for patients who have been cast for DRF. Efficacy needs to be demonstrated in well-designed clinical trials.

There is no consensus on the effectiveness of KT application on the analgesic effect in the early period of orthopedic rehabilitation.[18,27,29,30] According to the results of this study, the use of KT is effective in reducing pain in patients who are conservatively managed for DRF. The reduction in pain and edema is associated with functional improvement.[27] The use of KT also improves function in patients who are conservatively managed for DRFs.

In fracture patients, especially prolonged cast periods bring about a decrease in muscle strength.[31] Gaining muscle strength in this patient population forms the basis of orthopedic rehabilitation.[32] It has been reported that KT application after the anterior cruciate ligament reconstruction increases hamstring muscle strength.[18] The results showed that there was a significant increase in the grip strength of the affected extremity in KTG, as well as less loss of muscle strength compared to the intact extremity. The authors attributed the increase in muscle strength to an increase in exercise compliance and functionality with a decrease in edema and pain.

Early recovery of joint range of motion is very crucial in fracture rehabilitation, especially in upper extremity fractures.[33] In a study evaluating the efficacy of KT after total knee arthroplasty in

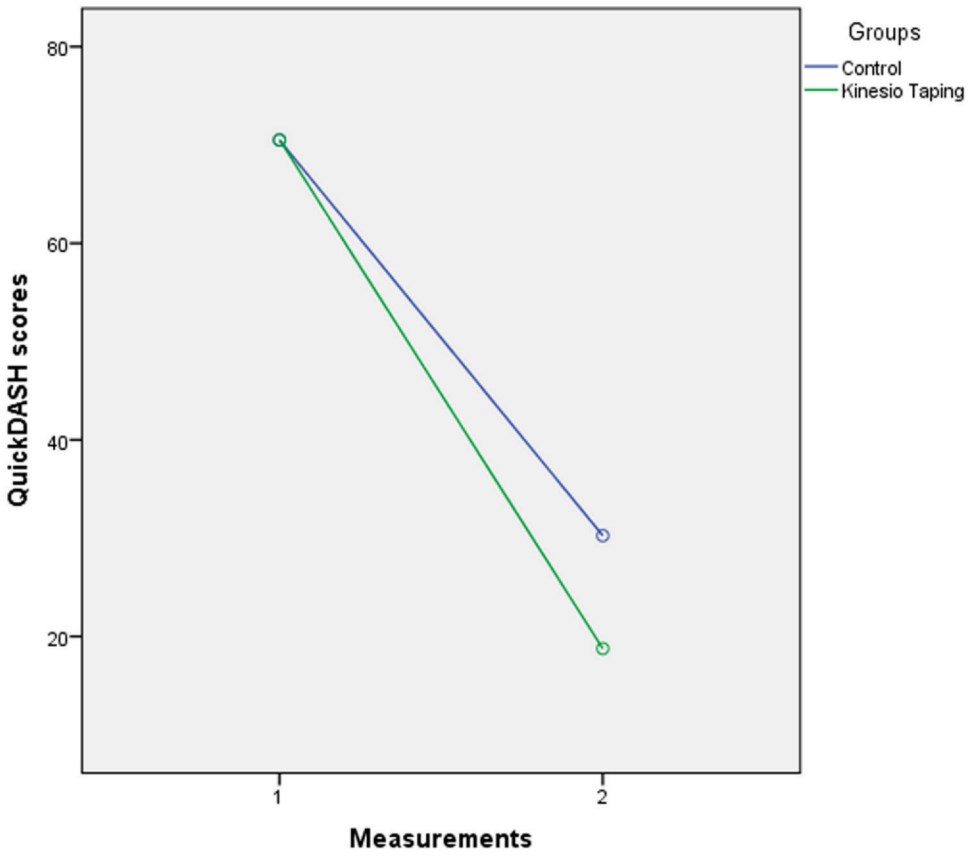

Fig. 6. Quick-DASH scores of the CG and KTG over time. DASH = Arm, Shoulder, and Hand Questionnaire for Disability; CG = control group; KTG = Kinesio taping group.

postoperative patients, nonelastic tape was used as a sham control and it was shown that the range of motion of the joint was retarded in this group. There was no difference in the range of motion of the group using KT compared with the CG, and they reported that the unique ecstatic structure of KT would not limit the range of motion of the joint.[27] It has been reported that the use of sterile KT in the acute period following ACL reconstruction can increase the range of motion of the joint.[17,18] According to the results of this study, KT application contributes to improving the joint range of motion in the subacute period.

Study limitations

The main limitation of this study is the short follow-up period. Although we evaluated the effectiveness of KT application in acute edema, studies with longer follow-up periods may be important, especially in terms of function and the range of motion. However, despite this limitation, to the best of our knowledge, this is the first study in the literature on this topic. It is advisable to conduct further studies focusing on the efficacy of computed tomography in patients undergoing surgical treatment for DRFs.

Conclusion

Although the application of a conventional exercise program in the subacute period after DRF was effective in improving clinical findings, it was found that adding KT application to the rehabilitation program was beneficial in reducing edema. It has been found that KT application is more effective in reducing pain intensity and improving functions, as well as increasing muscle strength and joint range of motion. KT may be a safe complementary therapy in this patient population. We recommend that clinical studies be conducted on the duration of administration and the method of administration of KT in patients who are followed up conservatively due to DRF.

Author contributions

L.H.: Conception, Data collection, Data analysis, Writing-reviewing and editing. B.C.K.: Conception, Intervention, Writing-original draft, Final approval. M.F.C: Data collection, Data analysis.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that there is no conflict of interest. No financial support was received for this study.

Acknowledgments

The authors gratefully thank all patients who agreed to participate in this study.

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Quiz: # A91

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

#1. The study design is
- a. qualitative
- b. RCTs
- c. retrospective cohort
- d. case series

#2. The following outcomes were tracked
- a. function
- b. edema
- c. ROM
- d. all of the above

#3. The following PRO was used
- a. Purdue Peg Board
- b. Michigan Wrist Questionnaire
- c. Quick-DASH
- d. Stanford Outcome Survey

#4. The Kinesio taping was applied
- a. circumferentially
- b. spirally volarly and dorsally
- c. longitudinally volarly
- d. longitudinally dorsally

#5. Kinesio taping was found to improve all outcome measures
- a. true
- b. false