Benefits of Kinesiology Tape on Tendinopathies: A Systematic Review

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ABSTRACT The purpose of this systematic review was to produce a best evidence synthesis of the effects of Kinesiology Tape (KT) in the treatment of tendinopathies. An electronic search on five databases (PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, SportDiscus, and Physiotherapy Evidence Database (PEDro)) was conducted. Studies were included if (1) patients suffered from tendinopathy; (2) isolated KT was applied in at least one group; (3) comparisons between other techniques were developed; (4) outcomes based on pain, function, disability, or quality of life were analysed. Two reviewers independently extracted data and assessed methodological quality using the Physiotherapy Evidence Database (PEDro) scale. A total of 13 articles met the eligibility criteria, involving 454 participants. Nine of these studies presented upper extremity tendinopathies, and four explored lower extremity tendinopathies. Selected papers ranged from low to high quality, with an average score of 5 on the PEDro scale. According to our findings, there is limited evidence to support KT alone for the treatment of tendinopathies beyond the short-term. Due to the mixed methodological quality and the insufficient number of clinical trials, larger, long-term, high-quality studies are needed to support the theory that tendinopathies can benefit from KT applications.

KEY WORDS kinesiotape, bandaging, tendon disorder, kinesiotaping

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Introduction

Tendon disorders are both acute, with partial or complete rupture components (Docheva et al., 2015), and chronic, with a duration of symptoms of greater than months being the most common presentations (Kaux et al., 2011). Nearly 30% of general practice consultations related to musculoskeletal pain involve tendon impairments (Kaux et al., 2011), reaching similar prevalence to those injuries related to sports activity (Khan & Scott, 2009). However, and although the overuse factor is widely accepted to be significant, the role of inflammation in the different phases of tendinopathy is not completely understood (Rees et al., 2014). In terms of tendon management, a conservative approach shows positive effects in improving pain and function in some studies (Fournier & Rappoport, 2005; Rees et al., 2006), but the ideal treatment for tendon injuries represent a challenge and remains unclear (Skjong et al., 2012).

Kinesiotape (KT) is a therapeutic taping technique developed by Dr Kenzo Kase in Japan in the mid-1970s (Halseth et al., 2004). Research has shown that a wide variety of musculoskeletal conditions such as patellofemoral pain (Campbell & Valier, 2016; Chang et al., 2015; Kurt et al., 2016), carpal tunnel syndrome (Aktürk et al., 2018) and shoulder impingement syndrome (Hsu et al., 2009; Shih et al., 2018) may benefit from this technique. This is not only in the context of musculoskeletal disorders, as the number of clinical conditions in which KT is gaining importance is increasing, including ophthalmological (Costin, 2018), urological (Krajczy et al., 2018), vascular (Aguilar-Ferrándiz et al., 2014) and neurological conditions (Jaraczewska & Long, 2006; Kalichman et al., 2010; Unger et al., 2018). Among its actions are pain relief (Ay et al., 2017; Hazar Kanik et al., 2018; Lim et al., 2013), ROM improvement (Yoshida & Kahanov, 2007), injury prevention (Berezutsky, 2018; Hsiao-Yun Chang et al., 2018; Williams et al., 2012), muscle activity facilitation (Wong et

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al., 2012; Yeung et al., 2015) or inhibition (Abubaker & Muaidi, 2018; Davison et al., 2016), lymphatic drainage (Taradaj et al., 2014; Tsai et al., 2009), joint position sense improvement (Kurt et al., 2016), improved proprioception and kinaesthetic awareness (Bischoff et al., 2018; Hosp et al., 2015; Seo et al., 2016), and dynamic balance enhancement (Hsiao-Yun Chang et al., 2018). Typical KT micro-convolutions, which provoke a lifting of the skin over the underlying tissue, may constitute a physical-base explanation. A psychological component has also been considered with regards to the support, comfort, and security perceived by patients (Vercelli et al., 2013).

The purpose of this study was to synthesize the available evidence regarding the benefits and harms of isolated KT for the treatment of tendinopathies. Recent systematic reviews have indicated a lack of consistent evidence regarding the efficacy of KT on musculoskeletal disorders (Mostafavifar et al., 2012; Parreira et al., 2014). Understanding the effect of KT on tendinopathy may change the therapeutic approach itself. Current therapeutic tendencies for tendinopathies widely vary, ranging from eccentric exercise and manual therapy to more invasive approaches such as dry needling (Aicale et al., 2018), with most treatments essentially focusing their action on increasing blood flow to the tendon. It has been postulated that the KT lifting effect may improve blood and lymphatic flow and reduce pain by mechanically decreasing pressure on pain receptors (Lee & Yoo, 2012). Therefore, the primary goal of this review was to ascertain the impact of kinesiology tape in the affected tendon in every different way this structure elicits a deficit.

Furthermore, despite the existence of systematic reviews that assess the effect of various interventions for both generic (Andia et al., 2014; de Vos et al., 2010; Gambito et al., 2010; Lui & Ng, 2013; Sanderson & Bryant, 2015) and concrete, well-defined (Habets & van Cingel, 2015; Kearney & Costa, 2010; Larsson et al., 2012; Littlewood et al., 2012; Wilson et al., 2018) tendinopathies, some of them firstly regarding the effectiveness of isolated KT for treating distinct musculoskeletal conditions and tissues, specifically ankle (Wang et al., 2018; Wilson & Bialocerkowski, 2015) and lower back disorders (Li et al., 2018; Nelson, 2016), no previous reviews have been identified that define specifically tendinopathies as a focus for evaluation. Considering this gap in the literature, there is justification to undertake a review to assess the effectiveness of isolated KT in the management of tendinopathies.

Methods

Study protocol and registration

This systematic review was conducted and reported according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) recommendations (Liberati et al., 2009). The study was registered with the International Prospective Register of Systematic Reviews (PROSPERO). It was registered after a pilot search and prior to updated data search and extraction (Registration number CRD42014013832). No funding was received in the preparation of this study.

Data Sources and Search Strategy

Individualized, computer-based search strategies for PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Library, SportDiscus, and Physiotherapy Evidence Database (PEDro) were conducted in January 2018, with no restriction on the earliest date. The search strategy was based on the medical subject heading (MeSH) and non-MeSH search terms. The following keywords were used: Kinesiotap*, Kinesio Tap*, Kinesio, Kinesio-tap*, Neuromuscular Tape, and Tendinopathy. The various synonyms of KT were also combined with the terms Tendon, Tendon Injuries, Tendinitis, Tendinosis, and the following specific tendinopathies Achilles tendinopathy, Jumper's knee, Patellar tendinopathy, Epicondylitis, Medial elbow epicondylar tendinopathy, Medial epicondylitis, Rotator cuff tendinitis, Subacromial impingement syndrome, De Quervain's syndrome, and De Quervain disease. The electronic search was complemented by hand searching reference lists from previous systematic reviews and related papers. In addition, a recognized expert in this field was consulted in an attempt to identify any further published studies.

Eligibility Criteria for Selection

A PICO (population or problem, intervention, comparison, outcomes) question was established as a framework and followed during the literature selection process (Table 1). According to this, studies were included if they met the following criteria: (i) population: patients with tendinopathy; (ii) intervention: KT was applied as a treatment method comprising at least one arm in the study; (iii) comparison: between KT and placebo, control, other tapes or techniques; (iv) outcomes: all clinical outcomes were analysed, including those based on pain, function, disability, or quality of life. Exclusion criteria were reviews, meta-analyses, case reports, expert opinions, and studies using multimodal approaches or mixed/hybrid bandage techniques. Articles, editorials, and letters published in abstract form were also discarded. Studies in languages other than English were not considered during the entire search. No date restrictions were used in order to maximize information collection.

To select relevant articles, titles and abstracts of all identified citations were independently screened by two reviewers (LM-S, IM-P) applying the a priori inclusion/exclusion criteria. Agreement between the two authors regarding which articles to read in full was determined by consensus. Full-text articles were retrieved if the abstract provided insufficient information to establish eligibility or if the article had passed the first eligibility screening. The reference lists of all selected publications were screened by all reviewers to retrieve relevant publications that were not identified in the computerized search. A predesigned data extraction form was used to collect and synthesize the data. The study characteristics extracted were study design, target

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TABLE 1. PICOS format and search key words

	Definition	Search Key Words	Studies
Population (P)	Any participants	Not set	Studies that evaluated the effect of kinesiotape on clinical and functional parameters in adults of any age with tendinopathy, regardless of gender, clinical stage and type of tendinopathy.
Intervention (I)	Any form of kinesiotape in isolation	Kinesio* OR kinesiotap*	Studies that reported the effect of kinesiotape on clinical and functional parameters in adults with tendinopathy. The intervention could take place in any setting and be delivered to a group or individual participant. All types of kinesiotape application were considered for inclusion.
Comparison (C)	Any interventions	Not set	The studies that compared kinesiotape with any other intervention.
Outcome (O)	Tendinopathy Tendon disorder Tendonitis Tendinosis	(pain) OR (functional outcome)	Clinical and functional parameters accompanying tendinopathy measured by specific or patient-reported assessment tools.
Study Design (S)	Randomized and non-randomized clinical studies	Not set	Both randomized and non-randomized clinical studies

population (gender, age), sample size, type of injury, follow-up duration, interventions (detailed information about the application of KT), and all reported outcomes. Data were extracted independently by two authors (LM-S and MO-C) and confirmed by one other author (IM-P). Any discrepancies were settled by further discussion and consensus. Papers not meeting inclusion criteria and duplicates were excluded. All decisions were discussed and agreed upon by three researchers, ensuring a rigorous application of the inclusion criteria.

Methodological Quality Assessment

The risk of bias was assessed using the critical evaluation of the Physiotherapy Evidence Database (PEDro) scale (Maher et al., 2003). This tool provides credibility or internal validity evaluation, as well as determining whether the trial contains sufficient statistical information to make it interpretable. Individual reviews were discussed among researchers resolving the points of disagreement by group consensus. Studies with a PEDro score ≥5 were considered at low risk of bias and high methodological quality (Moseley et al., 2002). According to Foley et al., studies with a PEDro score of ≥ 6 represent level 1 evidence (6-8 = good; 9-10 = excellent) whereas studies scoring ≤ 5 reach level 2 evidence (4-5 = acceptable; < 4 = poor) (Foley et al., 2003).

Outcomes of interest

Pain reduction over time and measures of functional recovery were our primary outcomes of interest. Pain was measured via a visual analogue scale (VAS) in six of the 13 studies (Dilek et al., 2016; Firth et al., 2010; Göksu et al., 2016; Homayouni et al., 2013b; Homayouni et al., 2016; Thelen et al., 2008), while two of the 13 studies used the Numerical Pain Raring Scale (NPRS) (Au et al., 2017; Massei et al., 2017). Types of painful sensation assessed included load-induced pain, pressure pain threshold, tenderness, pain at rest/activity, pain at daily living activities, pain at night, and palpation-induced pain. Strength data were also obtained through maximal grip strength, maximal wrist flexor strength, pain-free grip strength, force sense, rate of loading and power (using single-hop test and counter-movement jump (CMJ) procedures) (Au et al., 2017; Chang et al., 2012; Chang et al., 2013; Dilek et al., 2016; Firth et al., 2010; Griebert et al., 2016; Massei et al., 2017). Functional improvement was addressed according to different parameters depending on the specific impairment, such as muscle activity (motion tracking, EMG activity) muscle excitability (Hoffman reflex test), ROM and pain-free ROM, along with validated patient-reported outcome reports (PROs), such as the Shoulder Pain And Disability Index (SPADI), Victorian Institute of Sports Assessment – Achilles (VISA-A), Patient Rated (Forearm) Tennis Elbow Evaluation Questionnaire (PRTEE), Nirschl score, and Star Excursion Balance Test (SEBT) (Au et al., 2017; Dilek et al., 2016; Firth et al., 2010; Göksu et al., 2016; Liu et al., 2007; Massei et al., 2017; Shakeri et al., 2013; Thelen et al., 2008).

Results

Study Identification

A database search was performed using MEDLINE, SPORT Discus, CINAHL, PEDro, and the Cochrane Library, yielding 34 citations specific to the search terms used. Among them, 26 were from Pubmed, three from CINHAL, and three from SportDiscus. Two additional studies that met the criteria for inclusion were identified by hand search and checking the reference lists of selected studies. Removal of duplicates resulted in 21 references, whereas three were excluded by language, two after discovering patients did not suffer from tendinopathy, and nine after verifying that multimodal approaches were developed. Following consensus, a review of titles and abstracts resulted in the exclusion of seven references as they did not meet the eligibility criteria. After screening the citations by title and abstract, 13 studies that used isolated KT to treat tendinopathy were finally selected in the qualitative synthesis. Figure 1 represents the PRISMA flowchart for the selection process.

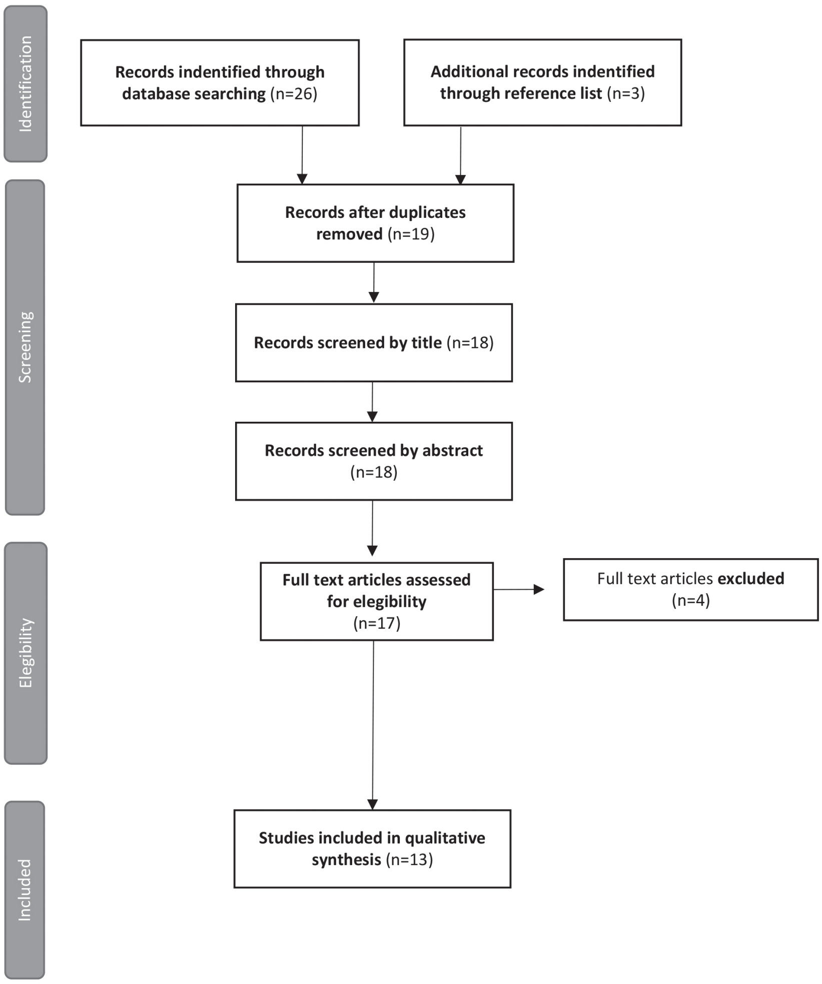

FIGURE 1. PRISMA flow diagram of search results

Study Characteristics

A total of 13 studies finally comprised this review, involving 454 participants (n=193 comparisons, n=261 interventions). Eight of them were conducted in Asia, whereas three studies were originally from North America and three from Europe. The final selection was published from 2007 to 2017. The included studies involved both athletes (n=64) and non-athletes (n=390). A summary of the included studies is presented in Table 2.

TABLE 2. Characteristics of selected studies

Authors, Year	Type of study	Sample size	Intervention groups	Type of injury	Intervention/Measures	Outcomes
Chang et al., 201371	RCT	n=27 male athletes	Healthy athletes group (n=17) and affection group (n=10)	Medial elbow tendinopathy	Three taping conditions (no tape, placebo tape and KT) in medial forearm in both groups to determine its clinical effectiveness in maximal grip strength and force sense.	No significant interactions in enhancing the overall strength and grip strength, just in absolute force sense error for KT and placebo tape.
Firth et al., 201063	NRCT	n=55 at baseline, n=48 at the end of the study	Healthy group (n=26) and affection group (n = 29). 7 subjects left the study, remaining 24 participants per group	Achilles tendinopathy	KT on the Achilles tendon in both groups to evaluate its effect on single-leg jump distance, pain and motor neuron excitability.	KT had no effects on the variables of the study.
Chang et al., 201270	Case control	n=27	Healthy athletes group (n=17) and affection group (n=10)	Medial elbow tendinopathy	Three taping conditions (no tape, placebo tape and KT) in both groups to search for immediate effects in pain, strength of wrist flexors and force sense.	No significant changes in wrist flexors strength and force sense between groups. Pressure pain significantly improved in both groups for KT and placebo tape.

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Authors, Year	Type of study	Sample size	Intervention groups	Type of injury	Intervention/Measures	Outcomes
Liu et al., 200773	Case series	n=2	Affection group (n=2)	Lateral epicondylitis	KT application to identify a potential benefit in the motion of the extensor carpi radialis muscles.	Results showed a smaller extension movement after 24 hours of KT.
Thelen et al., 200862	Prospective, randomized, double-blinded, clinical trial	n=42	Control group (n=21) and experimental group (n=21)	Rotator cuff tendinopathy/ shoulder impingement	KT application to determine short-term clinical efficacy in ROM, pain and function in comparison with sham taping.	Experimental group showed immediate significant improvements just in active shoulder abduction movement. Pain was only significant for KT at day 1.
Shakeri et al., 201374	RCT	n=30	KT group (n=15) and placebo tape control group (n=15)	Subacromial Impingement Syndrome	Investigate the effect of KT on pain intensity during movement, nocturnal pain, and pain-free shoulder ROM immediately after taping, after three days and after one week, in comparison with placebo taping.	Significant changes were found in the experimental group in pain during movement, nocturnal pain (also in control group), and pain-free ROM after KT. Immediately after KT, pain during movement and nocturnal pain changes were significantly better in the experimental group, with no differences between groups in ROM measures. No significant differences between groups were found after one week in pain intensity and shoulder ROM.
Homayouni et al., 201364	Prospective RCT	n=60	KT group (n=30) and physiotherapy group (n=30)	De Quervain's disease	KT application to assess changes in pain and swelling in comparison with physical therapy modalities (paraffin, ultrasound, TENS, friction massage).	Pain significantly improved in both groups, being more meaningful for KT group. Swelling changes were only significant in KT group.
Dilek et al., 201666	Case series	n=31	KT group (n=31)	Lateral epicondylitis	KT application to evaluate changes in pain, grip strength, disability and stage of the disease.	Significant changes were observed in all of the measured variables at 2 and 6 weeks.
Goksu et al., 201667	RCT	n=61	KT group (n=30) and local injection therapy group (n=31)	Subacromial Impingement Syndrome	KT application to observe potential changes in pain, ROM and function, in comparison with subacromial corticosteroid injection therapy.	Significant improvements were found in both groups for all of the measured variables, but results between groups were significant in favour of local injection therapy.
Griebert et al., 201672	RCT	n=40	Healthy group (n=20) and affection group (n=20)	Medial tibial stress syndrome	KT application in both groups to study possible changes in plantar pressures and rate of loading.	Significant changes in medial midfoot time-to-peak-forces in favour of healthy subjects at the beginning, not remaining immediate and 24 hours after taping, being only significant in affection group. Regarding lateral forefoot, significant within-group differences were observed between baseline and immediate application, not 24 after taping.
Homayouni et al., 201665	Comparative RCT	n=56 at baseline, n=46 at the end of the study	KT group (n=28) and naproxen/ physical therapy group (n=28). 10 subjects left the study, remaining 27 and 19 respectively	Pes anserinus tendino-bursitis	KT application to evaluate its benefits in pain and swelling, in comparison with naproxen/physical therapy.	Significant changes were observed in both groups, being more significant for KT group.
Au et al., 201768	Deceptive crossover trial	n=33 at baseline, n=30 at the end of the study	Affection group (n=33 at the beginning, n=30 at the end of the study)	Lateral epicondylitis	Four taping conditions (facilitatory KT, inhibitory KT, sham KT and no tape) to search for immediate effects in grip strength, pain and EMG activity	No significant changes in any of the measured variables were observed between taping conditions.
Massei et al., 201769	Case Series	n=10	Affection group (n=10)	Patellar tendinopathy	Four taping conditions (placebo tape, KT, leukotape and no tape) to assess immediate changes in pain, ROM, strength, power and balance	Significant changes in favour of KT were only observed in knee flexor strength and in anteromedial and posterolateral balance directions, as well as for lateral directions for KT, leukotape and placebo tape in comparison with no tape.

Note. RCT - Randomized Controlled Trial; NRCT - Non-randomized controlled trial; KT - Kinesiotape; ROM - Range of Motion; EMG - Electromyography.

The selected papers ranged from low to high quality, with an average score of 5 (range 0-9) on the PEDro scale (table 3). Three studies were considered to be of high quality (PEDro score ≥6), and ten studies were found to be of low quality (PEDro score <6). The PEDro scores for the studies in athletes and non-athletes ranged from 0 to 6 out of 10, and from 0 to 9 out of 10, respectively. In this sense, the worst-scored criterion was the blinding of the therapist, as this can not be assumed according to the intervention´s nature. Concurrently, the best-scored items were between-group comparisons, randomization when allocating, and point estimates and variability. According to Foley et al. (2003), less than half (n=5) of the included studies reached an acceptable level.

TABLE 3. PEDro Scale scores for selected studies

	PEDro Final score	Eligibility criteria specified (ítem does not score)	Random allocation	Concealed allocation	Similar groups at baseline	Blinding of subjects	Blinding of therapists	Blinding of assessors	Measure one key outcome from 85% patients	Intention-to-treat analysis	Between-group statistical comparisons*	Variability and point measurements*
Chang et al.	4/10		Yes	No	No	Yes	No	No	Yes	No	Yes	No
Firth et al.	4/10		No	No	No	Yes	No	No	Yes	No	Yes	Yes
Chang et al.	6/10		No	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Liu et al.	0/10		No	No	No	No	No	No	No	No	No	No
Thelen et al.	9/10		Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Shakeri et al.	8/10		Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Au et al.	5/10		Yes	No	No	Yes	No	Yes	No	Yes	Yes	No
Griebert et al.	2/10		No	No	Yes	No	No	No	No	No	Yes	No
Goksu et al.[67]	7/10		Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No
Homayouni et al.	7/10		Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes
Dilek et al.[66]	4/10		No	No	No	No	No	No	Yes	Yes	Yes	Yes
Homayouni et al.	5/10		Yes	No	Yes	No	Yes	No	No	Yes	Yes	No
Massei et al.	4/10		Yes	No	Yes	No	No	No	No	Yes	Yes	No

Note. * - for at least one key outcome.

Until now, three high-quality studies showed moderate significant improvement at the final follow-up measurement when compared with conventional physical therapy (Homayouni et al., 2013b; Homayouni et al., 2016), medication (Homayouni et al., 2016), or placebo taping (Shakeri et al., 2013). An indirect ROM improvement was also found in another RCT by Thelen et al. with no further changes (Thelen et al., 2008), while Griebrt et al. (2016) uniquely demonstrated an immediate biomechanical influence which tended to disappear after 24 hours. Additionally, one low-quality study corroborates such functional and clinical amelioration in terms of associated pain and grip strength (Dilek et al., 2016). Conversely, two high-quality studies showed no beneficial effect of KT for the management of tendinopathies when compared with placebo treatment (Chang et al., 2013) or corticosteroid injection (Göksu et al., 2016). Therefore, there is weak evidence that isolated KT improves pain and/or function in tendinopathies when compared with other treatment options.

Kinesiotape on Strength and Muscle properties

Strength and muscle properties were evaluated in six studies through dynamometry, functional test, electromyography (EMG), and specific software (Au et al., 2017; Chang et al., 2012; Chang et al., 2013; Dilek et al., 2016; Griebert et al., 2016; Massei et al., 2017). Assessed outcomes included maximal grip strength, pain-free grip strength, sense of related/absolute strength (both measured with a hydraulic hand dynamometer JAMAR) when assessing forearm structures, EMG activity of wrist extensors (during pain-free and maximal grip strength), rate of loading (pressure mat with a Tekscan® system), strength and power (counter-movement vertical jump procedure).

Strength in the presence of medial elbow tendinopathy was measured in two studies (Chang et al., 2012; Chang et al., 2013). Chang et al. aimed to determine the clinical effectiveness in maximal grip strength and grip force sense by the application of KT in comparison with healthy athletes (Chang et al., 2013). Three different tape dressings, including without-taping (WT), placebo KT (PKT), and KT were randomly applied with an interval of one week between measurements. In this study, significant changes among groups and taping conditions were only found in absolute force sense error (p=0.04), observing smaller errors for PKT and KT than WT in the experimental group (p<0.05). Also, WT presented larger errors than PKT in the control group. Comparing between groups, the experimental group showed smaller errors in PKT condi-

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tion ($p<0.05$). However, no significant improvements were found between groups and taping conditions for maximal grip strength and related grip force sense error ($p=0.50$ and 0.22, respectively). In another study, Chang et al. evaluated the same muscle properties (maximal grip strength and grip force sense), applying the same three taping conditions identically, in a study comparing baseball pitchers to healthy athletes (Chang et al., 2012). Results regarding maximal wrist flexor isometric strength also showed no significant difference among the three taping modalities for both healthy groups ($p=0.838$) and the medial epicondylitis group ($p=0.232$). For absolute force sense error, significant results among three taping methods for the ME group (WT > KT, $p=0.023$) were also found, not being significant for the healthy group. Regarding related force sense error, there was a significant difference for the healthy group ($p=0.036$) but not significant for the ME group ($p=0.741$).

Lateral epicondylitis was addressed in two studies (Au et al., 2017; Dilek et al., 2016). Au et al. (2017) aimed to evaluate pain-free grip strength, maximal grip strength (both of them measured using Jamar dynamometer) and EMG activity of wrist extensors during these two previous conditions. All participants went through four KT conditions (inhibitory KT, facilitatory KT, sham KT, and untaped), and were assessed immediately after each tape application. Results regarding pain-free and maximal grip strength showed no significant changes ($p=0.312$ and $p=0.499$, respectively) between different conditions. Similarly, there were no significant differences in the EMG activity measures in pain-free and maximal grip strength ($p=0.618$ and $p=0.774$, respectively). Dilek et al. (2016) focused on measuring grip strength using a Jamar dynamometer, and KT was applied twice a week for two weeks. Evaluations were carried out before treatment, at two weeks and six weeks after intervention. Results showed significant improvement ($p<0.05$) in handgrip scores at two and six weeks. Specifically, the handgrip strength of the affected side reached 67.5% of the unaffected side.

One study assessed KT and its effect in the presence of MTSS (Griebert et al., 2016). KT effects regarding the rate of loading and plantar pressure were evaluated in comparison with healthy subjects. A Tekscan® pressure mat system was used to calculate time-to-peak forces (TTPF) in each previously-divided area of the foot, including lateral forefoot (LFF), lateral midfoot (LMF), lateral rearfoot (LRF), medial forefoot (MFF), medial midfoot (MMF) and medial rearfoot (MRF). Measures were taken before (baseline), during (KT-1) and 24 hours (KT-2) after KT application. Outcomes showed significant TTPF differences at the MMF in favour of healthy participants at baseline ($p=0.021$), but not in KT-1 nor KT-2 applications, where these changes were only significant in the MTSS group ($p=0.022$ and $p=0.043$ respectively). Moreover, the MTSS group also showed significant within-group differences between baseline and KT-1 under the LFF ($p=0.031$), not remaining at KT-2 ($p=0.29$).

KT effects on patellar tendinopathy were analysed in one study by Massei et al. (Massei et al., 2017), in which four different tape conditions such as no tape (NT) as baseline session, placebo tape (PT), KT, and Leukotape (LT) were applied. Power and strength were measured using the counter-movement vertical jump procedure and electronic, hydraulic push-pull dynamometer, respectively. All subjects went through all four taping conditions, committing to four testing sessions with at least one day of rest between them. Results showed no significant changes regarding power between different taping conditions. However, significant improvements were observed in knee flexor strength when comparing KT with LT, NT and PT ($p<0.05$), but not regarding knee extensor strength, where no meaningful effect was found between taping conditions.

Kinesiotape on Joint Function

Functionality was assessed with several procedures in seven studies (Dilek et al., 2016; Firth et al., 2010; Göksu et al., 2016; Liu et al., 2007; Massei et al., 2017; Shakeri et al., 2013; Thelen et al., 2008), including the Shoulder Pain And Disability Index (SPADI), single hop test, Victorian Institute of Sports Assessment – Achilles (VISA-A), Patient Rated (Forearm) Tennis Elbow Evaluation (PRTEE), Nirschl score, and Star Excursion Balance Test (SEBT). Moreover, range of motion (ROM) variables were measured by goniometry in 4 studies(Göksu et al., 2016; Massei et al., 2017; Shakeri et al., 2013; Thelen et al., 2008), and neuron excitability was measured in one study (Firth et al., 2010). Additionally, one study comprised muscular motion tracking by ultrasonography (Liu et al., 2007).

Shoulder impingement was evaluated in three studies (Göksu et al., 2016; Shakeri et al., 2013; Thelen et al., 2008). Thelen et al. (2008) aimed to assess disability (SPADI) and pain-free ROM after KT application in comparison with sham taping. Subjects were randomly allocated in KT and sham KT groups. Measures were obtained at baseline, right after taping (except SPADI score), three and six days after the initial application, re-taping subjects on the third day after being inspected and assessed. Significant changes were found in all outcomes on the sixth-day follow-up, but none of them, apart from shoulder abduction at the first day ($p=0.005$), were more efficacious than sham taping (Thelen et al., 2008). Shakeri et al. studied the effect of KT on pain-free active shoulder ROM (abduction, flexion and scapular elevation) in comparison with placebo taping. Subjects were randomly allocated in KT and placebo KT groups, and measures were obtained at baseline, immediately after taping, three days and one week after initial application, re-taping subjects at fourth day after skin evaluation. Results showed significant improvements in all measures for both groups (except for shoulder flexion in the control group), but differences were not meaningful between them (Shakeri et al., 2013). Goksu et al. compared the effect of KT and local injection therapy. KT was applied three times at three-day intervals. Functionality was measured in terms of active flexion, abduction, internal and external rotation

ROM goniometry and SPADI score, obtaining results at baseline, one week and four weeks after therapy. Both groups showed significant changes in all outcomes at the first and fourth weeks ($p<0.05$). When comparing between-group results, only abduction ROM and SPADI scores were significantly relevant for the local injection group ($p<0.05$) (Göksu et al., 2016).

One study assessed KT and its effect in the presence of Achilles tendinopathy (Firth et al., 2010). Firth et al. investigated the effect of short-term KT in comparison with healthy people. Jumping distance and neuron excitability were measured using a single hop test and evoking Hoffman reflex (of the soleus and gastrocnemius muscles), respectively. VISA-A score in the Achilles tendinopathy group revealed a wide range of disability levels among participants, ranging from 21 to 94. Measurements were taken before the application of the band, during and after its disposal. Results showed no significant differences in the jumping distance when applying the bandage in both groups ($p=0.55$), and, as expected, the affected group did not jump as far as the healthy group did ($p<0.0005$). The Hoffman reflex amplitude in the soleus and gastrocnemius increased in the healthy group after removal ($p=0.01$ and $p=0.03$, respectively), while it remained unchanged in people with Achilles tendinopathy ($p=0.43$ and $p=0.16$, respectively) (Firth et al., 2010).

Two studies evaluated KT and its effect in the presence of lateral epicondylitis (Dilek et al., 2016; Liu et al., 2007). Dilek et al. (2016) assessed disability and the stage of the disease by using PRTEQ function subscales and Nirschl score, respectively. KT was applied twice a week for two weeks, and evaluations were done at baseline, at two and six weeks after treatment. Results showed significant changes for all outcomes at two and six weeks ($p<0.05$). Liu et al. (2007) studied two volunteers with lateral epicondylitis. Subjects performed both passive and active wrist flexion-extension for periods of two seconds, with and without KT. Motion tracking of the extensor carpi radialis muscles, in terms of longitudinal scans in proximal and distal areas of the lateral epicondyle, were recorded using dynamic ultrasound imaging. These experimental results showed a smaller extension movement after 24 hours of KT than before taping.

Massei et al. (2007) investigated KT effects in the presence of patellar tendinopathy. Knee ROM and dynamic balance were assessed by using a standard goniometer and SEBT score, respectively. Knee ROM measures were taken in the supine position, and SEBT information was obtained based on anterior, anterolateral, anteromedial, posteromedial posterior, posterolateral, medial, and lateral dynamic balance. All subjects received all four taping conditions, divided over four days with at least one day rest in between them. No significant changes in ROM were observed for knee flexion and extension. Regarding dynamic balance, a significant effect was found in anteromedial, lateral and posterolateral directions between taping conditions ($p<0.05$). Reach distances were greater for KT in anteromedial and posterolateral directions ($p<0.05$); as for lateral directions, significant changes were observed between KT, LT, and PT in comparison with NT ($p<0.05$).

Kinesiotape on Pain

Pain sensation was measured using different evaluation procedures in a total of 10 studies(Au et al., 2017; Chang et al., 2012; Dilek et al., 2016; Firth et al., 2010; Göksu et al., 2016; Homayouni et al., 2013b; Homayouni et al., 2016; Massei et al., 2017; Shakeri et al., 2013; Thelen et al., 2008), nine of them using validated scores such as the Visual Analogic Scale (VAS), Numeric Pain Rating Scale (NPRS), SPADI and PRTEQ (Au et al., 2017; Dilek et al., 2016; Firth et al., 2010; Göksu et al., 2016; Homayouni et al., 2013b; Homayouni et al., 2016; Massei et al., 2017; Shakeri et al., 2013; Thelen et al., 2008). Additionally, algometry was employed in one of the studies (Chang et al., 2012).

Shoulder pain was evaluated in three studies (Göksu et al., 2016; Hassan Shakeri et al., 2013; Thelen et al., 2008). Thelen et al. assessed the short-term effects of KT, using SPADI and VAS scores (Thelen et al., 2008). Subjects were randomly allocated in a therapeutic KT group and a sham KT group, and all measures were taken at baseline, immediately after taping (except SPADI score), three days and six days after tape application. Results showed significant changes within each group, but no between-group differences existed except for VAS on Day 1, which was significantly better for the KT group ($p=0.01$). Shakeri et al. evaluated the short-term effects of KT in comparison with placebo taping (Shakeri et al., 2013). Pain intensity during movement and nocturnal pain were assessed using the VAS scale, and measures were obtained at baseline, immediately after taping, as well as three days and one week after initial application. Significant changes in pain during movement (for KT group) and in nocturnal pain (for both groups) were found; however, they were only significantly greater for the KT group immediately after the initial application; those significant differences did not remain at the end of the study. Goksu et al. (2016) assessed pain in individuals with subacromial impingement syndrome in comparison with local injection therapy, applying KT three times over a three-day interval. Pain at rest and movement was assessed by using 100-mm VAS and SPADI scores, obtaining results at baseline, as well as one week and four weeks after therapy. Significant improvements were found at one and four weeks after treatment in both rest and movement pain variables for both groups ($p<0.05$), but only VAS pain at rest and the SPADI score were significant between groups in favour of the local injection therapy group ($p<0.05$).

Achilles tendinopathy was assessed in one study. Firth et al. evaluated the effect of KT on pain in comparison with healthy subjects (Firth et al., 2010). A 10-cm VAS score was used to determine the level of pain before tape application, with the tape in place and after tape removal. In addition, pain during a single-hop test was also recorded with and without tape. No significant changes were found in VAS scores by the application of

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this tape nor during the hop test with and without tape (p=0.74) (Firth et al., 2010).

Pain in medial elbow tendinopathy was measured only in one study, dealing with baseball pitchers suffering from tendinopathy and comparing them to healthy athletes (Chang et al., 2012). An algometer and a VAS score were used to measure the pressure pain threshold (PPT) and 4-kg pressure pain tolerance, both in the muscle belly and muscle-tendon junction of the common wrist flexors locations. Three taping conditions (no-taping, placebo taping and KT) were applied to each participant with an interval of one week. Results revealed significant changes in PPT and 4-kg pressure pain tolerance in favour of placebo and KT compared to no-taping for both the healthy and affected groups (p<0.05).

Homayouni et al. measured the effect of KT on pain in those with pes anserinus tendino-bursitis. They compared KT application with nonsteroidal anti-inflammatory drugs and physical therapy (Homayouni et al., 2016). Pain and swelling scores were recorded using VAS and soft tissue sonography. KT was applied three times for three weeks, with a one-week interval, assessing different scores at baseline and after treatment. Results showed significant changes in both groups after interventions for all outcomes (p=0.0001), but KT was significantly more effective for decreasing pain and swelling scores (p=0.0001).

Lateral epicondylitis was analysed in two studies by Au et al. (2017) and Dilek et al. (2016). The first study addressed pain after applying the following four KT conditions in every patient (inhibitory KT, facilitatory KT, sham KT and untaped) (Au et al., 2017). Similar to grip strength, pain was assessed immediately after each tape application, and an NPRS scale was employed. Pain intensity information was collected during the maximal grip strength test. Results also showed no significant differences in pain intensity among taping conditions (p=0.321). In the second study, KT was applied twice a week over a two-week period, measuring pain at rest, during of daily living activities, night and palpation on lateral epicondyle (Dilek et al., 2016). The VAS and PRTEQ scales were used at baseline, at two and six weeks after treatment. Significant improvements were observed in all parameters at two and six weeks for both VAS and PRTEQ scores (p<0.001).

De Quervain's disease was assessed in one paper in which KT effects on pain in comparison with physical therapy were studied (Homayouni et al., 2013a). Pain and the presence of swelling were measured using a 100-mm VAS score and physician inspection-palpation. KT was applied four times a week, and scores were recorded at baseline and one month after treatment. A significant decrease in VAS was observed at the end of the treatment in both groups (p< 0.001), being more meaningful in the KT group. Swelling changes were significant in the KT group (p<0.001) but not in the PT group (p>0.05), showing significantly better results for KT in comparison with PT.

Lastly, the study by Massei et al. (2017) was the only one focusing on patellar tendinopathy. This investigation evaluated pain after the application of four different tape conditions, comprising NT, PT, LT, and KT. These taping modalities were applied to all the participants in four different sessions. An NPRS score was employed to assess pain, recording pre- and post-treatment measures. Results from ANOVA showed no significant effects for time or taping condition.

Discussion

The theory about the benefits of KT in treating such a wide variety of conditions argues that its properties reduce recovery times due to several effects, such as decreasing pain, improving muscle and joint function, lymphatic circulation and, subsequently, microcirculation and inflammation (Halseth et al., 2004). The purpose of this systematic review was to investigate whether existing evidence supports the implementation of KT dressing technique in patients with tendinopathy. The findings provided conflicting evidence regarding the effectiveness of KT for the treatment of tendinopathies.

This review included 13 studies investigating the effects of kinesiotape for tendinopathies affecting diverse anatomical regions. Of the 13 studies, nine presented upper extremity tendinopathies, and four presented lower extremity tendinopathies. Studies reporting benefits (n=7) were greater in number to those that found no benefit or no significant changes (n=6) (Au et al., 2017; Chang et al., 2012; Chang et al., 2013; Firth et al., 2010; Liu et al., 2007; Massei et al., 2017). However, it is important to note that these improvements were not present at longer-term follow up, did not imply a clinical change in every case, and did not always arise from high-quality research. These results may not be due to methodological quality, however; the studies' methodological scores were generally inadequate, with less than half of the included studies (n=5)(Hsiao-Yun Chang et al., 2012; Göksu et al., 2016; Homayouni et al., 2013a; Shakeri et al., 2013; Thelen et al., 2008) scoring six or more points on the PEDro scale. Blinding of subjects, therapists, and evaluators were not generally achieved, with just two studies accomplishing, at least, two of these items (Au et al., 2017; Thelen et al., 2008) and six studies not fulfilling any of them (Dilek et al., 2016; Griebert et al., 2016; Homayouni et al., 2013b; Liu et al., 2007; Massei et al., 2017; Shakeri et al., 2013). Baseline group characteristics were similar in most of included the studies. Chang et al. (2013) presented no baseline data. The control group of Firth et al. (2010) differed in subjects' age and sex, while three studies just included a single experimental group (Au et al., 2017; Dilek et al., 2016; Griebert et al., 2016).

Regarding direction (origin-insertion theory), time and tensional percentage of the application, there is a lack of agreement in the reviewed literature. Most of the studies followed the "insertion to origin" fashion according to the inhibitory theory so as to stretch the Golgi tendon organ at the distal end of the target muscle, though Griebert et al. (2016) chose to apply from origin to insertion also obtaining consistent results for KT group. Moreover, Au et al. (2017) dealt with both application strategies and showed no significant differences between them, thus refuting the proposed mechanisms suggested by Kase (Halseth et al., 2004), but also noting that two circular holes were cut to allow for EMG electrode placement, which could affect the structure of the tape and subsequently the results. Time of application also differed among studies, varying from immediate application (Au et al., 2017; Firth et al., 2010; Massei et al., 2017), one day (Griebert et al., 2016) and two to three days (Shakeri et al., 2013). Uneven frequencies were also observed, ranging from daily to weekly, by way of two three-day intervals. Although similar designs were found for each type of injury, the stretching percentage of the band was inconsistent between studies, largely relying on the experience of the therapist. There was only one study where stretch tension was standardized, measuring the distance between the line 2 cm distal to the medial epicondyle of the humerus and the wrist joint line, and then multiplying by 0.8 to set the final length of the band (Chang et al., 2012). However, there was concordance in terms of the follow-up period, mostly lasting less than three weeks, with just three studies evaluating at the fourth week (Göksu et al., 2016; Homayouni et al., 2013a) and sixth week (Dilek et al., 2016).

The previous condition of the patient might have been a determinant for the final results in some studies. For instance, Thelen et al. (2008) allowed prescribed nonsteroidal anti-inflammatory drugs (NSAIDs) intakes prior to research enrolment. Massei et al. (2017) included active individuals (around 150 minutes of moderate to vigorous activity per week), and Goksu et al. (2016) provided guidelines for a home exercise programme, possibly ensuring prolonged pattern corrections which integrate properly with the therapy (Khan et al., 2013).

The KT lifting function over skin is proposed to relieve pressure on nociceptors immediately, thus directly reducing the perceived pain (Halseth et al., 2004). Generally, improvements in pain reduction were found among different studies (Chang et al., 2012; Dilek et al., 2016; Göksu et al., 2016; Homayouni et al., 2013b; Homayouni et al., 2016; Shakeri et al., 2013; Thelen et al., 2008), but its superiority against sham taping or other forms of treatment is not supported. One study found significantly better changes in favour of local injection therapy (Göksu et al., 2016), and six, despite observing significant intra-group changes, showed no significant differences in most of the different variables between sham taping (Au et al., 2017; Chang et al., 2012; Shakeri et al., 2013; Thelen et al., 2008), other taping conditions (Massei et al., 2017) or comparing to healthy subjects(Firth et al., 2010). However, Homayuni et al. (2013a; 2016) observed greater changes for KT in comparison to physical therapy alone and with nonsteroidal anti-inflammatory drugs. Similar results in favour of KT were also found by Dilek et al. (2016), although no comparison group was employed. Interestingly, Thelen (2008) reported no immediate differences between sham taping and KT, indicating that sham application provided a neutral effect as desired.

There is a general agreement on the gate control theory as one plausible explanation for this pain reduction, proposing that tape could stimulate neuromuscular pathways via increased afferent feedback (Kneeshaw, 2002), bringing different impacts to pain receptors and proprioceptors. This increased afferent stimulus to large-diameter nerve fibres, thus mitigating the nociceptive input activity from small-diameter fibres, might have alleviated pain-related symptoms.

Regarding muscle properties, miscellaneous findings can be observed in the literature. Strength improvements due to KT were not superior against other forms of taping (Au et al., 2017; Chang et al., 2012; Chang et al., 2013) or healthy subjects (Chang et al., 2013). Au et al. (2017) conducted all the tests in a single session, with just five minutes of rest between each taping condition, which could have led to muscle fatigue and alteration of the results. Massei et al. (2017) found no significant changes in power between taping conditions revealing, however, an increasing effect in knee flexor strength. It has been reported that the presence of swelling or oedema within the knee joint may inhibit muscular strength (Spencer et al., 1984). A possible anti-inflammatory KT effect, in addition to observed clinical changes in pain, could have influenced these results. Griebert et al. (2016) found significant immediate improvements in medial midfoot and lateral forefoot load forces in patients with MTSS following the immediate application of KT in the first hours. It seems noteworthy that loading capacity was better in the healthy group at baseline, supporting the presence of biomechanical differences among patients and the possible corrective effect following the application of the tape. However, a single experimental-group design was carried out in three of the mentioned studies (Au et al., 2017; Dilek et al., 2016; Massei et al., 2017), which could complicate the process of contextualizing and interpreting the results.

In terms of functionality, KT effects are not generally greater than other forms of treatment. Despite showing significant changes in different variables, most of them were not superior to sham tape (Shakeri et al., 2013; Thelen et al., 2008), other taping conditions (Massei et al., 2017), or local injection therapy (Göksu et al., 2016), showing this invasive modality better results in terms of shoulder abduction and SPADI scores. Firth et al. (2010) found significant increases in the Hoffman reflex excitability only in healthy subjects, and three studies (Au et al., 2017; Dilek et al., 2016; Griebert et al., 2016) did not include a control group, making the gathering of comparative information impossible to accomplish. However, Thelen et al. (2008) and Shakeri et al. (2013) reported immediate meaningful differences in shoulder abduction ROM in KT group, clinically consistent with previous reports circumscribing these positive effects to musculoskeletal shoulder pain at the short-term, although in combination with a home exercise programme (Kaya et al., 2011). One study (Liu et

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al., 2007) proposed a new dynamic ultrasound motion tracking algorithm for the extensor carpi radialis muscles in subjects with lateral epicondylitis, showing that movement after 24 hours of KT is smaller than before taping, which could apparently correlate with the assumed constriction effect of the tape.

Synthesis of the evidence proved difficult for several reasons. The methodological quality of the studies selected was poor. The main limitation of the present review is the low quality of the included studies, limiting clinical decisions based on strong evidence. Poor blinding procedures, lack of randomization, and lack of intention to treat analysis may have weakened the scientific merit of the reviewed papers due to increased potential biases. Additionally, the studies presented small sample sizes and very heterogeneous characteristics regarding age and clinical status, which may interfere with the validity of data. Clinical application of KT was either poorly reported or varied between studies, even when managing the same condition.

Conclusion

This systematic review identified thirteen studies reporting on the effectiveness of KT for treatment of tendinopathies and found that there is limited evidence to support KT for the treatment of these pathologies, especially for anything beyond the short-term. Only a small proportion of the included studies were randomized controlled trials showing real benefits, with other employing observational designs using relatively small sample sizes and no control group. In addition, improvements related to KT were not generally greater in comparison with other treatment modalities. Further research with rigorous methodological approaches, assuming more homogeneous and larger samples, thus reinforcing external validity and the generalization of the results, is needed to support the use of KT for tendinopathies.

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