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Kinesio Taping for temporomandibular disorders: Single-blind, randomized, controlled trial of effectiveness

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Abstract.
BACKGROUND: Data regarding the effectiveness of Kinesio Taping in temporomandibular disorders (TMD) is scarce.
OBJECTIVE: To determine the efficacy of Kinesio Taping (KT) in patients with TMD.
METHODS: Patients with TMDs were randomized into experimental and control groups. The experimental group ($n = 14$) received KT in combination with counseling and jaw exercise, whilst controls ($n = 14$) were given the regimen of counseling and exercise alone. Jaw movements, Visual analogue scale (VAS) scores and self-reported measures (functional limitation and masticatory efficiency) were evaluated at baseline, first and sixth weeks of the treatment. Biobehavioral questionnaire was filled out at baseline and at sixth week.
RESULTS: Active mouth opening improved more in the experimental group than controls ($p = 0.003$). In the experimental group, VAS for temporomandibular joint, masticatory efficiency and functional limitation improved significantly at the sixth week when compared to baseline ($p = 0.011$, $p = 0.001$ and $p = 0.001$, respectively), but not in controls. Subjective treatment efficacy was higher in the experimental group than that of controls ($p = 0.000$). Pain, depression and disability scores reduced significantly in the experimental group ($p = 0.001$, $p = 0.006$ and $p = 0.01$, respectively), but not in controls.
CONCLUSION: In conclusion, KT in combination with counseling and exercise is more effective than counseling and exercise alone in TMDs.

Keywords: Kinesio taping, temporomandibular disorder, temporomandibular joint, temporomandibular pain

1. Introduction

Temporomandibular disorder (TMD) is characterized by several issues regarding not only the joint itself, but also the associated structures such as masticatory muscles [1]. TMD often presents with pain, temporomandibular joint (TMJ) sounds, limited mouth opening and deviations in mandibular movements [2]. Over 25% of the general population experience TMD during their lifespan. It predominantly affects young to middle-aged females [1,3].

Diagnosis of TMD was set upon two main diagnostic categories: arthrogenous and myogenous. The most widely used diagnostic criteria which specifies a dual-axis diagnostic system for TMD is the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) developed by Dworkin and Le Resche [4].

There are several treatment approaches for TMD including surgical and non-surgical methods. Surgical management which is required for a limited number of patients comprises of arthrosynthesis or arthroscopy of the TMJ. Non-surgical methods are the first step of treatment for TMD. Education and counseling con-

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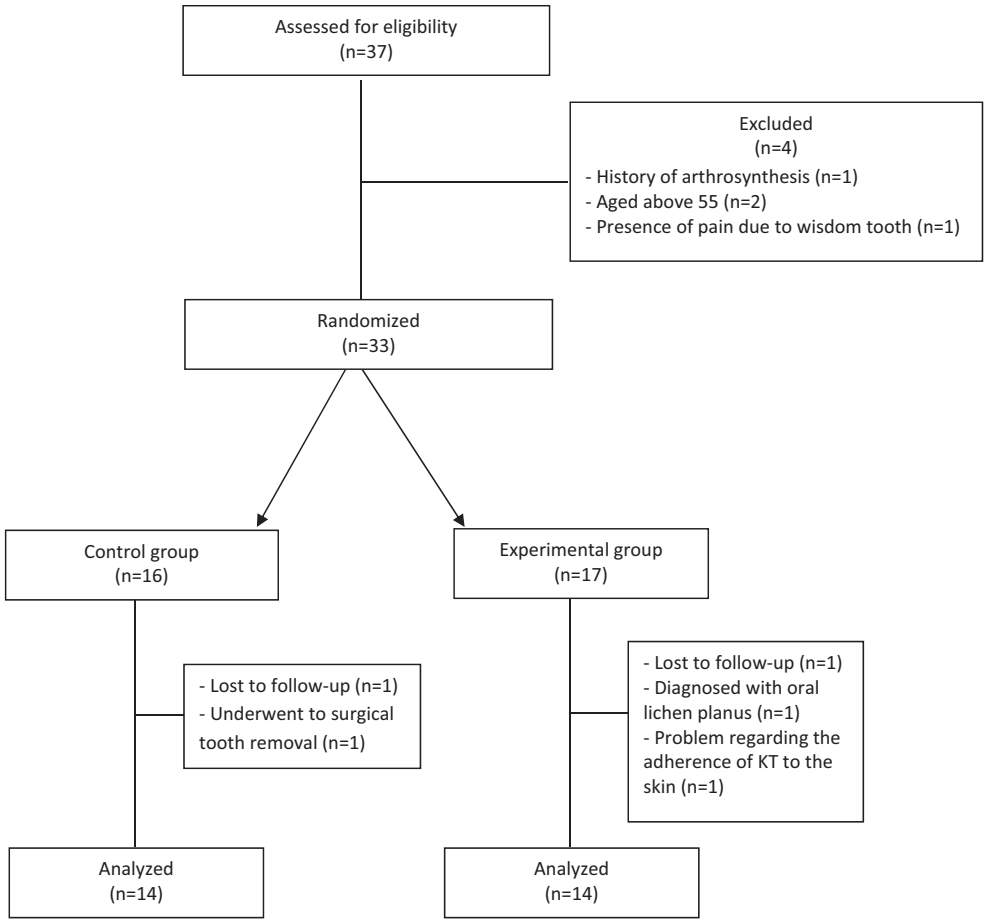


Fig. 1. Flowchart of the study.

stitute the cornerstone of non-surgical treatment. Occlusal splints, medications and physiotherapy techniques such as jaw exercises and electrotherapy are other components of conservative treatment [1,2].

The Kinesio Taping technique was first described by Dr Kenzo Kase, a Japanese chiropractor, in 1970s. Kinesio tape is a flexible, latex free adhesive that can be stretched 40% to 60% of its resting length. The tape is as thin as epidermis of the skin which avoids the sensory stimuli and the perception of its weight. The kinesio tape includes a polymer elastic strand wrapped by 100% cotton fibers which allows quick drying of body moisture [5,6].

Kinesio Taping was studied in a wide range of painful disorders including musculoskeletal pathologies [7–9]. Moreover, there are a number of studies using this technique in postoperative treatment of maxillofacial surgery [10–12]. However, knowledge regarding the efficacy of Kinesio Taping in TMD is limited. Therefore, in this randomized, controlled, single-blind study, we aimed to evaluate the additional effects of Kinesio Taping, if any, over a standard regimen of counseling and jaw exercise in patients with TMD. It was hypothesized that Kinesio Taping would provide an additional improvement in terms of pain relief and functional mobility in TMD.

2. Materials and methods

2.1. Patient selection

The study sample consisted of patients diagnosed with myofascial pain, arthralgia, and/or disc displacement with reduction according to the RDC/TMD by a dentist. Exclusion criteria were as follows: (1) history of any surgical procedures of the TMJ including arthrosynthesis and arthroscopy, (2) presence of any inflammatory joint disease such as ankylosing spondylitis and rheumatoid arthritis, (3) history of trauma to the

jaw, (4) being older than 55 years of age, (5) any known tape allergy (6) any reason of orofacial pain other than TMD.

2.2. Interventions

During a period of 6 months, a total of 33 patients were prospectively assigned for the treatment of TMD. Written informed consent was obtained from each participant and the study was approved by the local ethical committee of Medical Faculty. The participants were randomized into "experimental" and "control" groups by an envelope method. Both groups received lifestyle counseling along with instructions for jaw exercises. Additionally, Kinesio Taping was applied to the participants of the experimental group (Fig. 1).

A standard exercise regimen was tailored to all participants. It consisted of range of motion exercises to the jaw and isometric strengthening exercises to the masticatory muscles. Range of motion exercises comprised of right and left laterotrusions, active mouth opening and protrusion. Strengthening exercises were performed by making all four movements towards resistance, which was obtained by patients' own fingers, in order to achieve an isometric contraction for 8 seconds. Exercises were repeated 8 times per session, 3 times a day for 6 weeks [2].

Kineso Taping was applied to the experimental group two times by a certified physician (ICB, first author). Each application lasted for 3 days. Kinesio Tex Gold with a width of 5 cm was used as taping material. The skin was cleaned with alcohol prior to the application in order to remove oils, lotions and moisture, which might limit the adhezive's ability to adhere to the skin. Shaving of the area to be treated was provided when necessary. Taping technique described by Kenzo et al. for TMJ was performed as follows: a "Y" shaped kinesio strip was prepared according to the measurements for each individual. The practitioner asked the patient to open and close his/her jaw in order to locate the TMJ. The base of the "Y" strip was placed slightly posterior to the TMJ with no tension. The superior tail of the strip was applied with very light tension (0–15% of available) after pulling the skin from temporomandibular joint to the nose. Later on, inferior tail of the "Y" strip was applied by using the same technique (Fig. 2) [6].

2.3. Outcome measures

The following assessments were performed at baseline, after the removal of the second kinesio tape (first week) and at the sixth week of the treatment period by an assessor who is blinded to the group allocation [13]:



Fig. 2. Application of Kinesio Taping.

- Active mouth opening (mm) and laterotrusions (mm)
- Visual analogue scale (VAS) for TMJ pain at rest (cm)
- Visual analogue scale for TMJ, masseter muscle and temporal muscle pain on palpation (cm)
- Five-point Likert scale (0–4) for masticatory efficiency (4 represents "eating only semi-liquid" whilst 0 represents eating solid-hard food)
- Five-point Likert scale (0–4) for functional limitation during usual jaw movements (0 represents the "absence of functional limitation", while 4 represents "severe limitation of the function of TMJ") [13]

In addition, RDC/TMD Axis II Biobehavioral Questionnaire was filled out by all subjects at baseline and at the sixth week of the treatment period. Pain-related disability, pain intensity and depression level were calculated by means of the description in Axis II of the RDC/TMD. Accordingly, disability, level of depression and intensity of chronic pain were evaluated by questions number 10–13, 20 and 7–9, respectively [4]. Subjective efficacy of the treatment was also assessed by the patients at the first week and sixth week, by a Five-point Likert scale (0–4) in which 0 represents "poor efficacy", whilst 4 represents "excellent efficacy" [2,13].

Table 1
Baseline demographic and clinical indices of the groups

	Control group $n = 14$	Experimental group $n = 14$	p
Sex (male/female)[a]	3 (21.4)/11 (78.6)	1 (7.1)/13 (92.9)	0.596
Site (right/left)[a]	8 (33.3)/4 (66.7)	8 (57.1)/6 (42.9)	0.267
Age (year)[b]	31.1 (10.1)/31.5 (17–44)	31.6 (11.5)/29.5 (19–58)	0.903
Education (year)[b]	11.4 (3.2)/12.5 (5–15)	10.7 (5.6)/13 (0–17)	0.711
Active maximal mouth opening (mm)[b]	34.0 (6.8)/34.5 (20–45)	30.6 (9.4)/29 (21–50)	0.222
Laterotrusion (right) (mm)[b]	4.4 (1.5)/4 (2–8)	4.9 (1.1)/5 (3–7)	0.197
Laterotrusion (left) (mm)[b]	4.4 (1.3)/4.5 (2–6)	4.7 (1.1)/4.5 (3–6)	0.584
VAS for temporal muscle (cm)[b]	1.2 (2.4)/0 (0–7)	2.6 (3.7)/0.5 (0–10)	0.230
VAS for masseter muscle (cm)[b]	2.5 (3.2)/1 (0–9)	3.4 (3.4)/3.5 (0–8)	0.482
VAS for TMJ (cm)[b]	2.6 (3.2)/1.5 (0–9)	3.5 (3.3)/4 (0–9)	0.521
Masticatory efficiency[b]	2.2 (1.3)/2 (0–4)	2.6 (0.8)/2 (0–4)	0.462
Functional limitation[b]	2.1 (1.1)/2 (0–4)	2.9 (0.6)/3 (0–4)	*0.024*
Biobehavioral questionnaire			
Pain score[b]	60.9 (21.5)/66.7 (23.3–90)	58.8 (19.2)/61.7 (23.3–90)	0.628
Depression score[b]	1.1 (0.7)/0.9 (0–2.5)	1.5 (0.8)/1.3 (0.4–3.4)	0.154
Disability score[b]	0.9 (1.3)/0.5 (0–4)	1.4 (1.3)/1.5 (0–4)	0.288

VAS: Visual Analogue Scale, TMJ: Temporomandibular joint; [a]represents n (%), [b]represents mean (SD)/median (min-max).

2.4. Statistical analysis

The statistical analysis of the study was carried out by using SPSS version 17.0 for Windows (SPSS Inc., Chicago, IL, USA). For each continuous variable, normality was checked. Since the data was not distributed normally, appropriate non-parametric tests were chosen. Mann-Whitney U test was used to compare the mean values between-groups. The categorical variables between the groups were analyzed by using the Chi square test or Fisher's exact test. Time dependent intragroup data were analyzed by Friedman test. Within group differences toward the baseline values were analyzed by Wilcoxon rank sum test. Bonferroni's correction was applied ($p < 0.05$/n; where $n =$ number of comparisons) when multiple comparisons were made and a p value < 0.017 was considered as significant in that case. Results were given as mean $\pm$ standard deviation/median (minimum-maximum). Results with p values less than 0.05 were reported as statistically significant.

3. Results

Thirty-seven referred patients who were diagnosed with TMD were assessed for eligibility. Four of them were excluded according to the exclusion criteria. Remaining patients ($n = 33$) were allocated randomly into control and experimental groups. Five of these patients discontinued the study, due to several reasons, which were stated in the flowchart diagram (Fig. 1). Eventually, the analyses were performed on 28 patients (14 in the control group, 14 in the experimental group).

Baseline demographic and clinical indices of the groups were given in Table 1. Control and experimental groups were similar to each other in terms of the baseline characteristics including demographic data, determinants of the Biobehavioral Questionnaire and pain intensities, with the exception of self-reported functional limitation, which was significantly worse in the experimental group than controls ($p = 0.024$).

Table 2 reveals the results of the comparison of changes in clinical parameters over time, within and between groups. Regarding the active mouth opening, both groups improved significantly from baseline. Nevertheless, the improvement from the first week to the sixth week was not significant in the control group ($p = 0.032$). However, it showed significance in the experimental group ($p = 0.003$). The change in baseline active mouth opening was significantly higher in the experimental group, on the first and sixth week ($p = 0.034$ and $p = 0.003$, respectively). Additionally, from the first to the sixth week, experimental group improved better than controls, in terms of mouth opening ($p = 0.031$). In terms of the right laterotrusion, significant improvement was achieved by time in the experimental group, but not in controls. Regarding the left laterotrusion, both groups showed similar improvements from baseline to both first and sixth week follow-ups. Although temporal VAS decreased significantly more, from baseline to week 1 and week 6 in the experimental group ($p = 0.016$ and $p = 0.005$, respectively), the improvement from the first to the sixth

Table 2
Comparison of changes in clinical parameters over time, within and between groups

	Baseline	1st week	6th week	p_{1-0}	p_{6-0}	p_{6-1}
Active maximal mouth opening (mm)						
Control group	34.0(6.8)/34.5(20–45)	35.8(6.9)/37.0(22–45)	37.3(7.1)/38.5(22–45)	*0.002*	*0.002*	0.032
Experimental group	30.6(9.4)/29.0(21–50)	35.0(9.3)/36.0(24–50)	38.6(8.1)/39.0(27–50)	*0.002*	*0.001*	*0.003*
p_{ck}	0.222	0.800	0.678	*0.034*	*0.003*	*0.031*
Laterotrusion (right) (mm)						
Control group	4.4(1.5)/4.0(2–8)	5.1(1.6)/5.0(3–8)	5.3(1.8)/5.0(3–8)	0.04	0.026	0.317
Experimental group	4.9(1.1)/5.0(3–7)	6.4(1.4)/6.0(5–10)	7.1(1.3)/7.0(5–10)	*0.003*	*0.001*	*0.013*
p_{ck}	0.197	0.05	*0.009*	0.369	*0.014*	0.115
Laterotrusion (left) (mm)						
Control group	4.4(1.3)/4.5(2–6)	5.1(1.2)/5.5(3–7)	5.6(1.5)/6.0(3–8)	*0.014*	*0.004*	0.034
Experimental group	4.7(1.1)/4.5(3–6)	6.0(1.1)/6.0(4–8)	6.6(0.9)/7.0(5–8)	*0.003*	*0.001*	0.021
p_{ck}	0.584	0.113	*0.043*	0.103	0.075	0.445
VAS-temporal muscle (cm)						
Control group	1.2(2.4)/0(0–7)	1.5(2.4)/0(0–7)	1.4(2.3)/0(0–7)	0.180	0.414	0.317
Experimental group	2.6(3.7)/0.5(0–10)	0.9(2.2)/0(0–7)	0.2(0.8)/0(0–3)	0.042	0.018	0.180
p_{ck}	0.230	0.264	0.068	*0.016*	*0.005*	0.494
VAS-masseter muscle (cm)						
Control group	2.5(3.2)/1(0–9)	1.8(2.5)/0.5(0–8)	1.6(2.7)/0(0–9)	0.246	0.216	0.750
Experimental group	3.4(3.4)/3.5(0–8)	1.4(1.7)/0(0–4)	0.4(0.9)/0(0–3)	0.030	*0.011*	0.061
p_{ck}	0.482	0.745	0.237	0.169	0.090	0.169
VAS-TMJ (cm)						
Control group	2.6(3.2)/1.5(0–9)	2.5(2.7)/2.5(0–8)	2.4(2.7)/2(0–8)	0.671	0.719	0.915
Experimental group	3.5(3.3)/4.0(0–9)	1.6(2.3)/0(0–8)	0.7(1.4)/0(0–4)	0.021	*0.011*	0.248
p_{ck}	0.521	0.301	0.057	0.129	*0.046*	0.532
Masticatory efficiency						
Control group	2.2(1.3)/2(0–4)	2.5(1.0)/2(1–4)	2.5(0.9)/2(1–4)	0.157	0.336	1.0
Experimental group	2.6(0.8)/2(2–4)	1.0(0.6)/1(0–2)	0.6(0.9)/0(0–3)	*0.001*	*0.001*	0.132
p_{ck}	*0.462*	*0.000*	*0.000*	*0.000*	*0.000*	0.198
Functional limitation						
Control group	2.1(1.1)/2(0–4)	2.1(1.2)/2(0–4)	2.0(1.0)/2(0–4)	0.655	0.414	0.564
Experimental group	2.9(0.6)/3(2–4)	1.2(0.8)/1(0–3)	0.6(0.8)/0.5(0–3)	*0.001*	*0.001*	*0.011*
p_{ck}	*0.024*	*0.029*	*0.001*	*0.000*	*0.000*	*0.031*
Subjective treatment efficacy						
Control group	–	0.4(0.6)/0(0–2)	0.5(0.7)/0(0–2)	–	–	0.317
Experimental group	–	3.0(0.9)/3(2–4)	3.4(0.7)/3.5(2–4)	–	–	0.132
p_{ck}	–	*0.000*	*0.000*	–	–	0.423

VAS: Visual Analogue Scale, TMJ: Temporomandibular joint; Values are given as mean (SD)/median (min-max); p_{1-0}: p value for comparison of 1st week 1and baseline (week 0), p_{6-0}: p value for comparison of 6th week and baseline (week 0), p_{6-1}: p value for comparison of 6th week and 1st week, p_{ck}: p value for comparison of experimental and control groups; p values below 0.05 and 0.017 were considered as "statistically significant" in between group comparisons and within group comparisons, respectively.

week was similar between groups ($p = 0.494$). There was no difference regarding the reduction of masseter muscle VAS between groups. Although the reduction in TMJ VAS from baseline to sixth week was significantly higher in the experimental group than that in controls ($p = 0.046$), there was no statistically significant improvement from week 1 to week 6, in both groups. Regarding the self-reported clinical measures including functional limitation and masticatory efficiency, no significant improvement from baseline was observed in controls. However, improvement in the experimental group at first week was significantly favorable. While functional limitation continued to improve after the first visit in the experimental group, the self-reported masticatory efficiency remained almost the same beyond first week. Patients in the experimental group reported higher subjective treatment efficacy than those in the control group, both at the first and sixth week-follow-ups ($p = 0.000$ for both weeks). The reported efficacy at the second follow-up (sixth week) was similar with that at the first follow-up ($p = 0.132$).

Comparison of the results derived from Biobehavioral Questionnaire, between groups and within groups over time was given in Table 3. This comparison revealed that, all parameters of the Biobehavioral Questionnaire (pain, depression and disability scores) improved significantly in the experimental group, but not in controls. In addition, change from baseline to the sixth week was significantly higher in the experimental group than in controls, regarding the pain, depression

Table 3
Comparison of the results derived from Biobehavioral Questionnaire over time, within and between groups

	Baseline	6^{th} week	Delta (difference between baseline and 6^{th} week)	p_{6-0}
Pain score				
Control group	60.9(21.5)/66.7(23.3–90)	59.5(17.9)/61.7(23.3–83.3)	1.4(8.5)/0(–10–23)	1.000
Experimental group	58.8(19.2)/61.7(23.3–90)	22.2(24.5)/18.9(0–73.3)	36.6(21.8)/31.7(7–70)	*0.001*
p_{ck}	0.628	*0.001*	*0.000*	
Depression score				
Control group	1.1(0.7)/0.9(0–2.5)	0.9(0.6)/1(0–1.9)	0.1(0.5)/0.1(0–1)	0.208
Experimental group	1.5(0.8)/1.3(0.4–3.4)	0.9(0.6)/1(0–1.8)	0.6(0.6)/0.6(0–2)	*0.006*
p_{ck}	0.154	0.890	*0.046*	
Disability score				
Control group	0.9(1.3)/0.5(0–4)	0.6(1.0)/0(0–3)	0.3(0.6)/0(0–2)	0.102
Experimental group	1.4(1.3)/1.5(0–4)	0.2(0.4)/0(0–1)	1.2(1.2)/1.5(0–3)	*0.010*
p_{ck}	0.288	0.284	*0.026*	

Values are given in mean (SD) /median (min-max); p_{6-0}: p value for comparison of 6^{th} week and baseline (week 0), Wilcoxon test within each group, p_{ck}: p value for comparison of experimental and control groups, Mann Whitney U test between groups.

and disability scores ($p = 0.000$, $p = 0.046$ and $p = 0.026$, respectively).

4. Discussion

The hypothesis examined in this study is that KT along with counseling and exercise is more effective than counseling and exercise alone, in TMDs. The results of the study confirmed this hypothesis in several ways: KT which was added to counseling and exercise regimen was found to be more effective in terms of relieving pain, increasing ROM, improving disability and psychological status.

Counseling and exercise are widely used techniques in TMDs with favorable results in the literature. In a randomized-controlled trial by Nimela et al. [2], the efficacy of counseling and masticatory muscle exercises alone, found to be similar with the efficacy of stabilization splints, both in relieving pain and increasing active maximal mouth opening and laterotrusions. In accordance with this finding, Magnusson et al. [14] also showed that therapeutic jaw exercises, managed by a dentist or a dental assistant had positive and equal effect on the symptoms of TMD when compared to interocclusal appliance. In spite of the beneficial effects of counseling and exercise which was confirmed by several studies in the literature, the present study revealed that the benefits are significantly higher, both in short and long term when KT was added to counseling and exercise regimen. For instance, although exercise regimen and counseling without KT provided an improvement in mouth opening and right laterotrusion, this improvement was less than that was achieved by exercise and counseling in combination with KT. Moreover, active mouth opening continued to improve after the removal of last KT (beyond first week) in the experimental group, but not in controls. Since exercise and counseling alone failed to provide any pain relief effect, which was significant in the experimental group, this might serve as an explanation to the further improvement of joint movement in the experimental group. In other words, the further increase in range of motion in the experimental group could be attributed to the pain relief effect of KT which might have facilitated the patients to perform the range of motion exercises more effectively without pain. Self-reported measures of functional limitation and masticatory efficiency improved in the experimental group, whilst controls showed no significant difference. The beneficial effects on function and masticatory efficiency could be attributed to both increased mobility and decreased pain scores achieved by KT. Subjective treatment efficacy, which is another self-reported measure, was higher than that of controls both at the first (first week) and second visit (sixth week).

In terms of the Biobehavioral questionnaire, there was again supremacy of combined therapy (KT and exercise and counseling) to exercise and counseling alone. Although experimental group improved significantly regarding the three parameters of this questionnaire (pain, depression and disability), controls failed to achieve this improvement. Pain relief effect of KT could be explained as follows: the elastic tape can create folds and lifts the skin which leads to a charge of fluid flow from high-pressured areas to the low-pressured areas underneath the skin. The increase in blood and lymph flow may reduce inflammation which leads to the reduction of pressure on pain receptors [6,15,16]. In the present study, KT's pain relief ef-

fect, along with the success in improving in disability, might have played key role on the reduction of depression scores.

During the last years, many studies on the effectiveness of KT in musculoskeletal disorders have been carried out. Most of these studies dealt with the disorders regarding the upper/lower extremities [9,15,17–20], as well as, neck [7,8] and low back pain [21]. The published data on KT identified moderate evidence supporting immediate pain-relief effect of KT in musculoskeletal disorders [5]. Nevertheless, support indicating its long term effect is lacking. In the current study, last follow-up visits were performed at the sixth week. When compared to baseline values, experimental group showed significant improvement in range of motion, pain (on masseter and TMJ), function and depression scores at that time. However, change from the first to the second visit, was observed only in range of motion and self-reported functional limitation. The other outcome measures remained almost the same.

Despite the extensive research on KT, it has been introduced to the maxillofacial area almost recently [12, 13]. Moreover, knowledge regarding the potential effect of KT on TMJ is limited [22]. Ristow et al. [12] investigated the effectiveness of KT on postoperative swelling, pain and trismus in 26 patients who underwent open reduction and internal fixation of mandibular fractures. The results of this study revealed that the application of KT via lymphatic technique had the potential to lower the incidence of swelling and decrease turgidity by more than 60%, within the two days following operation. However, no significant pain-relief effect was observed [12]. Another study aiming to clarify the effect of KT on postoperative morbidity due to third molar surgery indicated that KT reduced swelling, trismus and pain, thereby lowered the morbidity rate following surgery [13]. The researchers not only called attention on the beneficial effects of KT, but also pointed out its safety and minimal investment [12,13]. In the current study, although KT was applied on the facial area, patients neither had any discomfort nor allergic reaction with respect to the tape. In addition to its safety, KT might also serve as an affordable treatment option in TMDs.

There are a number of limitations of this study. Firstly, although the sample size was enough to perform a statistical analysis which succeeded to detect the significance in comparisons, it would be more appropriate to support the results of this study with trials consisting of higher number of patients. Secondly, a single-blind rather than a double-blind design was applied. Finally, no placebo group was included in the present study. Placebo controlled studies on larger sample sizes should be performed, in order to elucidate the effectiveness of KT, if any, regardless with its placebo effect.

In conclusion, KT in combination with counseling and masticatory muscle exercises has additional benefit in relieving pain, improving disability and increasing the mobility of TMJ than counseling and exercise alone. Kinesio Taping might serve as an alternative and/or an adjuvant approach in the management of TMDs.

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