A randomized double-blind comparison of kinesio and athletic taping in the treatment of lateral epicondylitis: Clinical and sonographic outcomes

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ABSTRACT

Objective: To compare early effects of the application of kinesio and athletic taping as part of the intensive conservative physiotherapy of the lateral epicondylitis using the results from ultrasonography and clinical tests.

Methods: Twenty-eight volunteers aged from 27 to 55 years old who had been clinically diagnosed with the lateral epicondylitis received in addition to the 4-week conventional physiotherapy program, one group was treated with athletic taping (n=14), the other with kinesio taping (n=14). The patients were evaluated through clinical tests (visual analog scoring, isokinetic elbow, grip and pinch strength tests, a Disability of Arm and Shoulder questionnaire (DASH) and ultrasonography examination on the first and last days of the physiotherapy program.

Results: The two groups had similar characteristics in all the baseline findings-and they showed improvement in the DASH score and the regression in pain scores. The activity pain was further reduced in the kinesio group ($p = 0.006$). However, there were no significant differences in isokinetic muscle strength at 60^0 /s and 120^0 /s velocity speeds between kinesio and athletic groups. There was also a substantial reduction in the tendon thickness in the kinesio group ($p = 0.063$, 0.031, 0.07; respectively) The tendon thickness was reduced by 92.3% in the kinesio-taped patients, and only 22.2% in the athletic taped patients. The presence of a tear in the tendon had a negative effect on the tendon thickness reduction ($p < 0.001$).

Conclusions: The results showed that physiotherapy coupled with the kinesiotaping was considered to be the better choice in the short-term treatment of the lateral epicondylitis. Since the presence of a tear has an impact on the healing process, ultrasonography might be an efficient method to use to discover the existence of a tear in the tendon and informing the decision about the appropriate type of treatment.

Key words: Kinesio taping, athletic taping, ultrasonography, lateral epicondylitis, physiotherapy

What's already known about this topic?

- Lateral epicondylitis (tennis elbow) is a painful musculoskeletal condition, which is considered to be due to overuse, over-stress or over-exertion of the wrist extensors of the forearm, especially extensor carpi radialis brevis.
- Ultrasonographic examination gives a detailed image of the structures involved in lateral epicondylitis, confirms the diagnosis, and may be useful in monitoring treatment.
- No study exists comparing the effects of kinesiotaping and athletic taping as an adjunct to conventional physiotherapy with functional and sonographic aspects.

What does this article add?

- Ultrasonography might be an efficient method to use to discover the existence of a tear in the tendon and informing the decision about the appropriate type of treatment.
- The efficiency of applications of AT or KT over a 4-week period in addition to physiotherapy for the treatment of lateral epicondylitis was shown that both groups significantly improved in terms of self-reported pain and function after treatment.
- Kinesio taping with physiotherapy, it is considered to be better where the early effects after short-term management are expected since the activity pain decreases, there is a reduction in tendinosis and effusion and a decrease in tendon thickness.

Trial Registration Hacettepe University Clinical Trials Register HEK10/83

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INTRODUCTION

Lateral epicondylitis (tennis elbow) is a painful musculoskeletal condition, which is considered to be due to overuse, over-stress or over-exertion of the wrist extensors of the forearm, especially extensor carpi radialis brevis [1]. Diagnosis of lateral epicondylitis is typically made without radiological evidence. Ultrasound is used to detect lateral epicondylitis and the most common findings include the calcification of the common extensor tendon, focal hypoechoic regions within the tendon, complete or partial discrete cleavage tears, and diffuse heterogeneity [2-4]. Ultrasonographic examination gives a detailed image of the structures involved in lateral epicondylitis, confirms the diagnosis, and may be useful in monitoring treatment[5].

Kim et al., performed a systematic review and meta-analysis of 58 randomized controlled trials on the effectiveness of conservative treatments (electrophysiotherapy, physical therapy, and injections) on lateral epicondylitis [6]. The reviews [6,7] cover a widespread range of treatments including: shock wave therapy [8-10], orthotic devices [11,12], oral non-steroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injection [13,14].

Athletic taping is a method, which restricts movement of the affected part of the limb during rehabilitation over shorter durations [15]. Kinesio taping (KT) is invented by the Japanese chiropractor Kenzo Kase in the 1970s, the tape is an elastic woven-cotton strip with heat-sensitive acrylic adhesive and the maximum available tension of about 40–60% its overall length [16]. It has been suggested that KT supports weak muscles, corrects joint arrangement, increases blood and lymph circulation, provides proprioceptive input, and reduces pain and muscle spasm in lateral elbow tendinopathy [17–21]. Kase et al.,[22] claimed that applying kinesio tape had some physiological effects such as decreasing pain or the occurrence of abnormal sensations, supporting the movement of muscles, removing lymphatic fluid congestion or haemorrhages under the skin, and correcting the misalignment of joints. When the tape is correctly properly, patients often report symptomatic relief, comfort, or stability of the involved joint [20,21]. This would be a beneficial choice for treating patients with lateral epicondylitis.

To our knowledge, no study exists comparing the effects of kinesio taping or athletic taping as an adjunct to conventional physiotherapy with functional and sonographic aspects. Therefore, it was considered that research into this area would contribute to this treatment. We hypothesized that after 4 weeks with kinesio taping in addition to conventional physiotherapy as compared with athletic taping would improve grip and muscular strength, pain intensity, functional ability and limitation of activities due to pain in subjects with lateral epicondylitis. This study used ultrasonography and clinical tests to compare the early-stage effects of kinesio and athletic taping used in addition to intensive conservative physiotherapy treatment of lateral epicondylitis.

MATERIALS AND METHODS

The study was conducted with 32 patients aged from 27 to 55 having unilateral lateral epicondylitis for at least 3 months. The patients with lateral epicondylitis were examined by a doctor qualified in physical medicine and rehabilitation.

Participants were included in the study if they had pain over the lateral epicondyle, pain during grip strength testing, and pain with one of the following tests: extensor carpi radialis test (i.e., resisted middle-finger extension), resisted wrist extension, or passive stretch of the wrist extensors [23]. Furthermore, the participants had to agree to abstain from any other form of treatment during their involvement in this study. Excluded from the study were patients with inflammatory, autoimmune, endocrine or kidney diseases, cubital tunnel syndrome, carpal tunnel syndrome, radiculopathies due to cervical disc pathologies, additional shoulder-hand-wrist pathologies, inflammatory arthritis, upper extremity operations or traumas, allergies to adhesive tape, and the patients who received corticosteroid injection due to lateral epicondylitis within the last 3 months.

Written informed consent was obtained from all participants before their involvement in the trial. The study was approved by the University Research Ethics Committee.

Study Design: A randomized, clinical trial design was used. Randomization was designed according to the random cases sample in an SPSS –program and eligible patients were allocated to the kinesio taping or athletic taping group. The final data is provided in the flowchart in Figure 1. The physiotherapist using

129standard physiotherapy measures assessed the participants who also completed a Disability of Arm and
130Shoulder Questionnaire (DASH) [24]. After their first visit to the physiotherapy clinic for the assessment,
131the patients were sent to a radiologist, who was blinded to the group allocation, for assessment of their
132tendon thickness.

133 The subjects in the present study were randomly and blindly assigned by the author into two
134groups upon their arrival; group 1 (n=14 patients) received the kinesio taping (KT), and group 2 (n=14
135patients) received the athletic taping (AT).

136 The members of the KT group were taped 2 days per week for 4 weeks using the muscle and
137fascia correction techniques [22]. The patients were asked to remove the tape on the third day before
138receiving physiotherapy (Figure 2). The AT group was taped using McConnell technique, 3 days per
139week for 4 weeks (Figure 3) [25]. The McConnell taping technique started medially on the proximal forearm
140and tracks laterally across the joint line to anchor off on the distal humerus above the joint line, thus
141attempting to replicate the force applied during the sustained lateral glide with a pain-free grip. Athletic
142tape with adhesive backing was used (38 mm wide-Muller Protape-The Netherlands). Tapings were
143performed according to the guidelines given by Kase [22] for the kinesio taping and McConnell [25] for the
144athletic taping. The treatment duration was determined as 4 weeks since this is maximum time that a
145patient can undergo physiotherapy and rehabilitation in a clinical in any 6-month period according to the
146Turkish Health Ministry.

147 Both groups received intensive physical therapy 3 days per week for 4 weeks. The treatment
148consisted of; a cold pack (enclosed in a moist towel for 12 minutes around the elbow joint), TENS (in
149asymmetrical biphasic wave form and burst modulation, current width 150 mms, pulse frequency 5 Hz)
150[19], deep transverse friction massage (2 minutes of application to the locally sensitive areas determined
151through palpation on anterolateral surface of lateral epicondyle) [27] followed by home exercises. Patients
152were given a program of daily exercises designed to strengthen the muscles in the forearm and increase
153flexibility through stretching. The aim was to increase the range of motion (ROM) and the intensity of the
154exercises was increased each week [28]. The eccentric exercises consisted of; 3 sets of 20 repetitions for

wrist and elbow flexion; 2 sets of 10 repetitions for the wrist extension strengthening starting with 50% of the maximum strength and density increasing the resistance each week; finally, 2 sets of 10 repetitions for the wrist flexor and extensor muscle groups comprising 20 sec of stretching and 10 sec of relaxing using the healthy hand [28]. The participants were expected to perform exercises regardless of pain provocation.

Evaluation: A postgraduate tertiary qualified musculoskeletal physiotherapist performed the evaluation on all the patients and was blind to the taping techniques that had been used. The effectiveness of treatment that the patients received was assessed as follows:

Clinical Tests: The members of both the KT and AT groups underwent an initial assessment and clinical tests by the physiotherapist who identified their suitability for this study.

1. Pain evaluation using the visual analogue score (VAS) (night–rest-activity) [29]:

Each patient assigned a value for their pain between 0 and 10 on VAS scale. In this scale, the absence of pain was marked as 0 while the highest unbearable pain was expressed as 10.

2. Isokinetic Strength Test (Wrist extension/flexion) [30]:

The muscle strength of the wrist flexion and extension was evaluated using Biodex Multijoint Isokinetic System 3 Pro (Biodex Medical Inc, USA). Measurements were performed at two different speeds as 60°/sec and 120°/s. Patients were told to refrain from extreme physical activities 48 hours prior to testing. Patients were seated on a plain chair with a 90^0 flexion of hip and knee. Stabilization was performed with straps over the chest. The position of the upper extremity, which was performed with the subject comfortably seated, started with the forearm pronated fixed the side of the trunk. Before the test, all participants undertook 10 minutes of warm-up exercises (3 set of 20 s stretching and 10 s relaxing) and 3 repetitions of submaximal warm-up. Then, 5 maximal repetitions were completed for each angular speed with 20 seconds of resting intervals. Wrist flexor and extensor peak torque (PT) and total work (TW) values were recorded in joules.

3. Maximum Grip strength and Maximum Pinch Strength [31]:

Grip strength was evaluated using Jamar hand dynamometer (Lafayette Instrument Company, USA) in kilograms and repeated 3 times. The patients were seated on an armless chair with 90° flexion of hip and

knee. The patient pressed the dynamometer for a maximum of 3 seconds their shoulders were in adduction neutral rotation, their wrist was in flexion and the forearm was in a neutral position, the wrist was in semipronation with the thumb facing up right to provide a stronger grip.

A baseline pinch meter (Mechanical Pinch Gauges, NexGen Ergonomics Inc, Canada) was used to evaluate pinch strength in kilograms. The measurement was performed in the same position as the grip strength evaluation. To obtain the maximal lateral grip strength the patient pressed the gauge with the thumb for 5 s at 1-minute intervals.

4. Functional level evaluation concluded with the Disabilities of the Arm, Shoulder and Hand scoring (DASH) [24,32]:

Upper extremity function level was determined by using a Turkish version of DASH consisting of 30 questions 24. The patients were asked to grade the activities involving shoulder, arm and hand motions within the previous week as “without any difficulty” (1) and “unable to perform” (5). The scores for all questions were totalled and evaluated in the range of 0-100.

Ultrasonography Examination: Examinations were performed in real-time using a GE Logiq 7 ultrasound scanner (General Electric Medical Systems, USA) with a linear 12 MHz (10-14 MHz) probe. A standard technique as outlined by the European Society of Musculoskeletal Skeletal Radiology ultrasound subcommittee [33] was employed for all tests. Ultrasound examination was conducted prior to the physiotherapy session on the first day of treatment and on the last day of the treatment. Evaluations were performed by a radiologist with 15 years’ experience in musculoskeletal ultrasonography. The radiologist was blind to the patients' group, the treatment that had been applied, and the results of other tests that had been performed. The clinicians were also blind to the findings of the radiologist.

Tendon hyper-hypoechogenicity was considered to be tendinosis and loss of fibrillary continuation was a tear (if it was within the tendon as intrasubstance), echogenicity with acoustic shadowing within the tendon was referred to as calcification. Enthesophytes within the region of the tendon insertion and irregularities of the bony surface were regarded as “bony degeneration” and presence of fluid along the tendon was considered to be “effusion”. A power Doppler was utilized used for

Doppler examinations and new vessel formation thicker than 1 mm within the Common Extensor Tendon (CET) or encroaching on the CET was accepted as neovascularization [34].

The CET was imaged along the long axis and angled so that the whole tendon length could be optimally visualized. Care was taken to avoid probe compression during measurements in order not to interfere with the assessment of tendon thickness. The thickness of CET was measured at the deepest point of the capitellum (Figure 4).

Statistical Analysis: In this study the 14 kinesio-taped patients had 80% power with a 5% overall type I error level using the data of the tendon structure in tennis elbow (especially tendon thickness and tendon fibrillary) which was normalized according to the 14 athletic taped patients to detect the differences. We would need complete data for 40 patients (20 in each study group), for 90% power at a 5% two-tailed significance level. The sample size was calculated based on a statistical power (1-beta) of 80% and an alpha of 0.05. Eleven participants were required in each group to detect a significant difference in VAS score.

The data was analysed with statistical software (IBM SPSS data collection, USA). The distinguishing statistical continuous variables were defined as average ± standard deviation or median (min-max). The nominal variables were represented as the number of observations and as a percentage.

The normality of the distributions of the continuous variables was evaluated with the Kolmogorov-Smirnov test. In the comparison of the averages between two parameter groups, if the distribution was normal, a t-test was employed, and if the distribution failed the normality test, the Mann-Whitney U test was utilized. The percentage comparison between the groups was performed using Chi-Square test. Changes in the nominal data of the tests (i.e., effusion, hypoechogenicity/heterogeneity) before and after treatment were evaluated with McNemar test. The Spearman rho correlation test was conducted to determine the correlation between the ultrasonographic findings and the clinical tests. The confidence interval was 95%, and $p < 0.05$ was considered to be statistically significant.

RESULTS

The physical characteristics of the participants were given in Table 1. There was no significant difference between groups in terms of age and the duration of symptoms (n.s.).

At the baseline, there were no differences in VAS, the DASH score, and the grip and pinch strength tests between the two groups (n.s.) (Table 2). The test results of both the groups including baseline clinical and ultrasound examinations were found to be similar (n.s.).

There were significant differences in pain at rest and night and the DASH scores between the pre and post-treatment in both groups ($p<0.05$). Also, there was a significant difference in activity pain according to the VAS tests before and after treatments in the KT group (<0.001) and the AT group (<0.05). The only difference between groups for activity pain was that the KT group had better results in comparison with the AT group ($p= 0.006$; <0.05) (Table 2). There was no significant difference in the results of the grip and pinch strength tests on both sides in both groups before and after the treatment (n.s.) (Table 2).

The results of the isokinetic test are given in Table 3. The pain and the improvement in the functional levels (DASH) were observed during the activity in both groups. The gripping, pinching and isokinetic muscle strength remained insignificant after the physiotherapy program received by both groups (n.s.) (Tables 2 and 3).

The distribution of the effusion and tendinosis (hypo echogenicity/heterogeneity) criteria from the ultrasound tests before and after the treatment is given in Table 4. The regression of effusion and tendinosis after treatment in the KT group is significant ($p < 0.05$). However, there was no significant regression of effusion and tendinosis in the AT group after the treatment (n.s.). The results of the ultrasonographic examination showed that while the decrease in tendon thickness after the treatment in the KT group was significant ($p < 0.05$), the decline in the AT group was not significant (n.s.) (Table 4). After the treatment, the tendon thickness decreased in 12 patients (92.3%) in the KT group and 2 patients (22.2%) in the AT group. No significant correlation was determined between the decrease in tendon thickness and pain or the unimproved DASH scores (n.s.).

In the cases in which the tendon thickness decreased after treatment, the distribution of tears in the groups was given as percentage. For all the participants while 12 patients without a tear had a decrease in tendon thickness, only 2 patients with a tear experienced a decrease in the thickness ($p = 0.001$)(Table 4). Therefore, it is concluded that the presence of a tear has a negative effect on the decrease in tendon thickness. Tendon thickness reduction after treatment was observed only in 4 patients in AT group.

Tear, tendon calcification, bone degeneration and neovascularization anomalies are the findings that did not change following the treatment and their distribution is given separately in Table 5. These findings were encountered at similar rates within both groups (n.s.) and only the intrasubstantial type of tear was observed.

DISCUSSION

The main finding of this randomized trial which assessed the efficiency of applications of AT or KT over a 4-week period in addition to physiotherapy for the treatment of lateral epicondylitis was shown that both groups significantly improved in terms of self-reported pain and function after treatment. In the comparison of the pre-post treatment differences between the groups only the activity pain score in the KT group showed a greater decrease, but neither treatment has an effect on strength and function. However, no change in the common extensor tendon thickness was identified. Neither of the groups indicated significant improvements in grip, pinch and isokinetic strengths.

Unlike the athletic taping kinesio taping can stay on the skin for four to five days and is too water resistant. With the techniques, which were used for this study, the superficial fascia, of common extensor muscle was supported [26]. Thus, this kind of support of elbow probably enabled pain decrease for the patients. Previous studies have demonstrated the positive effects of kinesio tape in relieving elbow pain [26, 35,36].

One of the two clinical tests that improved after treatment was the pain score that decreased while resting, during activity and at night in both groups. The physiotherapy program with the taping employed may have had an additional benefit on reducing pain. According to some studies the sensorimotor and

proprioceptive feedback mechanisms are the reasons of the positive effects of taping [37]. Athletic [38] and kinesio [39] tapings were reported to decrease the pain and increase pain-free grip strength in lateral epicondylitis. In the present study, a reduction of pain level during the activity was achieved in the KT group. Since the physiotherapy program followed was the same for all participants, it is considered that the pronounced relief in pain during activity in the KT group may result from the use of the kinesio tape. Similarly, the kinesio taping is reported to lessen the pain during activity, resting and at night in lateral epicondylitis [35] and it was reported that the pain-free grip strength improved after the application of kinesio taping [26]. In cases with KT, an increase in the number of muscles fibres and improvement in the muscle activity performance were observed [17]. One theory that has been proposed is that pain modulation occurs through the gate control theory as the tape stimulates the neuromuscular pathways by increased afferent feedback[16]. Another explanation is that the improved motion results from an increased recruitment in the motor units of the muscle to perform the activity due to an increased proprioceptive stimulus [40].

The other clinical test that improved after treatment was the DASH score. Lessening the pain through the taping resulted in a similar improvement of the DASH score, in both groups. It is possible that the application of DASH scoring after 3 to 6 months after the treatment might produce differences in the results of the KT and AT groups. Since the purpose of the present study was to observe the acute effects, long-term tests were not conducted.

No improvement for either group was noted on grip, pinch and isokinetic strength tests upon completion of the treatment. Croiser et al., [28] observed an increase in strength after the completion of a 9-week treatment. Since it is not expected that strength would increase immediately after the completion of the short-term treatment, it is arguable whether these tests should be conducted at this stage. Despite the insufficient results from strength tests, the ultrasound results obtained at the end of the short-term treatment application are rather perplexing. Effusion regressed in both groups, but this was only significant in the KT group. It is possible to say that the kinesio tape, which is believed to improve the lymphatic drainage by lowering the pressure under the skin of area of application, was effective in the regression of the effusion in the KT group. Tendinosis also regressed in both groups; however, the

regression in the KT group was significant. In addition to the possible secondary role of the kinesio tape in reducing effusion and activity pain, the better results were obtained regarding tendinosis in the KT group might be due to the increase in the number of muscles fibres taking part in the activity and thus, the increase in performance of the muscle [35]. Both types of taping were reported to increase the pain-free activity [41-45] these assists in the more effective realization of the proposed exercise program, thereby, forcing the remodelling of the tendon through the isokinetic eccentric exercises assigned to the patients [28,45]. It should also be mentioned that the conventional physical therapy given to both groups has a role in reducing the effusion and tendinosis. An advantage of the present study was that there was exercise intervention in addition to the treatment methods applied. Grip strength may be increased by strengthening the forearm muscles.

In this study, the grip strength improved only in the kinesio taping group after 4 weeks following the completion of the treatment. The Kinesio tape expands the distance between the muscle and the interstitial area and lifts the skin upwards by creating micro curves on the skin. Thus, lymphatic circulation is accelerated, and the stimulation of the subcutaneous pain receptors is prevented [38,39,43]. Thanks to these properties, KT may increase the range of motion without pain and allow the muscle to produce more force. Furthermore, KT stimulates cutaneous mechanoreceptors, creates proprioceptive feedback, and increases the activation of motor units [39]. There have been variable results about the effect of KT on grip strength in patients with LE. Cho et al. [16] revealed that KT reduced pain, increased grip strength, and improved functionality immediately after taping. Dilek et al. [36] demonstrated that VAS at rest, grip strength, and PRTEE scores improved within 2 and 6 weeks following a 2-week application of KT. Eraslan et al. [26] investigated the effects of KT, ESWT, and classic physiotherapy for 3 weeks. The patients received a cold pack and TENS treatment for 15 sessions and a home exercise program including stretching and strengthening exercises in addition to KT and ESWT. The pain, grip strength, and functionality improved according to baseline in 3 groups. However, the KT group was found to be superior to the classic physiotherapy and ESWT like our study.

The use of ultrasound to assess muscle morphology and guide the physical therapy decision making in the rehabilitation process can be traced back to the late 1960s [46]. From an evaluation

perspective, the measurements of morphology include variables such as muscle length, thickness, width, cross-sectional area, and pennation angles [34,41,46]. It was determined by sonography that the common extensor tendon thickness had receded; however, the improvement was only significant in the KT group. It could be stated that the recession in oedema and inflammation and the remodelling of the tendon result in the re-attaining the appropriate fibrillary structure of the tendon and the reduction in tendon thickness, namely, in recovery. However, no correlation has been determined between the reduction of tendon thickness and lowering the pain score. A number of authors have reported non-correlation between the sonographical and clinical findings and claimed that ultrasound findings should not be taken solely as basis for the management of the condition [42,46,47]. A more careful examination, separating tendon pain from muscle pain, might help design the treatment according to the tissue affected. Perhaps, this is the reason why we have not found the treatment of choice for lateral epicondylitis yet. The subjectivity of the pain scoring certainly has an effect on the discrepancy between the pain score and the ultrasound findings [43]. The effectiveness of the taping in lateral epicondylitis has been shown by ultrasound for the first time in the present study. We used the thickness for this study as a new way of looking inside the tendon formation. Further research is needed for different treatments with long-term follow-up to observe the changes.

The bone degeneration, tendon calcification, tears and neovascularization that were observed at similar rates in the ultrasound examinations in both groups were the criteria which remained unchanged throughout the treatment. Other researchers reported similar results in this respect [3,4]. The observation of the negative effect of an intrasubstantial tear on the improvement of the tendon thickness was interesting. Out of all the participants, the tendon thicknesses decreased in 12 patients with no-tear, however, decreases were only observed in 2 patients with a tear. Hence, the presence of a tear while being the cause of a poor prognosis in the conservative treatment of lateral epicondylitis it does indicate the importance of carrying out an ultrasound examination prior to treatment. However, the tears in the present study were not classified with respect to size.

It could be considered as a limitation of this study that the patients were only examined once (on the last day of treatment) for the post treatment check and there was no long-term follow up. However, this study did not aim to observe long-term results.

In the AT group, 2 people out of 16 either withdrew or were withdrawn from the study by the researchers and two withdrew from the KT group. The main reason for the loss of participants in both groups was the occurrence of mild skin reactions to the taping. As detailed earlier, the researchers attempted to minimize the risk of skin reaction through a multi-step approach to the application of the tape including the use of barrier wipes to provide a protective coating for the skin and the application of hypoallergenic woven tape beneath the rigid strapping tape [25]. It can be argued that another weak point of the study is the difference in the taping duration between the KT and AT groups. However, the study was designed taking into account the most effective duration of these techniques. A group in which only taping without any additional physiotherapy, or a group having physiotherapy and sham taping are applied could be set up. It is believed that new studies with such combinations would shed lighter on the topic. Future research is also needed to address these issues.

This study found that the presence of tear degrades the reduction of tendon thickness thereby the tendon remodelling therefore, it is recommended that an ultrasound examination is carried out before starting the treatment since the existence of a tear can change the therapy management from conservative to operational or the interventional approaches. The application of the strength tests following short-term management does not seem to be significant. It can be the cause of fear and the lack of confidence.

Conclusion

This study shows that physiotherapy coupled with the kinesio taping or athletic taping decreases pain in the lateral epicondylitis and improves the patient's functional score. Kinesio taping with physiotherapy, it is considered to be better where the early effects after short-term management are expected since the activity pain decreases, there is a reduction in tendinosis and effusion and a decrease in tendon thickness. In conclusion, when a patient presents to a physiotherapy clinic with symptoms and signs resembling lateral epicondylitis, other pathologies should be considered beyond inflammation of the extensor tendon before the treatment regime is begun.

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Ethical statement: The authors confirm this study meets the guidelines of the Declaration of Helsinki and after local ethical approval all subjects provided written informed consent. Ethics approval was provided by the Ethics Committee of Institutional Review Board.

Contributions: GB conceived the idea for the project and SS is the PI. All authors contributed to writing and reviewing the protocol, as well as reviewing and submitting the protocol for publication. NB provided advice with statistical and methods design. GB provided all the direct interventions for the KT group. UT will perform all the ultrasonographic examinations for the KT and AT groups.

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Table Legends

Table 1. Demographic data of both groups

Table 2. Pre-post treatment data for pain and DASH scores, grip and pinch strength tests values within groups, and differences between the groups

Table 3. Pre-post treatment, distribution and comparison of isokinetic strength tests within groups, and differences between the groups

Table 4. Pre-post treatment, distribution and comparison of ultrasound findings within groups, and differences between the groups

Table 5. Data of the ultrasound findings of the groups

Figure Legends

Figure 1. Flow chart diagram of the subjects

Figure 2. The general application guidelines for lateral epicondylitis including application of kinesio taping to the common extensor (long black tape) and the fascia correction technique (short black tape)

Figure 3. The application of athletic taping to the common extensor muscles

Figure 4. The longitudinal appearance of the common extensor tendon and measurement point (open arrow)

570Table 1. Demographic data of both groups

Variables	KT group (n=14)	AT group (n=14)	p
Men/Women	3/11	3/11	0.96
Age (years)	42.21±8.19	42.50±4.67	0.92
BMI (kg/m^2)	24.79±4.76	25.92±4.36	0.13
Symptom duration (days)	172±196	128±105	0.47

571*p<0.05, given as “mean±SD”

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583Table 2. Pre-post treatment data of pain and DASH scores, grip and pinch strength tests values 584within groups, and comparison of differences between the groups

Variable	KT group			AT group			P for differences between groups
	Before	After	p	Before	After	P	
VAS Night	4 (0-8)	0(0-8)	0.04*	5(0-9)	1(0-4)	0.09*	0.58
VAS Rest	3 (0-7)	0(0-4)	0.01*	3(1-7)	3 (0-8)	0.49*	0.25
VAS Activity	7.5 (3-9)	3(0-7)	<0.001	7.5(4-9)	5.5(3-9)	0.04*	0.006*
DASH	47 (19-72)	23.5(2-63)	0.001	43(31-82)	33(13-78)	0.009*	0.31
Grip strength	47.5 (30-85)	55(25-95)	0.76	50(20-65)	55(20-100)	0.13	0.13
Pinch	16 (10-20)	15 (12-22)	0.79	15.5 (10-22)	14.5 (10-28)	0.41	0.40

585*p<0.05, given as “median (min-max)”

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590Table 3. Pre-post treatment, distribution and comparison of isokinetic strength tests within 591groups, and comparison of differences between the groups

Variable	KT group			AT group			P for differences between groups
	Before	After	p	Before	After	p	
IFTW 60	1.65 (0-44)	4.3 (0.1-25.1)	0.7	3 (0.2-10.8)	4.8 (0-32.2)	0.07	0.23
IFTW 120	1.1 (0.1-16.3)	2.3 (0.1-15.8)	0.16	1 (0-4.8)	2.15 (0-15.2)	0.06	0.31
IFPT 60	6.4 (3.1-23.2)	8.1 (2-16)	0.65	6.2 (3.1-26.2)	8 (3-25)	0.9	0.93
IFPT 120	6.3 (4.5-13.7)	7.7 (2.5-18.4)	0.48	5.8 (2.2-27.8)	5.5 (1.8-14.6)	0.45	0.66
IETW 60	16.1 (7-46)	17.9 (1-49)	0.66	14.1 (2-37)	15.8 (3.8-25)	0.32	0.66
IETW 120	11.6 (6-27.7)	11.6 (1.4-32.9)	0.69	15.4 (2.4-35)	10.2 (3.9-25)	0.18	0.66
IEPT 60	11.1 (5-21.5)	11 (1.7-24.6)	0.94	9.6 (5.6-20.6)	9 (5.2-17.7)	0.42	0.47
IEPT 120	9.7 (4.8-21.4)	8.8 (2.9-17.3)	0.57	7.3 (4.2-18.7)	7.6 (4.9-16.7)	0.26	0.5

592*p<0.05, given as “median(min-max)”. IFTW: Isokinetic Flexor Total Work, IFPT: Isokinetic 593Flexor Peak Torque, IETW: Isokinetic Extensor Total Work, IEPT: Isokinetic Extensor Peak 594Torque. Each measurement was done at 60°/s and 120°/s velocities.

595Table 4. Pre-post treatment, distribution and comparison of ultrasound findings within groups,

596and comparison of differences between the groups

Variable	KT group			AT group		
	Before	After	P	Before	After	p
Effusion	8 (57.1%)	3 (21.4%)	0.063*	4 (40%)	2 (20%)	0.83
Hypoechogenity/ **Heterogeneity**	12 (85.7%)	6 (42.9%)	0.031*	7 (70%)	6 (60%)	1
Thickness (mm)**	5.20±0.87	4.28±0.58	0.003	5.07±1.18	4.89±1.02	0.07

597*p<0.05, given as n (percentage %)

598**P for differences between groups: 0.001

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611Table 5. Data of the ultrasound findings unaffected by conservative treatment across groups

Variable	KT group	AT group	p
Tear	3 (21.4%)	3 (30%)	0.66
Calcification	2 (14.3%)	1 (10%)	1
Bone degeneration	3 (21.4%)	6 (60%)	0.09
Neovascularization	2 (14.3%)	1 (10%)	0.89

612*p<0.05, given as n (percentage %)

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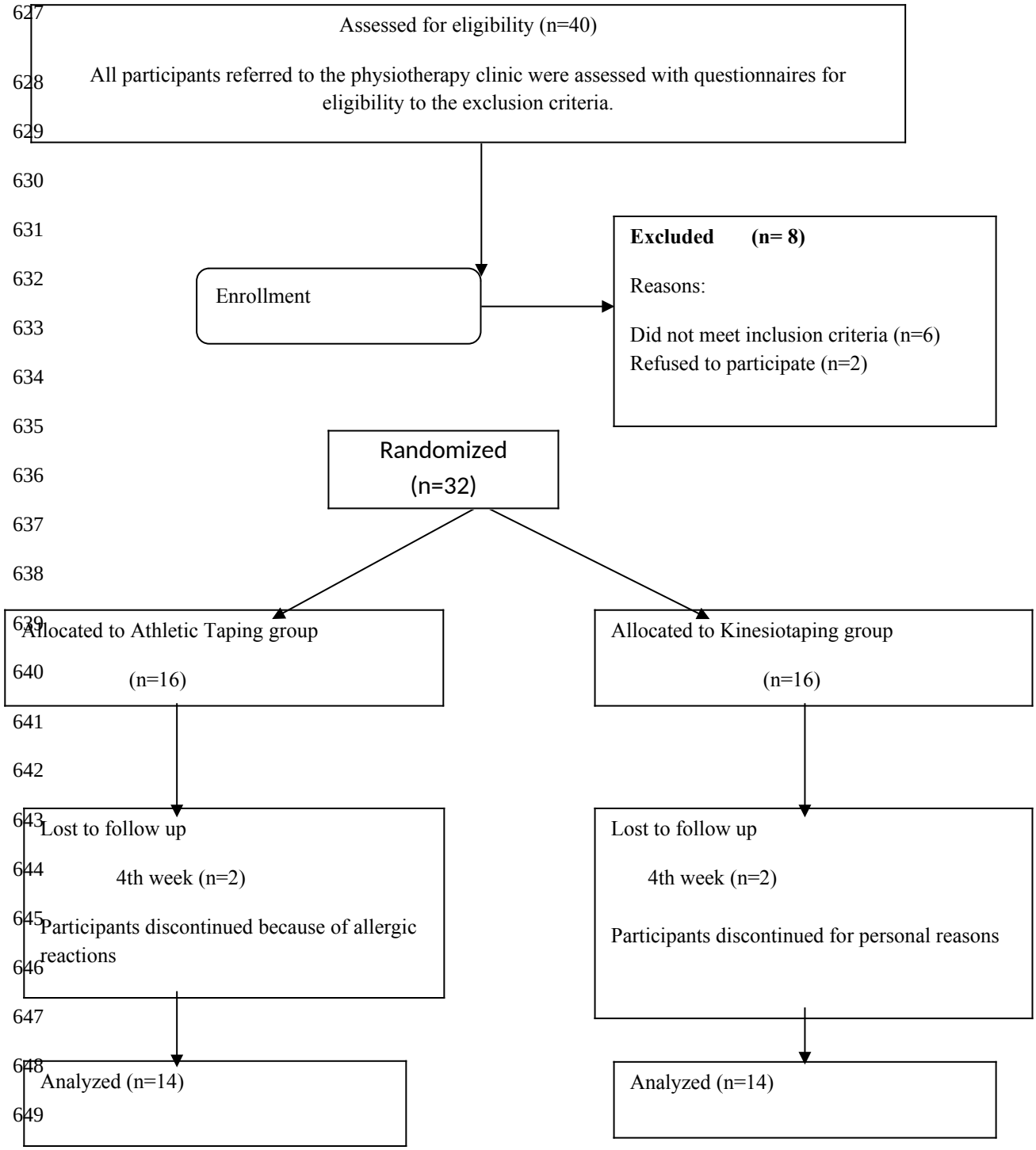
Assessed for eligibility (n=40)
All participants referred to the physiotherapy clinic were assessed with questionnaires for eligibility to the exclusion criteria.
Enrollment
Excluded (n= 8)
Reasons:
Did not meet inclusion criteria (n=6)
Refused to participate (n=2)
Randomized
(n=32)
Allocated to Athletic Taping group
(n=16)
Allocated to Kinesiotaping group
(n=16)
Lost to follow up
4th week (n=2)
Participants discontinued because of allergic reactions
Lost to follow up
4th week (n=2)
Participants discontinued for personal reasons
Analyzed (n=14)
Analyzed (n=14)