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A systematic review of the effectiveness of Kinesio Taping® - Fact or fashion?

A. KALRON [1, 2], S. BAR-SELA [3]

In this systematic review article, we assessed the effects of therapeutic Kinesio Taping® (KT®) on pain and disability in participants suffering from musculoskeletal, neurological and lymphatic pathologies. Four online databases (CINAHL, Cochrane Library, MEDLINE, PEDro) were comprehensively searched from their inception through March 2012. The initial literature search found 91 controlled trials. Following elimination procedures, 26 studies were fully screened. Subsequently, 12 met our inclusion criteria. The final 12 articles were subdivided according to the basic pathological disorders of the participants' musculoskeletal (N.=9), neurological (N.=1) and lymphatic (N.=2) systems. As to the effect on musculoskeletal disorders, moderate evidence was found supporting an immediate reduction in pain while wearing the KT®. In 3 out of 6 studies, reduction of pain was superior to that of the comparison group. However, there is no support indicating any long-term effect. Additionally, no evidence was found connecting the KT® application to elevated muscle strength or long-term improved range of movement. No evidence to support the effectiveness of KT® for neurological conditions. As to lymphatic disorders, inconclusive evidence was reported. Although KT® has been shown to be effective in aiding short-term pain, there is no firm evidence-based conclusion of the effectiveness of this application on the majority of movement disorders within a wide range of pathologic disabilities. More research is clearly needed.

KEY WORDS: Physical therapy modalities - Musculoskeletal manipulations - Musculoskeletal diseases - Physical and rehabilitation medicine.

Corresponding author: A. Kalron, 60 Habanim Street, Herzilia, Israel, Tel: 972-9-9512726; Mobile phone: 052-2436839.
E-mail: alkalron@gmail.com

[1]Multiple Sclerosis Center
Sheba Medical Center
Tel Hashomer, Israel
[2]Research and Sport Medicine Unit
Wingate Institute, Natanya, Israel
[3]Physical Therapy Unit
Meuhedet Sports Medicine Institute
Ramat-Gan, Israel

The KinesioTaping® (KT®) technique utilizes latex free and quick drying tape designed to mimic the qualities of human skin through its specific thickness and high elasticity. The tape was developed by Dr. Kenzo Kase, a Japanese chiropractor.[1] The material used in the Kinesio tape and the original concept of the taping technique was first introduced in Japan in 1979 and the United States in the 1990s. The elastic tape is capable of stretching up to 130-140% of its resting static length ensuring free mobility of the applied muscle or joint. Dr. Kase claimed that by applying the KT®, physiological effects would include a decrease in pain by stimulating the neurological system, restore correct muscle function by supporting weakened muscles, remove congestion of lymphatic fluid or hemorrhages under the skin, and correct misalignment of joints by reducing muscle spasms.[2] After applying the tape, the taped area form convolutions, thus increasing the space between the skin and muscles. Once the skin is lifted, the flow of blood and lymphatic fluid is promoted.[2, 3]

The KT® can be applied to virtually any muscle or joint in the body.[2] However, minimal evidence

supports the use of this type of tape in the treatment of musculoskeletal disorders. Documentation relies on very few case series,[4-6] small pilot reports [7, 8] and research studies performed on healthy participants.[9, 10] These data represent lower levels of clinical evidence. In addition, Dr. Kase described different KT® applications believed to aid in neurological and lymphatic disorders.[2] The most prevalent lymphatic disorder is lymphatic insufficiency, or lymphedema. Lymphatic fluid is accumulated in the interstitial tissue causing swelling, most often in the arm(s) and/or leg(s), and occasionally in other parts of the body. The space and lymphatic correction techniques are thought to reduce pressure by lifting the skin and acting as channels to direct the exudates to the nearest lymph duct. Regarding neurological pathologies according to the KT® manual, when the application is followed correctly, the taped area can be used to facilitate a weakened or hypotonic muscle, recover sensory deficits, reduce spasticity and relax an overused muscle.[3]

At present, studying these effects has revealed conflicting data. For example, the KT® did not alter muscle activity before, during, or after a sudden inversion perturbation in 43 male athletes balancing on a tilt board.[11] In contrast, following placement of the KT® on the anterior thigh of 27 healthy participants, an increase in the bioelectrical activity of the vastus medialis muscle after 24 hours was demonstrated. This effect was maintained for another 48 hours following removal of the tape.[12]

There appears to be at least some merit for using the KT® as a treatment adjunct.[13, 14] However, according to the evidence-base practice paradigm,[15] careful examination of the current literature is warranted in order to clarify whether the KT® has significant clinical benefits. Therefore, the primary purpose of this systematic review was to examine the effects of therapeutic KT® application on pain, muscle strength and range of motion in participants suffering from musculoskeletal pathologies. We also examined the effects of therapeutic KT® on related disorders in participants suffering neurological and lymphatic pathologies.

Materials and methods

Four online databases (CINAHL, Cochrane Library, MEDLINE, PEDro) were comprehensively searched from their inception through March 2012. The search query included the terms "kinesio tape", "kinesio taping", "kinesiology tape", "KT®", and "kinesiology taping", entered with and without spacing between two words. Since KT® originated in Japan, it has been widely accepted in many Asian countries. In order to estimate the extent of this relatively new treatment, no restrictions were initially placed on the publications or language. The reference lists of viable studies were cross-referenced in order to identify additional articles undetected in the original medical database searches.

Following each database search, two independent reviewers (A.K, S.B) selected the articles to be included in the systematic review. Articles were excluded from the search owing to duplication and a language other than English. Each study title was then screened for relevance. Abstracts with relevant titles were then reviewed for pertinence. At this stage, case studies, expert opinions, small pilot studies and trials performed on children were excluded. If an abstract suggested that the manuscript provided information relating to the effect of KT on orthopedic, neurologic or lymphatic disorders, the article was subsequently read and thoroughly assessed for inclusion or exclusion criteria.

Studies were included if they satisfied the following criteria: 1) the treatment group received KT®; 2) only patients diagnosed with musculoskeletal, neurological or lymphatic complaints were included in the study; 3) a detailed description of the KT® application; 4) detailed eligibility criteria for patients participating in the study were provided; 5) primary outcome measures including at least one of the following parameters: pain, muscle strength or range of motion. Regarding lymphatic pathologies, we included outcome measurement of edema volume.

Studies were excluded based on the following criteria: 1) absence of a comparison group; and 2) KT® application performed solely on healthy participants.

Two reviewers (A.K, S.B) independently applied the criteria in order to select potential relevant studies from the full text. A consensus method was used to solve any disagreements concerning inclusion of studies. Quality of selected studies was obtained by utilizing the PEDro scale.[16] This scale helped to identify which of the known or suspected randomized clinical trials or case control trials were likely to be internally valid, and would have sufficient statisti-

cal information to accurately interpret their results The scale scores 10 items; each item is scored as either present (1) or absent (0) and a score of 10 is obtained by summation. Two reviewers independently appraised the methodological quality of the included studies. Due to the wide heterogeneity of the patient selection and the KT® application methods, a meta-analysis was deemed unsuitable. Relevant articles were categorized under three subheadings: musculoskeletal, neurological and lymphatic disorders.

Results

The initial literature search found 91controlled trials. Following elimination due to duplication, and/or a language other than English, single case reports, irrelevant titles or abstracts, small pilot studies and expert opinions, 26 studies were fully screened. Subsequently, 12 studies met our inclusion criteria. With regard to study selection, there was excellent reviewer agreement. The absolute agreement between raters for screening procedures was 96%. Figure 1 illustrates the identification process. The final 12 articles were subdivided according to the basic pathological disorders of the participants. Results are presented accordingly. Table I summarizes the main features of the 12 articles included in the present review. Table II presents the methodological quality of selected articles according to the PEDro scale.

Effect of KT® on musculoskeletal disorders

Nine articles relating to musculoskeletal disorders were thoroughly investigated and included in the present study. Out of the 9, 4 were double blinded randomized controlled trials (RCT), 3 were single blinded RCT, 1 was a cross-over trial and 1 used a case control (patients vs. healthy participants) within the study design. Orthopedic disorders included 3 studies addressing shoulder impingement syndrome,[17-19] two addressing patella femoral pain [20, 21] and four single studies comprising patients with chronic low back pain,[22] plantar fasciitis,[23] acute neck pain,[24] and Achilles tendinopathy.[25]

All studies reported the use of one or more KT® strips applied according to Kase's principles.[3] The use of additional modalities and therapeutic exercises varied. Regarding the comparison group, 4 studies used placebo KT®.[17, 18, 20, 24] This taping application looks very similar to therapeutic KT® but all therapeutic elements have been removed. The placebo taping usually consists of the same material as the real application, which is applied without tension. Four studies used applied traditional physical therapy modalities including therapeutic exercises, muscle strengthening, soft tissue stretching, ultrasound therapy and sensory electrical stimulation.[19, 21-23] A single study used healthy participants.[25]As to patient characteristics, with the exception of a single study dealing with acute whiplash syndrome,[24] the average duration of symptom onset was two months or more, indicating a subacute or chronic orthopedic condition. Outcome assessments were performed prior and immediately following the KT® application. Only three studies included a short-term follow-up, varying from 24 hours to two weeks.[17, 19, 24]

Pain

With the exception of one study,[23] all others reported preintervention and post-intervention pain values mainly using the visual analog scale (VAS). Six studies [17, 19, 21-24] demonstrated an immediate reduction in pain intensity following the KT application. In three out of the six studies, reduction of pain was superior to that of the comparison group. Gonzales *et al.*[24] reported that when measured against the placebo KT® group, patients in the intervention group experienced a greater reduction in neck pain immediately post-therapeutic KT® application (-1 [95% CI: -1.2, -0.8] and at the 24-hour follow up (-1.1 [95% CI: -1.5, -0.9]). Kaya *et al.*[19] demonstrated a larger reduction in pain intensity at rest, at night and during active shoulder elevation movements in the KT® intervention group compared to controls, at the first week examination compared to baseline (P=0.001). Tsai *et al.*[23] measured pain intensity in 52 subjects suffering from plantar fasciitis. According to the McGill pain questionnaire a larger reduction was reported in the KT® intervention group compared to the control group (-5.14± 3.81 *vs.* -2.75± 2.55; P<0.005).

Two studies [21, 22] demonstrated a similar reduction of pain (low back pain and patellofemoral pain, respectively) between the KT® therapeutic intervention group and a controlled exercise group. Furthermore, there was no additional pain reduction when

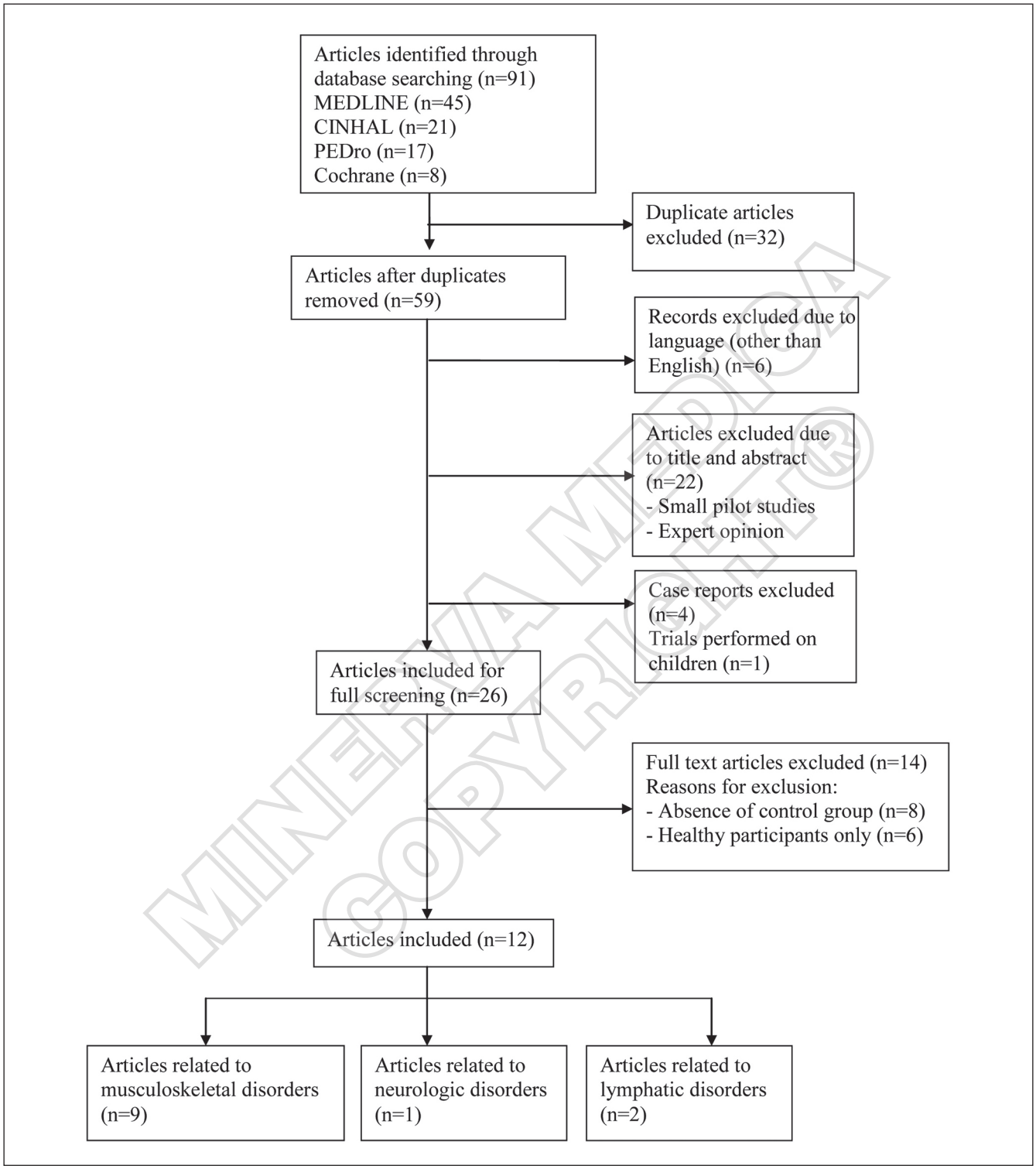

Figure 1.—Study selection flow diagram.

TABLE I.—*Main features of articles included in final analyses.*

Study	Study design	Participants	Clinical condition	KT practitioner	Intervention	Outcome measures	Results
Kaya *et al* (2010) [19] Turkey	RCT	55 patients assigned to: – Physical therapy group (N.=25) – Therapeutic KT® (N.=30)	Shoulder impingement syndrome	Not defined	Both groups received a home base exercise program. Additionally; – KT® group included 3 strips with tension on the deltoid, supraspinatus and teres minor muscles. Tape was worn 3 times with a 3 day interval. – Physical therapy group received US, TENS and hot pack daily for two weeks.	1. VAS with and without shoulder movement. 2. Disability of arm, shoulder and hand scale. Assessment performed at baseline and at a 1 and 2 week follow up.	KT® group demonstrated reduced pain at first week. (P=0.001) No differences between the two groups at second week
Hsu *et al.* (2008) [18] Taiwan	Cross-over trial	17 amateur baseball players	Shoulder impingement syndrome	Not defined	All participants received two types of taping: therapeutic KT directed to the lower trapezius muscle and placebo taping.	EMG activity of the upper and lower trapeziums and the serratus anterior muscle during arm elevation.	KT® improved: – Lower trapezium activity during 600-300 of the lowering phase of arm scapation (P<0.05) – increased Scapular posterior tilt at 300 and 600 of arm scapation (P<0.05)
Firth *et al.* (2010) [25] UK	Case control – within subject design	48 participants – people with Achilles (N.=24) tendinopathy – healthy people (N.=24)	Achilles tendinopathy	4 senior PT	Both groups received KT® over the Achilles tendon.	1. Single-leg hop test 2. VAS 3. Change in motoneural excitability of calf muscles. Measurements were taken with and without the tape.	– No changes regarding hop distance and pain when tape applied. – Calf muscles were facilitated by KT® solely in healthy participants. (P<0.001)
Gonzales *et al.* (2009) [24] USA	RCT	41 participants randomized to – Therapeutic KT® (N.=21) – Placebo KT® (N.=20)	Acute whiplash injury	Single PT	Therapeutic KT®: 2 strips with tension (Posterior cervical muscles and mid-cervical region) Placebo KT: 2 strips with no tension	1. Numerical pain scale 2. Neck disability index 3. Cervical ROM Assessment performed at baseline, immediate post treatment and at a 24h follow up.	Therapeutic KT® group demonstrated improvements in pain and ROM immediately post application and at a 24h follow up (both, P<0.001).
Paoloni *et al.* (2011) [22] Italy	RCT	39 patients randomized one of three groups: – KT® plus exercice (N.=13) – KT® alone (N.=13) – exercise alone (N.=13)	Chronic low back pain	Single PT	KT® was applied by 3 longitudinal strips with tension (changed every 3 days). Therapeutic exercises consisted 30min, 3 times weekly for 4 weeks.	1. VAS 2. RMDQ Assessment performed at baseline, immediate post application and at the end of treatment (fourth week)	1. Immediate post application reduction in VAS in KT® groups. Average reduction of 1.7 ± 1.6; P<0.001 No differences between KT® groups. 2. Following 4 weeks, all groups presented with pain reduction. (F=64.93; P<0.0001). Only the exercise-alone group presented with a decrease in pain-related disability (F=6.03; P=0.01)
Tsai *et al.* (2010) [23] Taiwan	RCT	52 patients randomly and divided into: – KT® plus traditional physical therapy (N.=26) – Traditional physical therapy (N.=26)	Plantar fasciitis	Single PT	Both groups received US and TENS modalities on a daily basis for one week. – KT® included 2 strips with tension on the plantar fascia and gastrocnemius muscle	1. McGill pain questionnaire 2. Ultrasonographic (measuring of plantar fascia thickness) Assessment performed at baseline and end of intervention program.	KT® group demonstrated a larger decrease in pain intensity (-5.14± 3.81 *vs.* -2.75± 2.55; P<0.005). and reduced thickness of plantar fascia compared to the control group (P<0.005).
Aytar *et al.* (2011) [20] Turkey	RCT	22 subjects with patella femoral pain syndrome divided into two groups: -Therapeutic KT® (N.=11) -Placebo KT (N.=11)	Patello femoral pain syndrome	Single PT	Therapeutic KT® – Two strips with tension over the anterior thigh. Placebo KT® –A sticking plaster without stretch material.	1. Quadriceps muscle strength 2. Joint position sense 3. Static and dynamic balance 4. Pain intensity Measurements were taken before and 45 min after application.	No differences between groups in all outcome measures.

TABLE I.—*Continues from previous page.*

Study	Study design	Participants	Clinical condition	KT practitioner	Intervention	Outcome measures	Results
Akbas *et al.* (2011) [21] Turkey	RCT	31 women with patella femoral pain syndrome divided into two groups: -Therapeutic KT® (N.=15) -control group (N.=16)	Patello femoral pain syndrome	Two experienced PT	Both groups received a 6-week home based program including knee muscle strengthening and soft tissue stretching. KT® group additionally received KT® at five days interval for 6 weeks. KT® strips was applied over quadriceps, ITB, VMO and hamstrings	1. VAS during 9 activities: resting, prolonged sitting with knees flexed, kneeling, walking, squatting, ascending and descending stairs, going up and down hills. 2. Caliper to evaluate mediolateral position of patella. 3. Ober's test 4. Hamstring tension length. Assessment performed at baseline and at end of week 32 and 6. 4. Anterior knee pain scale / Kujala scale	In both groups pain decreased for all positions (P<0.05). hamstring tension decreased (P<0.05), ITB length increased (P<0.05) and Kujala score increased (P<0.05). No difference between groups in all measurements (P>0.05).
Thelen *et al.* (2008) [17] USA	RCT	42 participants assigned to – Therapeutic KT® (N.=21) – Placebo KT® (N.=21)	Rotator cuff tendonitis / impingement	Single PT	Therapeutic KT®: 3 strips with tension (Deltoid and Supraspinatus muscles) Placebo KT®: 2 strips with no tension	1. VAS 2. Shoulder ROM 3. Shoulder pain index Assessment performed at baseline and at a 3, 6 day follow-up	Therapeutic KT® showed immediate improvement in pain free ROM abduction. 16.9° ± 23.2°; P=0.005 No other differences at any time.
Bialoszewski *et al.* (2009) [28] Poland	RCT	24 patients randomly divided into the following groups: – KT® and physical therapy (N.=12) – Physical therapy and standard lymphatic drainage (N.=12).	Patients with lower limb edema following limb lengthening using the Ilazarov method	Not defined	– KT® was in the form of four strips without tension (Fork strip). Strips were maintained for an average of 10 days. – Lymphatic drainage massage was performed once a day for 10 days.	Circumferences were measured at three areas in the thigh, two areas at the crus and at the knee	The KT® group, demonstrated a decrease in the thigh in all three areas (P=0.02) and in both measurement areas in the crus (P=0.03). The control group demonstrated a decrease in two out of the three areas of the thigh and in one of the two areas in the crus. In both groups- no reduction of edema at the knee.
Tsai *et al.* (2009) [27] Taiwan	RCT (Single blinded)	41 patients divided into: – KT® group (N,=20) – Bandage group (N.=21)	Breast cancer related lymphedema	4 PT	Both groups received standard decongestive lymphatic therapy combined with pneumatic compression. Difference between groups was the addition of KT® or a short stretch bandage. Intervention was given for 4 weeks, 5 days per week.	1. Limb size 2. Water composition of the upper extremity. 3. Lymphadema- related symptoms. 4. Health-related quality of life. – Assessment performed on baseline, following a 4-week control period, following 4-week intervention period and at a 3 month follow up.	No differences between groups in all outcome variables throughout the entire study period.
Karadag-Saygi *et al.* (2010) [26] Turkey	RCT (Double blinded)	20 hemiplegic patients randomized divided into the following groups: – Therapeutic KT® + a botolinum toxin injection (N.=10) – Placebo KT® + a botolinum toxin injection (N.=10)	Hemiplegic patients with spastic equines foot	Single PT	Therapeutic strips of KT® were applied with tension over the plantar flexors.	1. Modified Ashworth scale. 2. Passive ankle dorsiflexion 3. Step length 4. Gait velocity Assessment performed at baseline and at week 2 and 1,3,6 months follow up	Intergroup comparison demonstrated an average benefit of 5° (P=0.015) in passive dorsiflexion in the therapeutic KT® group only at two weeks. No other differences between groups.

ITB: iliotibial band; KT: kinesio taping; PT: physical therapist; RCT: randomized controlled trial; ROM: range of motion; RMDQ: Roland Morris disability questionnaire; VMO: vastus medialis oblique; US: ultrasound; VAS: visual analogue scale.

TABLE II.—*Methodological quality of selected articles according to the PEDro scale.*

Included study / PEDro criteria	Karadag-Saygi *et al.* (2010) [26]	Tsai *et al.* (2009) [23]	Bialoszewski *et al.* (2009) [28]	Kaya *et al.* (2010) [19]	Hsu *et al.* (2008) [18]	Firth *et al.* (2010) [25]	Gonzales *et al.* (2009) [24]	Paoloni *et al.* (2011) [22]	Tsai *et al.* (2010) [27]	Aytar *et al.* (2011) [20]	Akbas *et al.* (2011) [21]	Thelen *et al.* (2008) [17]
Eligibility*	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Random allocation	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Concealed allocation	No	Yes	No	No	No	No	Yes	No	Yes	No	No	Yes
Baseline comparability	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Blind subjects	Yes	No	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes
Blind therapists	No	No	No	No	No	No	No	No	No	No	No	No
Blind assessors	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Adequate follow-up	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Intention-to-treat analysis	No	No	No	No	No	Yes	No	Yes	No	No	No	Yes
Between-group comparisons	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Point estimates and variability	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total score (0-10)	7/10	7/10	3/10	5/10	4/10	5/10	8/10	7/10	5/10	7/10	6/10	9/10

*Eligibility criteria is not included in the scoring of Pedro scale.

the KT® was combined with exercises compared to exercise alone. Additionally, Thelen *et al.*[17] did not observe significant differences in reduction of shoulder pain intensity scores between therapeutic KT® and placebo KT® taping groups. Two studies [20, 25] failed to demonstrate a reduction in pain intensity following a KT® intervention program. None of the studies provided evidence of pain reduction, at any period of time, following removal of the therapeutic KT®.

Muscle strength

Three articles included assessment of muscle strength.[18, 20, 25] Hsu *et al.*[18] measured the EMG activity of the upper and lower trapeziums and the serratus anterior muscle during arm elevation of baseball players with shoulder impingement while wearing therapeutic KT®. Lower trapezium activity improved during 60°-30° of the lowering phase of arm scapation ($P<0.05$). Aytar *et al.*[20] examined 22 subjects with patellofemoral pain. Assessment included quadriceps muscle strength. No significant differences were found between the therapeutic KT® intervention group and the placebo group. Firth *et al.*[25] assessed the strength of the soleus and gastrocnemius muscle via the hop test and Hoffman reflex amplitudes in 29 participants suffering from Achilles tendinopathy. Results failed to demonstrate significant differences in hop distance and motoneural excitability of calf muscles during the application of the tape.

Range of movement

Three studies evaluated joint range of movement.[17, 18, 24] Thelen *et al.*[17] found that on the first day of therapeutic KT® application, the change score for pain free shoulder abduction range of movement, significantly improved when compared to the placebo KT® group ($F_{1,41}=8.8$; $P=0.005$). A mean difference of 19.1° (99% CI:1.7, 36.5) was shown. No benefit was found on follow up day three and six. No effect was confirmed as to shoulder forward flexion on the first day of application through follow-up. One study examined muscle flexibility [21] and demonstrated better hamstring flexibility (measured using a conventional goniometer) in both the KT® group and control group at the end of the three week and six week intervention program. No statement was defined relating to differences between groups.

Similarly, Hsu *et al.*[18] measured the scapular motion of baseball players with shoulder impingement while wearing therapeutic KT®. Compared to the placebo taping group, the only difference demonstrated in the KT® group was an increased scapular posterior tilt at 30^0 and 60° of humeral elevation, though change in scapular displacement was not statistically different between the groups. Conversely, Gonzales *et al.*[24] examined patients suffering from an acute whiplash injury and found that patients who had received therapeutic KT® compared to placebo KT®, demonstrated an immediate overall improvement in all directions of cervical range of motion: flexion (F=50.8; P<0.001), extension (F=50.7; P<0.001), right (F=39.5; P<0.001) and left (F=3.8; P<0.05) lateral flexion, and right (F=33.9; P<0.001) and left (F=39.5; P<0.001) rotation.

Effect of KT® on neurologic disorders

Following the inclusion criteria, only one study was included in the present review. Karadag-Sayagi *et al.*[26] examined 20 hemiplegic patients with spastic equinus foot. Patients were enrolled and equally randomized into one of the two groups. One group received a botulinium toxin-A injection and therapeutic KT®, the second received a similar injection and placebo taping. No significant differences were found between the groups as to gait velocity, step length and spasticity level.

Effect of KT® on lymphatic disorders

Two studies were included in the final review process.[27, 28] Tsai *et al.*[27] examined 41 patients with unilateral breast-cancer-related lymphedema. Participants were randomly grouped into one of the following groups: one group received standard decongestive lymphatic therapy; the second group received a similar intervention combined with the KT®. No significant differences were found between the groups in limb size, water composition of the upper extremity, lymphedema-related syndromes and health-related quality of life score.

Bialoszewski *et al.*[28] examined 24 patients who had been subjected to lower limb lengthening using the Ilizarov method and had developed edema of the thigh. Patients were randomized into two groups. The intervention group received 10 consecutive days of standard lymphatic drainage therapy combined with the KT® while the control group received only standard lymphatic drainage. Measurements were taken in three areas of the thigh, two areas of the lower leg and at the knee. The KT® group, demonstrated a significant decrease in the circumference of the thigh in all measurement areas (P=0.02) and in both measurement areas in the lower leg (P=0.03). In contrast, the control group demonstrated a decrease in only two out of the three measurement areas of the thigh and in one of the the two areas in the lower leg. In both groups, decreased edema at the knee did not meet significant level. Statistical analysis was not performed between groups.

Discussion

KT® has been suggested as an alternative treatment for a wide range of pain pathologies.[2] This systematic review assessed evidence of the KT® effect taken from 12 clinical trials (432 participants), comparing outcomes on pain, disability, range of movement, muscle strength and function. The majority of included studies (N.=4) originated in Turkey. Three studies were conducted in Taiwan and two from the USA. The remaining three studies were conducted in Italy, Poland and the United Kingdom. All articles were published during the last four years, with 7 out of the 12 published during the last two years (2010-2011).

Our main findings indicate inconclusive evidence of a beneficial effect of treatment with KT®. The majority of data included in this review originated from studies performed on patients suffering from pathologies in the muscular and skeletal systems (N.=9). In this subgroup, 6 out of 8 studies demonstrated an immediate reduction in pain intensity following the KT® application. However, a greater reduction of pain was found in 3 out of the 6 studies compared to the control group. Nevertheless, due to the fact that the majority of studies did not include follow up assessment, there is no support indicating any long-term effect. As to muscle strength, three studies examined this parameter. While the study examining scapular muscle activity provided evidence connecting KT® application to elevated, muscle strength, the studies dealing with the knee and ankle region failed to demonstrate significant motor effects. Moreover, range of movement was assessed by three studies; two examined the shoulder joint

and one the neck. Although, these trials provided evidence of an immediate positive effect, no long-term effect was reported.

Concerning the KT® effect on neurological impairments, only one article met our inclusion criteria, limiting the drawing of solid conclusions. Despite this constriction, we found no evidence of any effect of KT® on hemiplegic patients. A similar quantity limitation concerned lymphatic disorders, whereas only two reports met the inclusion criteria. Inconclusive evidence was reported in both studies. While Tsai *et al*.[27] failed to observe differences between the KT® intervention and the control groups, Bialoszewski *et al*.[28] demonstrated a superior reduction of edema in the lower limb in the KT® group. However, statistical analysis compared only changes within the groups, leaving doubts as to authors' conclusions.

It is worth noting that the present review excluded single case reports and studies performed solely on healthy participants. Although these articles provided information on the effects of KT®, practitioners should be cautious before concluding that similar effects can be achieved on a clinical population. Despite these statements, we shall introduce significant findings from a few studies performed on healthy participants or sport athletes. These studies provide relevant clinical data, providing rationalization for further examination of this relatively new treatment technique.

Fu *et al*.[29] examined the immediate and delayed effects of KT® on the isokinetic muscle strength of the knee flexors and extensors in 14 healthy young athletes. Their main findings demonstrated neither decreased nor increased muscle power during KT® application and 12 hours after its removal. Chang *et al*.[10] found no significant improvement in maximal grip strength after applying KT® on the forearm of 21 healthy collegiate athletes. Similar conclusions were observed by Lee *et al*.[30] The study carried out on 17 healthy participants, examined the influence of KT® on the motor neuron conduction velocity of major peripheral nerves of the upper limb (ulnar, median, radial). Results confirmed no significant differences in motor nerve conduction parameters when applying the KT® to no application at all. Finally, Halseth *et al*.[9] failed to observe improvement of proprioception sense at the ankle joint in thirty healthy individuals during KT® application.

In contrast to these documents, single case reports reported positive results achieved with KT®. These included reduction of myofascial pain in the shoulder,[31] enhanced quadriceps activity, weight bearing stability in the management of traumatic patella dislocation,[4] increased trunk range of motion in a patient suffering from acute low back pain [6] and enhanced shoulder girdle functional abilities following a brachial plexus injury.[5] As stated earlier, these data represent lower levels of clinical evidence.

Strengths and limitations

The primary limitation of the current review was the inability to carry out a meta-analysis due to the limited number of RCT's, broad patient and pathologic selection and an unbounded variation among the comparative KT® intervention applications. Although all articles included in this review underscored that KT® intervention procedures were according to Dr. Kase's original concept, each of the included articles utilized the KT® application technique in a different manner, even while addressing a similar pathologic disorder.

Additionally, while our search through four databases was extensive, biases may have existed within our search criteria. Literature searches were performed in medical databases accessible through medical institutions or online. While these databases captured a majority of KT® trials, it is possible that they might have missed or failed to index other trials. Moreover, our decision to exclude articles published only in English might have excluded pertinent articles in other languages.

We shall not conclude before addressing an exceptional feature of the KT® application: its wide spreading popularity. The KT® has been extensively used in many Asian countries and since the Beijing 2008 Olympics has increased in popularity in Europe and North America. Many practitioners, mainly physical and manual therapists, employ KT® in their clinical practice, especially in treating sports injuries. During the last decade, a dramatic increase has been observed in the number of new KT® distributors offering KT® seminars, courses, products and accessories. Products and application methods are directed towards individuals (not only companies), who suffer from disorders relating to the muscular, skeletal, nervous and lymphatic systems.

In contrast with most physical therapy modalities (medical exercises, joint passive mobilization techniques, thermo and electrotherapy devices, etc), KT® tape is marketed in a wide range of bright colors, application methods are creative and promotion strategies are far more intense than any other physical therapy modality. Moreover, the KT® application is a visible treatment.

As a consequence of its rising popularity among active sport professionals, more and more individuals are becoming aware of this application (ie viewing sport competitions on TV or the internet). It is assumed that patients, especially those involved in amateur sport activities, tend to gravitate towards techniques or modalities they believe have helped the professional sport community. However, they are also uninformed as to the application's effectiveness.

Conclusions

One of the primary roles of the health professional is to confirm, through evidence- based knowledge, the effectiveness of a treatment modality, not only due to its popularity. Therefore, future studies are still warranted in order to characterize the KT® effect on different pain and movement disorders within a wide range of pathologic disabilities.

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