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ORIGINAL STUDY

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Kinesiotaping therapy for midshaft clavicular fractures: a randomised trial study

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Midshaft clavicle fractures with shortening by less than 2 cm or minimal displacement without neurovascular injury can be treated conservatively. We hypothesized that kinesiotaping reduces the disadvantages of conservative treatment, such as early-phase pain, high nonunion rates, and a prolonged time to return to work, and yields better clinical and functional outcomes.

Forty patients were randomly divided into the arm slings only (group S) or arm sling with kinesiotaping therapy group (group K). The outcome measures included the visual analog scale (VAS) score, Constant score, American Shoulder and Elbow Surgeons (ASES) score, union time, magnitude of shortening, and time to return to work.

The mean follow-up period of the study was 8.5 (6-10) months. The ASES and Constant scores were significantly better in group K than in group S in the 3rd month. The mean union time was 8.60 (8-12) weeks in group S and 8.25 (6-12) weeks in group K. The mean time to return to work was 7.23 (4-12) weeks in group S and 5.37 (2-10) weeks in group K, and the difference was statistically significant (p <0.05). There was no significant difference in terms of shortening between the two groups.

Compared with an arm sling only, an arm sling with kinesiotaping can yield better clinical functional results, higher union rates, and a shorter the time to return to work due to the early control of pain and edema.

Keywords: clavicle; fracture; kinesiotaping; return to work.

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INTRODUCTION

Clavicle fractures constitute 2.6-4% of all skeletal fractures *(1)* and fractures of the middle one-third

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of the shaft (midshaft) of the clavicle account for 81% of all clavicle fractures *(2)*. The junction of the distal and middle thirds is not protected with muscle or ligamentous attachments. Thus, the midshaft region is the thinnest region of the clavicle bone. Furthermore, deforming forces of the neck muscles also increase the risk of fractures *(3)*.

Clavicle fractures are mostly seen in young, active men and occur during equestrian sports, cycling, or competition sports such as soccer and basketball. The mechanism of trauma is usually a fall over the shoulder or a direct hit to the clavicle *(4)*.

The recommended indications for conservative treatment are shortening by less than 2 cm or minimal displacement without neurovascular injury *(5)*. Figure-of-eight bandages and simple arm slings are the two most commonly used conservative treatment methods. There are no significant differences in terms of the bony union time and functional results between the two techniques, but arm slings have been shown to be more satisfactory in terms of the ease of application and pain control *(6)*.

The disadvantages of conservative treatment are that it does not provide adequate pain or edema control in the early period. Skin problems, poor functional results because of long-term immobilization or nonunion due to the risk of displacement, and shortening are other disadvantages *(6, 7)*.

Kinesiotaping supports the muscle and lymphatic systems by imitating the skin thickness and flexibility and enables mechanical rest without restricting movements in the area where it is applied *(8, 9)*. The tape lifts the skin, promoting blood and lymphatic circulation due to an increase in the subcutaneous space. Kinesiotaping is used for the conservative treatment of rib fractures and metatarsal stress fractures, including mandible fractures, to control the swelling and relieve pain after surgical treatment *(10-12)*.

We aimed to evaluate the effectiveness of the kinesiotaping technique for the conservative treatment of clavicle midshaft fractures. The study was approved by our institutional review board. We hypothesized that kinesiotaping reduces the disadvantages of conservative treatment, such as early-phase pain, high nonunion rates, and a prolonged time to return to work, and yields better clinical and functional outcomes by providing good mechanical support and neutralizing the deforming muscle forces around the fractured clavicle.

MATERIALS AND METHODS

This is a multicenter prospective randomized controlled study. Forty patients in whom conservative treatment for clavicle midshaft fractures was indicated between January 2018 and July 2019 were included. Patients with shortening by less than 2 cm or minimal displacement without neurovascular injury were included in the study. Patients with open fractures, complex fractures, pathological fractures, nonisolated fractures, bilateral midshaft clavicle fractures, and a presentation delayed by more than 24 hours posttrauma were excluded. Shortening was measured after fracture union was achieved by comparing the distance from the center of the sternoclavicular joint to the center of the acromioclavicular joint in the anteroposterior (AP), 20° and 45° cephalic and 45° caudal tilt views, including both clavicles, as recommended by Austin et al. *(3)* (Figure 1).

The patients were randomly divided into two groups: either a broad arm sling only group (group S) or an arm sling with kinesiotaping therapy group (group K). We used the sealed envelope method to ensure randomization. Each patient was given a pair of sealed envelopes that included the names of each of the groups; after the first applicant selected an envelope, the next patient was given the remaining envelope, which included the name of the other group. After the final exclusions, both groups were checked, and the groups were found to be similar in terms of age, sex distribution, fracture type, and proportion of patients for whom the dominant hand was affected. All participants were informed of the study details and signed an informed consent form.

In group S, the fractured upper extremity was immobilized in an internally rotated position with a conveniently sized arm sling for four weeks. The patients in group K additionally received kinesiotaping and used a sling for four weeks. The strip renewal time was determined to be every 5 days, considering the patient's skin type, reactions, and tape brand. At every outpatient visit the strips

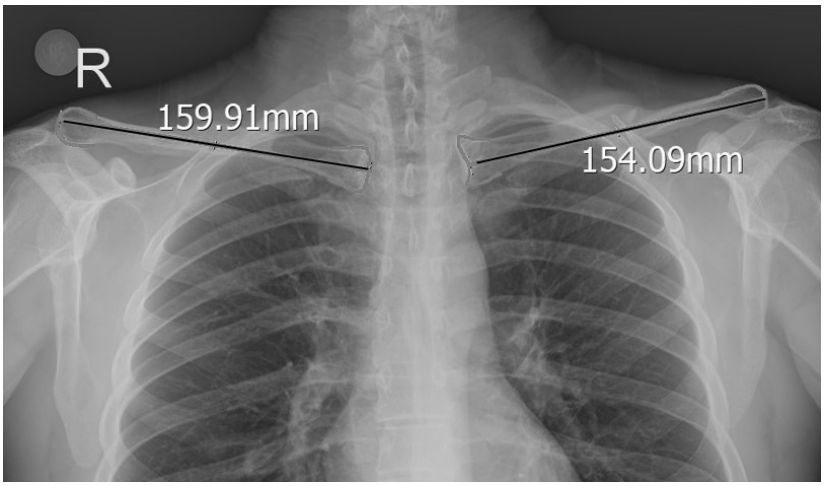

Figure 1. — Shortening was measured after fracture union by comparing the lengths of the two clavicles.

were renewed properly by physicians trained in kinesiotaping (BK, AK).

The visual analog scale (VAS) was used to assess pain. We used the Constant and American Shoulder and Elbow Surgeons questionnaires to assess function after nonunion was excluded. Radiographic union was defined as evidence of complete cortical bridging of all four projected cortices between fragments in AP and 20° cephalic radiographs *(13)*. Three different shoulder surgeons with more than 10 years of experience (KB, SSD, Yİ) evaluated the radiographs. We obtained radiographs at week 4, week 6, and once every 2 weeks until union occurred.

Both groups were recommended to perform gentle finger, hand and wrist stretches and range of motion (ROM) exercises if they could tolerate the pain during the 4-week treatment period. We started Codman pendulum exercises after 4 weeks under the supervision of a physical therapy and rehabilitation specialist. The sling was discontinued and forward elevation, external rotation and strengthening exercises were started after the sixth week.

Kinesiotaping is performed to stimulate or inhibit muscle tone to prevent displacement and shortening and to fix fractures by restoring a muscle balance. Muscle attachments play a significant role in fracture displacement. While the medial fragment is elevated by the pull of the sternocleidomastoid muscle (SCM), the lateral fragment is held inferiorly by weight of the arm and inferomedially by the pectoralis major and latissimus dorsi muscles *(13)* (Figure 2). According to the proposed method, we placed the kinesiotape from the origin of the muscle to the end of the muscle (insertion to origin) to stimulate the muscle, and we place the tape in

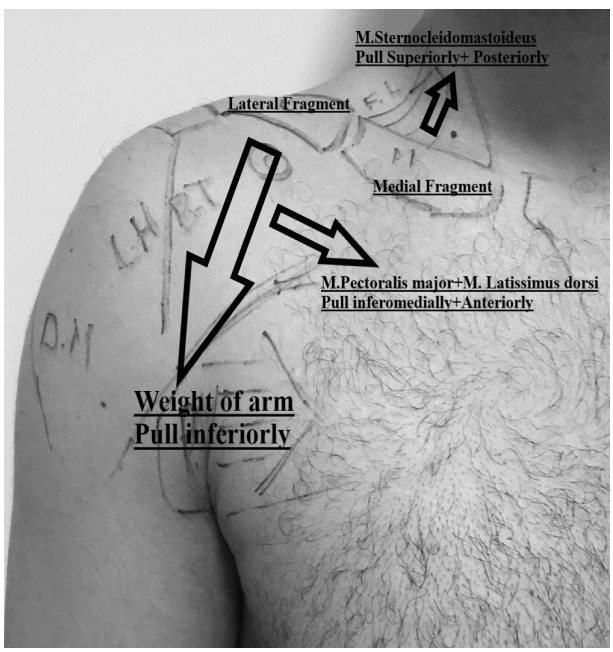

Figure 2. — The medial fracture fragment is elevated by the pulling force of the sternocleidomastoid muscle, and the lateral fragment is held inferiorly by the weight of the arm and inferomedially by the pectoralis major and latissimus dorsi muscle.

opposite direction (origin to insertion) to inhibit the muscle *(14)*.

The kinesiotape strips can be placed in formations such as the Y, I, X, fan, web, and donut formations. The formation is selected according to the desired treatment effects and the affected muscle volume. Y and I formations are the most commonly preferred formations. We used a combination of these two formations.

There are several sizes of kinesiotape strips available on the market for different use on different places on the body. We prefer to use 2-inch strips in our routine applications. The strips also come in different colors. There are red, blue, black, and beige strips. The choice of color may vary according to the age, culture, and sex of the patient. Cağlar et al. *(15)* reported that the color of the strip may affect patients' feelings (warm, cool, powerful, fresh, etc.) However, the color used does not affect the clinical results. In our study, we selected the color of tape that the patients preferred.

All anatomical landmarks were marked with a marker before the procedure was started. We applied the first strip from the medial fragment to the insertion of the deltoid to balance the elevation effect of the SCM muscle (Figure 3a). We applied the second strip from the medial fragment to the 4-5th intercostal space to increase medial fragment stabilization (Figure 3b). We applied the third strip from the triceps insertion point to the posteromedial scapular region to balance the weight of the arm (Figure 3c). We applied the fourth strip from the medial fragment to the pectoralis major insertion to make the fixation more rigid (Figure 3d). The fifth strip was applied circumferentially from the lower border of the lateral fragment to the posteromedial edge of the scapula against the medializing effect of pectoralis major muscle (Figure 3e). We applied the sixth strip from the origin of the upper fibers of the trapezius muscle to the posterior aspect of the lateral fragment to inhibit pulling the fragment superior and posteriorly (Figure 3e). We completed the procedure after the sling was applied. We performed the taping procedure every 5 days, following the manufacturer's recommendations company, because kinesiotaping is effective for 5 days before the elastic polymer diminishes.

The mean, standard deviation, median, minimum, maximum frequency, and ratio values were used to describe the data. The distribution of the data was assessed using the Kolmogorov–Smirnov test. To compare the differences between two groups, one-way ANOVA was used. $p < 0.05$ was considered significant. SPSS 22.0 software was used for all analyses.

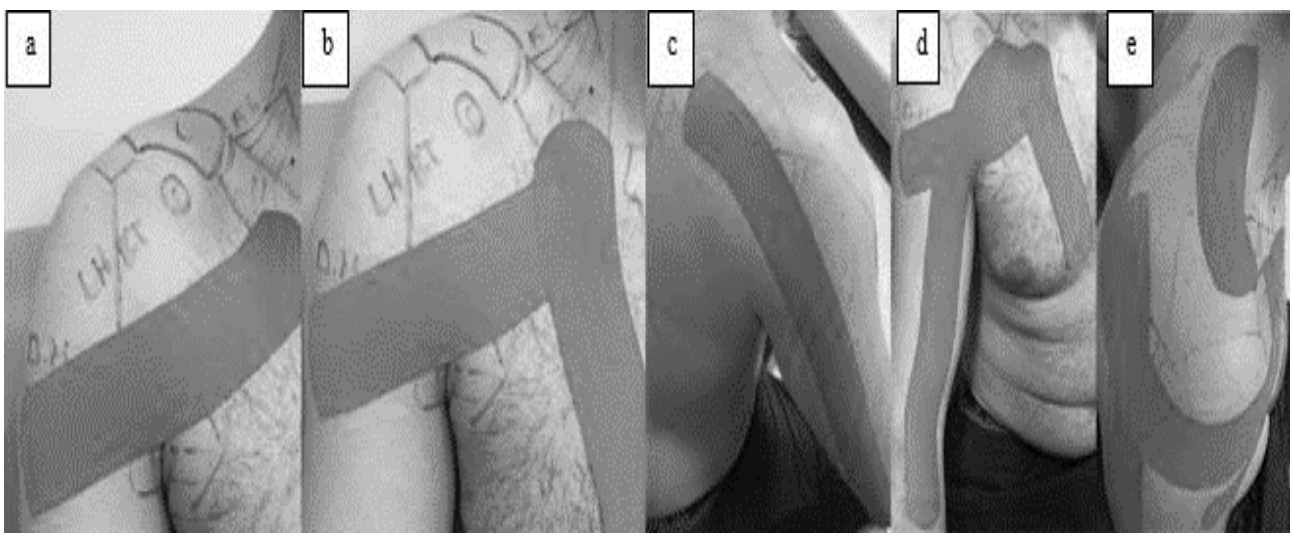

Figure 3. — The application of 6 strips on a patient (a-e).

RESULTS

The mean follow-up period of the study was 8.5 (6-10) months. The mean age was 36.1 (17-62) years. The mean age of group S was 35.7 (19-60) years, and that of group K was 36.6 (17-62) years. The kinesiotaping group (group K) had a higher mean age than did the control sling group (group S) (p: 0.813).

There were 7 left and 13 right clavicle fractures in group S and 11 left and 9 right clavicle fractures in group K. In the sling group, the AO OTA classifications were A1 in 7 patients, A2 in 2 patients, B1 in 3 patients, B2 in 6 patients, and B3 in 2 patients. The classifications for group K were A1 in 4 patients, A2 in 3 patients, B1 in 3 patients, B2 in 9 patients, and B3 in 1 patient.

The mean VAS score of group S was 5.4 on the 1st day, 3.1 on the 7th day, 1.60 on the 6th week, and 0.9 on the 6th month. The mean VAS score of group K was 4.2 on the 1st day, 2.65 on the 7th day, 1.3 in the 6th week, and 0.8 in the 6th month. The VAS score on the first day was better in group K than in group S. (p: 0.044) (Table I).

The mean ASES score in group S was 87.86 (71.6-100) in the 3rd month and 97.80 (93.30-100) in the 6th month. The mean ASES score in group K was 92.79 (79.9-100) in the 3rd month and 98.27 (90-100) in the 6th month (Table I). The ASES score was significantly better in group K than in group S in the 3rd month (p: 0.048); however, we did not observe a significant difference in the 6th month (p: 0.0573).

The mean Constant score was 84. 30 (71-96) in the 3rd month and 96.85 (94-100) in the 6th month in group S and 93.20 (76-100) in the 3rd month and 97.20 (90-100) in the 6th month in group K. The Constant score was significantly better in group K than in group S in the 3rd month (p: 0.001); however, we did not observe a significant different in the 6th month (Table I).

The mean union time was 8.60 (8-12) weeks in group S and 8.25 (6-12) weeks in group K. Union was achieved in 17 (85%) of the 20 patients in the first group (Table II). We observed nonunion in 3 patients. One of these patients was 62 years old (the oldest patient), and the other patient had a history of smoking. According to the AO OTA classification, 2 patients had type B3 fractures, and 1 patient had a type B2 fracture. In group K, 19 (95%) of the 20 patients exhibited union. The patient with nonunion had a high-energy trauma (motorcycle accident) and had a type B3 fracture according to the AO OTA classification. We operated on the nonunion patients in both groups. Open reduction and internal fixation (plate osteosynthesis) were performed. Union was achieved in all patients at the end.

There were no differences in the occupational demands or type of work between the groups. The mean time to return to work or school in group S was 7.23 (4-12) weeks. Thirteen of the 17 healed patients were laborers or students (2 students). The mean time to return to school for the students was 4 weeks and the mean time to return to work for the 3 light laborers was 5.3 weeks. The mean time to return to work or school in group K was 5.37 (2-10)

Table I. — Comparison of two groups according to the VAS, ASES, and Constant scores.

Mean		Group S		Group K		
		± SD	Mean	± SD	p score	
VAS	1st day	5.40	1.78	4.20	1.85	0.044
	7th day	3.10	1.12	2.65	0.59	0.120
	6th week	1.60	0.75	1.30	0.92	0.267
	6th month	0.9	0.64	0.80	0.62	0.618
ASES	3rd month	87.86	8.76	92.79	6.28	0.048
	6th month	97.8	2.53	98.27	2.70	0.573
Constant	3rd month	84.3	8.00	93.20	6.96	0.001
	6th month	96.85	2.41	97.20	3.40	0.709

Table II. — Comparison of the two groups according to the union time, magnitude of shortening, and time to return to work

	Group S		Group K		
	Mean	± SD	Mean	± SD	p score
Union Time (weeks)	8.60	1.14	8.25	1.61	0.434
Shortening (mm)	8.50	1.79	8.40	1.60	0.853
Back to work or school (weeks)	7.20	1.99	5.35	1.66	0.003

weeks. The mean time to return to work or school for the 3 light laborers and 1 student was 2 weeks. The time to return to work was significantly shorter in group K than in group S ($p < 0.05$) (Table 2).

The mean magnitude of shortening was 8.50 (4-11) mm in the sling group and 8.40 (5-11) mm in group K (p: 0.0853). There was no significant difference between the two groups in terms of shortening (Table II).

The range of motion was normal, and there were no restrictions in either group. There were cosmetic complaints due to bone prominence in 3 patients in group S and 2 patients in group K. Superficial skin irritation occurred in 2 patients in group K.

DISCUSSION

Arm slings are frequently used for the treatment of nondisplaced or minimally displaced clavicle midshaft fractures in particular *(16)*. Slings have disadvantages such as a risk of failure to completely relieve pain in the early recovery period, a risk for nonunion or malunion because of insufficient fracture immobilization, cosmetic problems due to bony prominence and the pulling of muscles, and a prolonged time to return to work or previous activities *(16, 17)*.

Ersen et al. *(6)* reported slings to be superior to the figure-of-eight bandages in terms of patient comfort and early pain management. Hill et al. *(7)* evaluated 52 patients who were treated conservatively. They reported poor functional results for 16 patients (31%). In our study, the ASES and Constant questionnaires were used to evaluate the functional status of patients in the 3rd and 6th months. The functional scores of both groups were satisfactory. Group K was found to be statistically superior to group S in the 3rd-month in terms of function. A functional evaluation was performed only when there was bony union in either groups.

The nonunion rates in our study are consistent with those for conservative treatment reported in the literature. Qin et al. *(1)* reported the nonunion rate for nine randomized clinical trials to be 11%. Woltz et al. *(16)* compared the nonunion results of open reduction plate fixation and conservative treatment, and they reported the rate of nonunion for conservative treatment to be 16%. This rate was 2% for the open reduction group. The total nonunion rate in our study was 10%. When we compared the two groups, the nonunion rate was 5% in group K and 15% in group S. The nonunion rate was significantly in group K (p: 0.292). Three of the 4 nonunion patients had multifragmentary fracture patterns corresponding to type B3 in the AO OTA classification system.

According to previous studies, the mean time to return to work (RTW) after conservative treatment of clavicle midshaft fractures varies widely from 4-16 weeks *(6, 18, 19)*. The mean time to RTW was 5.37 weeks in group K and 7.23 weeks in group S. It was significantly shorter in group K ($p < 0.05$). Our result is consistent with others reported in the literature. This period was 2 weeks for students and nonheavy workers. Pain control plays an important role in the time to RTW. Kinesiotaping reduces edema and decreases the time to RTW *(12)*.

The most undesirable result of conservative treatment is shortening because the development of shortening cannot be prevented completely *(19)*. Many studies have reported that shortening by more than or equal to 2 cm is associated with higher rates of nonunion or symptomatic nonunion and the chance of unsatisfactory results *(7, 16, 20, 21)*.

However, in their study comparing the figure-of-eight bandages with the sling, Ersen et al. *(6)* showed that shortening by more than 15 mm does not cause worse functional results. However, Figueiredo et al. *(22)* showed that there is no correlation between shortening by 2 cm and functional results at the end of the first year, although the early VAS scores were low. In our study, there was no significant difference between groups in terms of the magnitude of shortening. The mean magnitude of shortening was 8.42 mm in group K and 8.58 mm in group S. There was no correlation between the magnitude of shortening and functional scores.

There were no differences between groups in cosmetic skin problems. Five patients had cosmetic complaints, but no additional treatment was administered. In 2 patients who developed skin irritation during the application of kinesiotape, the problem was resolved by decreasing the tension of the strips and changing their location.

The short follow-up time (under 1 year) and the small number of patients are some of the limitations of our study. Another limitation is that proper tension could not be standardized in the application of strips during the application of kinesiotape. Since the tension is related to the experience of the practitioners, we tried to standardize the tension applied across practitioners before the study started.

CONCLUSION

We concluded that kinesiotaping with a shoulder-arm sling would increase stabilization and decrease edema and pain in the conservative treatment of clavicle midshaft fractures in the early period. This method may yield better clinical functional results, increase the union rate, and reduce the time to return to work due to the early control of pain and edema.

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