Kinesio taping in musculoskeletal pain and disability that lasts for more than 4 weeks: Is it time to peel off the tape and throw it out with the sweat? A systematic review with me...

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Kinesio taping in musculoskeletal pain and disability that lasts for more than 4 weeks: is it time to peel off the tape and throw it out with the sweat? A systematic review with meta-analysis focused on pain and also methods of tape application

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ABSTRACT

Introduction In recent years, Kinesio tape has been used to support injured muscle and joints, and relieve pain. We compared the pain and disability in individuals with chronic musculoskeletal pain who were treated with Kinesio taping with those using minimal or other treatment approaches.

Methods Searches of eight major electronic databases were conducted. Data for pain and disability scores were extracted. Meta-analyses (wherever possible) with either a fixed or random effect(s) model, standardised mean differences (SMDs) and tests of heterogeneity were performed.

Results Seventeen clinical-controlled trials were identified and included in the meta-analyses. When compared to minimal intervention, Kinesio taping provided superior pain relief (pooled SMD=−0.36, 95% CI −0.64 to −0.09, p=0.009) but the pooled disability scores were not significantly different (pooled SMD=−0.41, 95% CI −0.83 to 0.01, p=0.05). No significant differences were found when comparing Kinesio taping to other treatment approaches for pain (pooled SMD=−0.44, 95% CI −1.69 to 0.82, p=0.49) and disability (pooled SMD=0.08, 95% CI −0.27 to 0.43, p=0.65).

Discussion Kinesio taping is superior to minimal intervention for pain relief. Existing evidence does not establish the superiority of Kinesio taping to other treatment approaches to reduce pain and disability for individuals with chronic musculoskeletal pain.

INTRODUCTION

In recent years, the application of Kinesio tape (KT) has emerged as an interesting and relatively novel method for treating musculoskeletal conditions.[1] This elastic tape purportedly mimics the thickness of the skin and the manufacturers claim it works by lifting the skin, which increases blood circulation and lymphatic drainage leading to a reduction in pain.[2] Ever since it was donated for use during the high-volume physiotherapy treatment at the Olympic Games,[3 4] it is now increasingly seen on high-profile athletes and is being used by healthcare practitioners today.[5]

The bulk of published literature does not favour the use of KT to improve range of motion,[6] strength,[7 8] proprioception[9] and functional performance.[10] However, there have been limited positive findings in terms of range of motion[11 12] and strength.[13] Many systematic reviews[4 14–17] did not report effectiveness of Kinesio taping for musculoskeletal injuries in clinical practice; however, some reviews[18 19] have reported evidence for pain reduction with the use of KT. From a methodological perspective, many of the reviews[14–16 18] used a descriptive approach to summarise their results, while the others[4 17 19] attempted a quantitative approach to evaluate the effects of KT on certain clinical parameters. Even though there have been extensive efforts invested in evaluating the efficacy of KT, there is still a dearth of attempts in collating the findings of individual studies to determine the effects of KT application on pain and disability, and, if it does, the magnitude of these effects.

We aimed to systematically review randomised controlled trials comparing the effect of KT (intervention) with other forms of interventions (comparisons) for pain and disability (outcomes) in individuals with chronic musculoskeletal pain (participants). We included trials that also had individuals with chronic musculoskeletal pain or musculoskeletal pain persisting beyond the acute phase, defined as pain lasting longer than 4 weeks.[20] A secondary objective was to review the parameters of KT application and to investigate whether these factors influence pain and disability outcomes.

METHODS

Search strategy

We searched MEDLINE (1966–present), CINAHL (1966–present), EMBASE (all years), Cochrane Central Register of Controlled Trials, Physiotherapy Evidence Database (PEDro), Scopus, Google Scholar and ProQuest Dissertations and Theses databases for literature on the use of Kinesio taping for pain and disability in chronic musculoskeletal conditions. The limits applied included 'humans' and 'randomised controlled trials'. The last search was run on 2 July 2014. The following search terms were used to search the databases: kinesio taping; kinesio* adj2 taping; taping and strapping; and musculoskeletal pain. These steps were then repeated for the other databases. The reviewers followed a selection process, defined prior to the beginning of the review, which included a checklist for inclusion criteria. Articles were eligible for inclusion if they were randomised controlled human trials, included individuals with chronic musculoskeletal pain condition or musculoskeletal

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pain that persisted beyond the acute phase,[20] assigned an experimental group to receive treatment which includes KT, assigned the comparison group to receive other forms of interventions other than KT and those which used outcome measures that included pain and disability measures. Eligibility assessment for the manuscript was performed by two reviewers (ECWL and MGXT). Disagreements between reviewers were resolved by consensus.

Data extraction and quality assessment

The methodological quality of the trials was assessed using the 11-item PEDro scale.[21] Assessment of quality of trials was performed by two independent reviewers (ECWL and MGXT). We assessed the methodological quality of the studies by evaluating the domains of population, treatment allocation, blinding, prognostic comparability and analysis. By using a standardised extraction form the information on characteristics of trial participants (age, gender and duration of complaint), details of intervention (amount of tension applied and duration of each tape worn in situ), and pre-outcome and post-outcome measures (pain and disability) was extracted from each included trial. Outcomes that were closer to the end of treatment were used whenever there were multiple time points within a study. If the outcomes were reported for more than one activity, testing condition, or over more than one site, the pre-outcome and post-outcome measures which gave the worst mean difference were extracted. When there was inadequate information about the outcomes to allow data analysis, the authors were contacted. Of the three authors who were contacted, one replied to our queries.[22]

Quantitative data synthesis and analysis

Reliability analyses of inter-rater agreement were performed with PASW Statistics V.18.0 for Windows (SPSS Inc, Chicago, Illinois, USA). Inter-rater reliability was reported for the total quality score with κ statistics[23] and was interpreted as poor (<0.00), slight (0.00–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80) or almost perfect (0.81–1.0).

Where appropriate and possible, the results were pooled with formal meta-analytical techniques using RevMan 5 (Copenhagen, Denmark: The Nordic Cochrane Centre, The Cochrane Collaboration, 2006). To account for differing outcome scales used in the studies, we calculated the standardised mean differences (SMDs) for pain and disability scores, their 95% CIs and performed tests of heterogeneity (χ^2). The I^2 statistic was used to measure the extent of between-trial heterogeneity. Fixed effects or random effects models were used as appropriate and were based on our interpretation of commonality of effect size.[24] For example, data were pooled using a random effects model, if trials differed in ways that might have plausibly impacted on the pooled outcome.[24]

Subgroup analyses based on intervention (control arm) strata were then analysed to make the control arm more comparable to the arm with KT. For example, trials in which participants received no taping or sham taping when assigned to the control groups were grouped as 'KT versus minimal intervention'. Such grouping also included trials which used other methods of ensuring minimal intervention to the control arm, that is, by providing exercise, general physiotherapy, etc to both groups. In contrast, trials in which participants received treatment (other than KT) when assigned to the control groups were grouped as 'KT versus other forms of intervention'. The differences were calculated such that negative differences indicated that the results favoured KT, while positive differences indicated that the results favoured the alternate intervention (ie, minimal intervention or other forms of intervention). For all analyses, significance was set at $p<0.05$. To assess the risk of publication bias (resulting from non-publication of small trials with negative results), we also plotted SMD versus SE for both pain and disability scores.[25] The symmetry of this 'funnel plot' was assessed visually.[25] A funnel plot is a scatter plot of intervention effect against a measure of study size. It is used primarily as a visual aid in detecting bias or systematic heterogeneity. A symmetric inverted funnel shape arises from a 'well-behaved' data set in which publication bias is unlikely. An asymmetric funnel indicates a relationship between intervention effect and study size. This suggests the possibility of either publication bias or a systematic difference between smaller and larger studies ('small study effects').

RESULTS

Study selection

The initial electronic database search resulted in a total of 606 articles; of these, 29 were selected for detailed inspection and 17 eligible papers remained in this review. Figure 1 shows the flow of papers through review and includes the reasons for exclusion of articles. One additional paper[26] was also discovered during a more detailed reading of these papers and was included.

Methodological quality

There was substantial agreement between the two reviewers ($\kappa=0.62$, $p<0.001$). Percentage of agreement for individual items ranged from 36.4% to 100%. The methodological quality assessment using the PEDro scale revealed a mean score of 6.17 (range 3–9) of a possible 10 points; that is, quality scores for individual studies ranged from 30% to 90% (3–9) of maximum possible attainable points (table 1). Criteria commonly not met were concealment of allocation, and blinding of treating therapists and patients. It was noted that one of the cross-over randomised trials[27] used insufficient amount of time for 'washout' between treatment periods, which may give rise to a carryover effect[28] and potentially affect the pooled estimates. Consequently, we decided to exclude this paper due to methodological concern.

Study characteristics

Seventeen trials (416 patients in the experimental group and 406 patients in the control group), which had data for measures of pain and/or disability, were available for pooling (figure 2). Four trials evaluated the effects of KT on pain and/or disability in knee pain,[29–31 36] four trials in low back pain,[32 34 37 38] three trials in neck pain,[33 35 39] two trials in shoulder pain,[41 42] two trials in plantar fasciitis,[26 40] one trial in de Quervain's disease[22] and one trial in myofascial pain.[43] Evidence of considerable symmetry in the funnel plots (figure 2A, B) was visually confirmed. The studies were distributed symmetrically about the combined effect size and there was an equal concentration of studies on either side of the SMD.

Pain—KT versus minimal intervention

Data were pooled using a random effects model; there was a significant pooled SMD in pain (−0.68, 95% CI −1.11 to −0.25, $p=0.002$) between the KT and minimal intervention groups. There was a high level of heterogeneity ($I^2=80\%$, $\tau^2=0.40$, $\chi^2=49.39$, df=10, $p<0.00001$; figure 3A). To investigate whether the presence of outliers could have contributed to the overall significance, we excluded two studies.[30 33] However, the

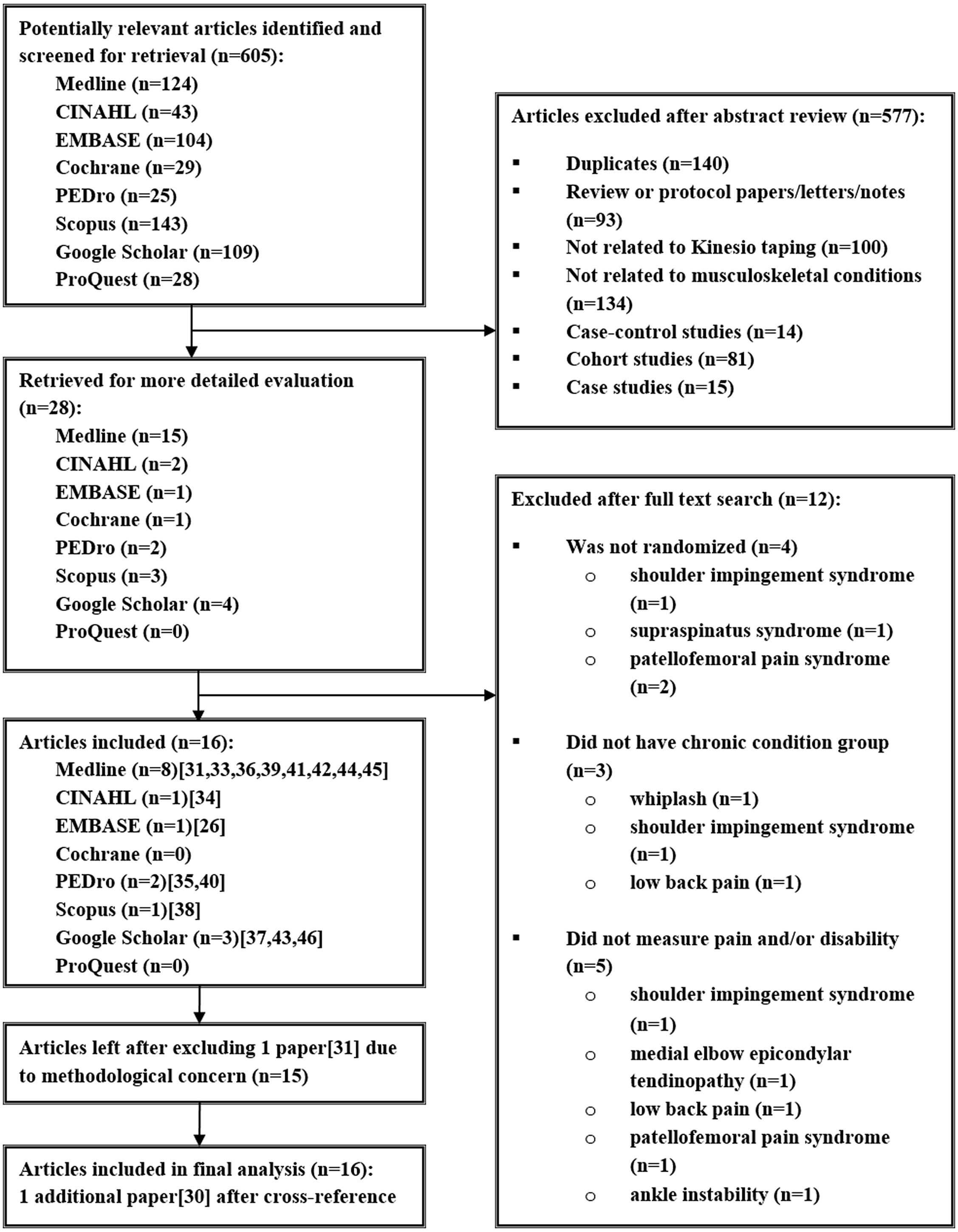

Figure 1 Selection process for studies included in analysis.

pooled SMD in pain between the groups remained significant (−0.36, 95% CI −0.64 to −0.09, p=0.009) with a low-to-moderate level of heterogeneity (I^2=42%, τ^2=0.07, χ^2=13.87, df=8, p=0.09).

Pain—KT versus other forms of intervention

When comparing SMD in pain between the KT and other intervention groups, the pooled SMD in pain between the groups was not significant (−0.44, 95% CI −1.69 to 0.82, p=0.49) with a high level of heterogeneity (I^2=96%, τ^2=2.72, χ^2=154.58, df=6, p<0.00001; figure 3A).

Disability—KT versus minimal intervention

When comparing SMD in disability between the KT and minimal intervention groups, the pooled SMD in disability between the groups was not significant (−0.41, 95% CI −0.83 to 0.01, p=0.05) with a moderate level of heterogeneity (I^2=66%, τ^2=0.15, χ^2=11.93, df=4, p=0.02; figure 3B).

Disability—KT versus other forms of intervention

When comparing SMD in disability between the KT and other intervention groups, the pooled SMD in disability between the groups was not significant (0.08, 95% CI −0.27 to 0.43,

Table 1 Details of the included randomised controlled trials

Author (year), study design, population	Intervention (n)	Age (years)	Gender (M, F)	Duration (months), mean (SD)	Brief details of intervention	Preintervention, mean (SD)	Postintervention, mean (SD)	Mean difference between groups (95% CI)	Score
Akbas (2011),[29] RCT, patellofemoral pain syndrome	KT+exercise=15	41.1 (11.3)	M 0, F 15	11.8 (10.8)	Individualised Kinesio taping, 5 strips, changed every 4–5 days for 6 weeks and home exercises (see below)	VAS pain* 2.57 (2.15)	1.71 (1.67)	0.5 (−0.21 to 1.22)	7
	Exercise=16	44.9 (7.75)	M 0, F 16	14.8 (16.3)	Home exercises—6 weeks of stretches, strengthening and open and closed chain exercises	VAS pain* 3.16 (3.98)	0.81 (1.16)		
Anandkumar (2014),[30] RCT, knee osteoarthritis	KT=20	55.7 (5.8)	M 9, F 11	8.4 (1.5)	Kinesio taping, 3 strips, 50–75% tension, origin to insertion, for 30 min	VAS pain 7.4 (1.1)	5.0 (1.3)	−2.07 (−2.85 to −1.28)	7
	Sham=20	55.9 (5.0)	M 8, F 12	8.4 (1.1)	Sham KT, without stretch, for 30 min	VAS pain 7.3 (1.3)	7.5 (1.2)		
Aytar (2011),[31] patellofemoral pain syndrome	KT=12	22.4 (1.62)	M 0, F 12	16.2 (9.68)	Kinesio taping, 4 strips, 50–75% tension, origin to insertion, 45 min	VAS pain* 42.5 (24.5)	42.1 (23.9)	0.14 (−0.7 to 0.98)	6
	Placebo=10	26.2 (3.52)	M 0, F 10	13.7 (8.0)	Placebo—plaster without stretch	VAS pain* 45.0 (23.2)	41.0 (23.8)		
Castro-Sanchez (2012),[32] RCT, low back pain	KT=30	50.0 (15.0)	M 9, F 21	Not reported	Kinesio taping, 4 strips, 25% tension, kept in situ for 1 week	VAS pain 5.6 (1.8) ODI 28.0 (3.0) RMDQ 10.9 (2.1)	4.7 (1.4) 26.0 (3.0) 9.8 (2.2)	VAS pain −0.72 (−1.25 to −0.19) ODI 0.0 (−2.17 to 2.17) RMDQ 0.1 (−1.22 to 1.42)	8
	Control=29	47.0 (13.0)	M 10, F 19		Sham KT application, 1 strip, kept in situ for a week	VAS pain 5.4 (1.3) ODI 29.0 (3.0) RMDQ 9.8 (2.9)	5.6 (1.4) 27.0 (6.0) 8.6 (3.0)		
Dawood (2013),[33] RCT, mechanical neck pain	KT+exercise=19	Range 22–36†	M 39, F 15	At least 3 months†	Kinesio taping, two strips, replaced every 4 days over 4 weeks and exercises (see below)	VAS pain 7.34 (0.86) NDI 23.87 (9.62)	2.56 (0.75) 9.53 (3.17)	VAS pain KT+exercise vs exercise−2.42 (−3.32 to −1.53) KT+exercise vs cervical traction +exercise −0.48 (−1.08 to 0.12) NDI KT+exercise vs exercise −9.62 (−15.0 to −4.29) KT+exercise vs cervical traction +exercise −2.3 (−8.06 to 3.46)	6
	Cervical traction +exercise=19				Cervical traction, 15–20 min, 3 times per week for 4 weeks and exercise (see below)	VAS pain 7.16 (1.20) NDI 22.6 (11.03)	2.86 (0.84) 10.56 (4.5)		
	Exercise=16				Exercises—neck stretches, postural correction and isometric exercises	VAS pain 6.98 (0.86) NDI 23.32 (7.57)	4.5 (1.17) 18.6 (7.59)		
Homayouni (2013),[22] RCT, de Quervain's disease	KT=30	45.2 (2.2)	M 13, F 17	2.025 (0.55)	Kinesio taping, 3 strips, stretched by 70%, insertion to origin, repeated four times weekly	VAS pain 58 (6.2)	13 (3.1)	−27.0 (−29.6 to −24.4)	5

Continued

Table 1 Continued

Author (year), study design, population	Intervention (n)	Age (years)	Gender (M, F)	Duration (months), mean (SD)	Brief details of intervention	Preintervention, mean (SD)	Postintervention, mean (SD)	Mean difference between groups (95% CI)	Score
	PT=30	46.0 (1.3)	M 14, F 16	1.825 (0.7)	Paraffin bath, ultrasound, transcutaneous electrical nerve stimulation and friction massage, every 3 days for 10 sessions	VAS pain 56 (5.7)	38 (4.0)		
Kachanathu (2014),[34] RCT, low back pain	Conventional physiotherapy +KT=20	34.8 (7.54)	M 30, F 10	At least 3 months†	Kinesio taping, 2 strips, origin to insertion, three treatment sessions per week for 4 weeks and conventional physiotherapy (see below)	VAS pain 6.2 (1.4) RMDQ 10.3 (3.2)	6.0 (1.8) 10.8 (5.0)	−1.00 (−2.06 to 0.06)	4
	Conventional physiotherapy=20				Conventional physiotherapy—stretching exercises, strengthening exercises	VAS pain 2.9 (1.4) RMDQ 4.7 (2.9)	3.7 (2.0) 7.0 (5.5)		
Llopis (2012),[35] RCT, mechanical neck pain	KT+usual care=5	30.1 (12.0)	Not reported‡	Not reported‡	Kinesio taping, 2 strips, insertion to origin, two treatment sessions per week for 6 weeks and usual care (see below)	Change in VAS pain* 5.55 (1.47)		−0.87 (−2.21 to 0.46)	3
	Usual care=5				Usual care—stretching exercises, strengthening exercises and massage	Change in VAS pain* 3.98 (1.76)			
Osorio (2013),[36] cross-over RCT, patellofemoral pain syndrome	KT=20	21.2 (2.9)	M 7, F 13	Not reported	Kinesio taping over the patella and knee joint, 4 strips, insertion to origin; 2nd and 3rd strips with mild amount of tension	VAS pain* 3.0 (2.2)	1.6 (2.0)	−0.30 (−1.64 to 1.04)	5
	McConell=20				Medial glide McConnell taping	VAS pain* 3.0 (2.2)	1.9 (1.7)		
Paoloni (2011),[37] RCT, low back pain	KT+Exercise=13	62.0 (13.4)	M 5, F 8	At least 12 weeks†	Kinesio taping, 3 strips, 40% tension, changed every 3 days and therapeutic exercises (see below)	VAS pain 7.6 (1.6) RMDQ 9.5 (4.0)	3.7 (2.5) 7.3 (3.6)	KT vs exercise VAS pain 0.10 (−1.68 to 1.88) RMDQ 3.7 (−0.13 to 7.53)	6
	KT=13	62.7 (13.7)	M 5, F 8		Kinesio taping (see above)	VAS pain 7.1 (1.9) RMDQ 10.3 (4.3)	3.1 (2.8) 9.5 (6.8)		
	Exercise=13	62.7 (10.4)	M 4, F 9		Therapeutic exercises—relaxation, and streching and active exercises	VAS pain 7.6 (1.7) RMDQ 9.9 (3.6)	3.5 (2.4) 5.4 (3.9)		
Parreira (2014),[38] RCT, low back pain	KT=74	51.0 (15.0)	M 18, F 56	24.0 (264.0)	Kinesio taping, 2 strips over the erector spinae muscle, 10–15% tension, twice a week, over 4 weeks	VAS Pain 7.0 (2.0) RMDQ 11.5 (6.2)	4.4 (2.8) 8.3 (6.9)	VAS pain −0.17 (−0.49 to 0.16) RMDQ −0.2 (−2.22 to 1.82)	9
	Sham=74	50.0 (15.0)	M 15, F 59	36.0 (176.0)	Sham taping, same Kinesio taping but without tension, twice a week, over 4 weeks	VAS Pain 6.8 (2.0) RMDQ 10.4 (5.3)	4.6 (2.5) 7.4 (6.4)		
Saavedra-Hernandez (2012),[39] RCT, mechanical neck pain	KT=40	46.0 (9.0)	M 21, F 19	82.0 (19.0)	Kinesio taping, 2 strips, 15–25% stretch, insertion to origin, kept in situ for a week	NPRS 5.2 (1.4) NDI 21.4 (2.3)	2.7 (1.2) 15.4 (1.8)	NPRS −0.20 (−0.91 to 0.51) NDI −0.3 (−1.79 to 1.19)	9
	Manipulation=36	44.0 (10.0)	M 19, F 17	75.0 (18.0)	Thrust manipulation directed at the mid-cervical spine and cervicothoracic junction	NPRS 5.0 (1.9) NDI	2.7 (1.6)		

Continued

Table 1 Continued

Author (year), study design, population	Intervention (n)	Age (years)	Gender (M, F)	Duration (months), mean (SD)	Brief details of intervention	Preintervention, mean (SD)	Postintervention, mean (SD)	Mean difference between groups (95% CI)	Score
						22.5 (4.3)	16.8 (3.9)		
Shahane (2013),[40] RCT, plantar fasciitis	KT+ myofascial release=30	Range 40–60†	M 30, F 30	At least 6 weeks†	Kinesio taping over the ankle and calcaneum, origin to insertion, 5 times per week for 2 weeks. Myofascial release (see below)	VAS pain 7.33 (0.84)	5.33 (0.99)	2.93 (2.46 to 3.4)	5
	Stretches+myofascial release=30				Myofascial release 15 min per session and plantar fascia stretch, 30 s hold, 6 reps per session. Both were given 5 sessions per week for 2 weeks	VAS pain 7.30 (0.88)	2.37 (1.00)		
Shakeri (2013),[41] RCT, shoulder impingement syndrome	KT=15	46.5 (13.3)	M 7, F 8	7.63 (7.43)	Kinesio taping, four strips, 50–75% stretch, insertion to origin, replaced every 2–3 days over 1 week	VAS pain* 5.86 (1.8)	2.9 (2.25)	−0.72 (−1.46 to 0.02)	8
	Placebo=15	46.6 (14.2)	M 8, F 7	9.33 (10.5)	Placebo Kinesio taping; three I-strips with no tension	VAS pain* 5.53 (1.55)	4.2 (2.7)		
Simsek (2013),[42] RCT, subacromial impingement syndrome	KT+Ex group=19	48†	M 8, F 11	10.4 (8.26)	Kinesio taping, 3 strips, 50–75% stretch, insertion to origin, changed every 3 days for 12 days, and exercises (rotator cuff strengthening and scapular stabilisation)	VAS Pain* 2.74 (2.73) DASH 46.15 (19.83)	1.43 (2.22) 25.14 (17.35)	VAS pain −0.28 (−0.92 to 0.36) DASH −15.4 (−26.8 to, −4.0)	7
	Sham+Ex group=19	53†	M 5, F 14	10.4 (6.65)	Sham taping with exercises (rotator cuff strengthening and scapular stabilisation)	VAS pain* 3.21 (2.92) DASH 52.69 (16.42)	2.65 (2.67) 47.1 (17.87)		
Tsai (2010),[26] RCT, plantar fasciitis	KT+PT group=29	52.7 (28.8)	M 19, F 33	3.92 (1.80)	Kinesio taping, 2 strips, 33% stretch, insertion to origin, kept in situ for a week, and physical therapy program (see below)	MMPQ 9.29 (2.69)	4.14 (3.02)	−0.72 (−1.26 to −0.19)	5
	PT group=28	30.5 (13.1)		4.33 (3.01)	Therapeutic ultrasound, low-frequency electrotherapy	MMPQ 14.63 (2.61)	11.88 (2.36)		
van der Westhuizen (2012),[43] RCT, myofascial pain	KT=25	27.1 (6.20)	M 7, F 18	Not reported	Kinesio taping, anchor and three halved strips, 15–25% stretch, insertion to origin, replaced every 3 days over 1 week	NRS pain 36.7 (17.8) NDI 8.04 (3.62)	11.8 (13.6) 3.88 (4.55)	NRS pain −9.92 (−19.6 to −0.22) NDI 0.88 (−1.43 to 3.19)	6
	Dry needling=25	28.3 (6.16)	M 9, F 16		Dry needling over upper trapezius	NRS pain 32.9 (19.7) NDI 8.96 (4.3)	18.0 (17.7) 3.92 (4.03)		

*Values which gave worst outcome (mean difference) were extracted; when pain measures were reported in more than 1 activity, condition, testing condition or site.
†Mean and/or SD not reported.
‡Gender not reported.
DASH, Disabilities of the Arm, Shoulder and Hand (score out of 100); F, female; KT, Kinesio tape; M, male; MMPQ, McGill Melnack pain questionnaire (score out of 20); NDI, Neck Disability Index (score out of 50), with higher scores indicating greater disability; NPIS, Numeric Pain Intensity Scale (score out of 10); NPRS, Numerical pain rating scale (score out of 10); ODI, Oswestry Disability Index (score out of 100); RCT, randomised controlled trial; RMDQ, Roland-Morris Disability Questionnaire (score out of 24); SPADI, Shoulder Pain and Disability Index (score out of 100), with higher scores indicating greater pain and disability; VAS, visual analogue scale (score out of 10 cm or 100 mm).

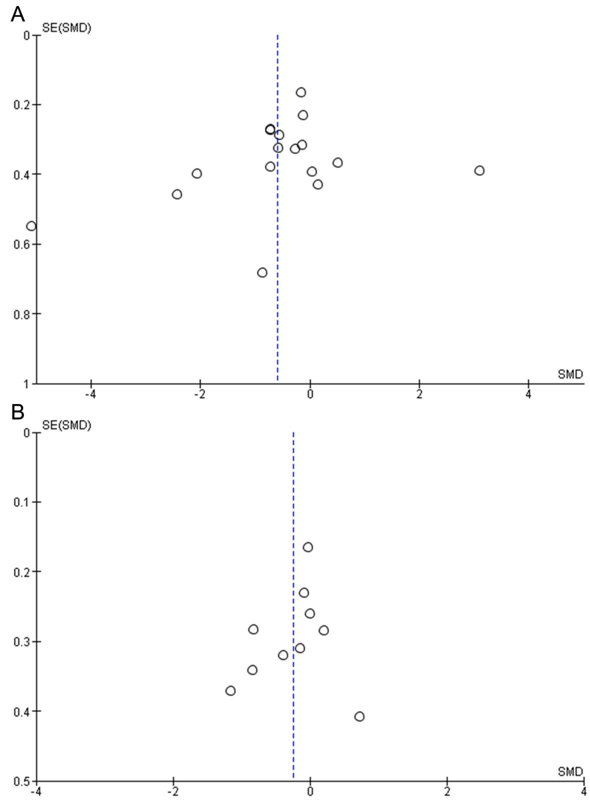

Figure 2 Funnel plot of standardised mean difference (SMD) against SE based on (A) pain intensity and (B) disability.

p=0.65) with a low level of heterogeneity (I^2=29%, τ^2=0.04, χ^2=4.23, df=3, p=0.24; figure 3B).

Parameters of KT application

Four studies (23.5%)[30 31 41 42] used an average tension of 62.5% stretch and four studies (23.5%)[35 37 42 43] replaced the tape every 3 days (table 2). The average amount of tension applied ranged from 12.5% to 70% stretch,[22 26 29–32 37–39 41–43] while the average duration of each tape worn in situ ranged from 45 min to 7 days[22 26 29 31–33 35 37–43] (table 2).

Multivariable meta-regression analysis identified amount of tension applied (% stretch) (β=0.796, p=0.024) and duration of each tape applied in situ (days) (β=0.644, p=0.046) as independent predictors of the effect size of the reported pain score in participants with chronic musculoskeletal pain who received KT (table 3). The model correctly predicted 80.7% of the effect size of reported pain score. Owing to the limited number of studies which measured disability, multivariable meta-regression analyses could not be computed.

DISCUSSION

This systematic review synthesised the evidence for KT effectiveness in participants with painful conditions who are managed in primary healthcare practices. KT proved to be superior to minimal intervention, which includes no taping, sham taping and usual care, for the reduction of pain in individuals with >4 weeks of musculoskeletal pain. However, KT is not more effective than other forms of intervention in reducing pain. KT is also not more effective than minimal or other forms of intervention in the reduction of disability related to chronic musculoskeletal pain.

Besides reflecting the multidimensional phenomenon of disability, which encompasses the complex interaction between impairment, activity limitation and participation restriction,[44] the null effect of KT on disability signals the need for conventional therapy, for example, other active forms of intervention, over and above passive treatment, in the management of musculoskeletal pain lasting >4 weeks. This is supported by findings of non-significant differences in pain and/or disability between groups reported by trials which used Kinesio taping only.[32 38]

KT as an adjunct to exercise therapy

In contrast, the two trials which used KT as an adjunct to exercise reported a significant difference in pain and disability between groups, favouring the experimental group.[33 42] This is not surprising as exercise has been reported to garner good evidence of effectiveness as a standalone or adjunctive treatment for chronic musculoskeletal pain.[45] Taken together, our review suggests that KT, when used in combination with conventional therapy, may be effective in reducing pain. Our clinical impression is that many clinicians use KT in this way—as an adjunct to exercise.

Compared to minimal intervention, we found a significant effect size (reduction in pain) by 0.36 to 0.68, which is considered small to moderate, among patients with >4 weeks of

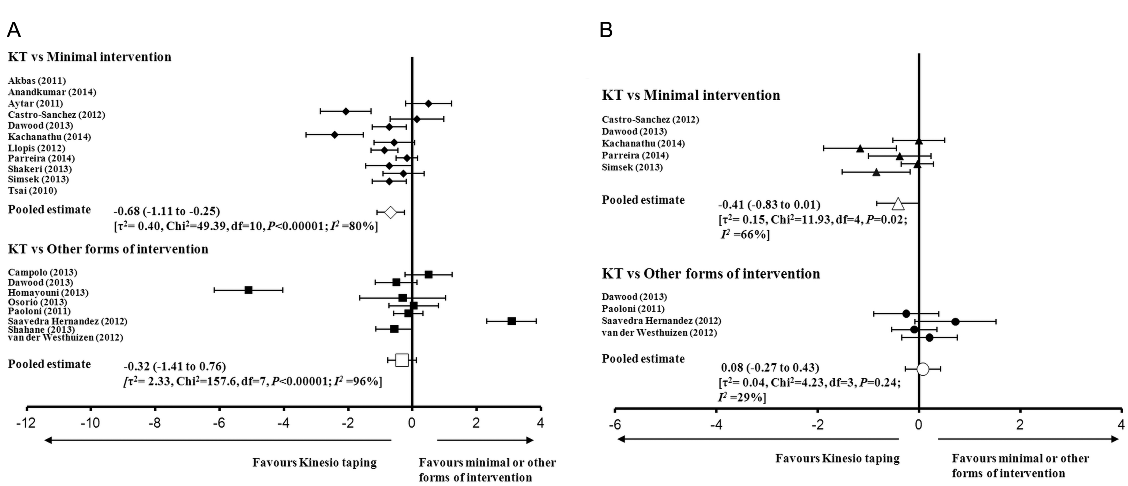

Figure 3 Forest plot (effect size and 95% CI) of the (A) pain and (B) disability score of randomised controlled trials. Pooled estimates which represent effect size (standardised mean difference) and 95% CI (using a random effects model) are indicated by empty symbols (KT, Kinesio tape).

Table 2 The parameters of Kinesio taping used by the various studies (n=17)

Parameters	Significant difference in outcome measure (favouring Kinesio taping)			
	Pain		Disability	
	Yes	No	Yes	No
Average amount of tension used (% stretch)				
12.5		Low back pain[38]		Low back pain[38]
20		Myofascial pain;[43] mechanical neck pain[39]		Mechanical neck pain;[39] myofascial pain[43]
25	Low back pain[32]			Low back pain[32]
33	Plantar fasciitis[26]			
35		Patellofemoral pain syndrome[29]		
40		Low back pain[37]		Low back pain[37]
62.5	Knee osteoarthritis[30]	Patellofemoral pain syndrome;[31] shoulder pain[41 42]	Shoulder pain[42]	
70	de Quervain's disease[22]			
Not reported	Plantar fasciitis;[40] mechanical neck pain[33]	Mechanical neck pain;[35] patellofemoral pain syndrome[36] Low back pain[34]	Mechanical neck pain[33]	Low back pain[34]
Average duration of each tape worn in situ (days)				
<2	Knee osteoarthritis[30] Plantar fasciitis[40] de Quervain's disease[22]	Patellofemoral pain syndrome[31]		
2		Low back pain[38]		Low back pain[38]
2.5		Shoulder pain[41]		
3		Shoulder pain;[42] mechanical neck pain;[35] myofascial pain[43] Low back pain[37]	Shoulder pain[42]	Low back pain;[37] myofascial pain[43]
4	Mechanical neck pain[33]		Mechanical neck pain[33]	
5		Patellofemoral pain syndrome[29]		
7	Plantar fasciitis;[26] low back pain[32]	Mechanical neck pain[39]		Low back pain;[32] mechanical neck pain[39]
Not reported		Patellofemoral pain syndrome[36] Low back pain[34]		Low back pain[34]

musculoskeletal pain who received KT. We propose that this observed magnitude is a clinically meaningful change.[46] This is borne out to some extent by the mean difference of 0.92 to 1.33 during an ad hoc analysis of the weighted mean difference in pain measure between groups.

Our finding did not concur with a recent systematic review[19] which reported a non-significant negligible magnitude of 0.08. The difference in results could be attributed to the inclusion of trials which were non-randomised[47 48] and trials which sampled participants with acute musculoskeletal conditions[12 49] in their meta-analysis.[19] For example, individuals with varying duration of symptoms may respond differently to KT, such that the effects in different directions for the acute pain and more long-lasting pain subgroups may combine to give the impression of no effect for the combined group (washout effect).[50]

What is the mechanism of action?

To date, the underlying pain-relief mechanism of such proprietary tape remains poorly understood. Nonetheless, it is tempting to speculate that the afferent stimuli provided by the applied KT may inhibit the transmission of nociceptive signals to the spinal level[51] in chronic musculoskeletal pain conditions, leading to the attenuation of pain experience. The basis of such assertion is the commonality in feature, that is, spinal cord hyperexcitability among chronic musculoskeletal pain conditions.[52] However, the approximate thickness of the KT in relation to the epidermis of the skin was intended to avoid sensory stimuli when properly applied.[53] To this end, it remains unclear to what extent the gate control theory is involved in the efficacy of KT.

On another note, it is plausible that the decongestive property of KT may play a role, at least in part, in the efficacy of KT on pain reduction among musculoskeletal pain lasting >4 weeks with swelling. Such assertion is inferred from two of the trials with large effect sizes,[22 30] that is, Anandkumar *et al*[30] who investigated the efficacy of KT in knee osteoarthritis (OA) which is characterised by pain and joint effusion,[54] while Homayouni *et al*[22] investigated chronic de Quervain's disease which is characterised by tenderness and swelling around the styloid process.[55] A possible explanation for these observations could be the skin-lifting effect of KT, which promotes blood circulation and improves lymph drainage[53] leading to a reduction in swelling and subsequently, to pain-relief. Conversely, Stedge *et al*[56] reported a lack of significant difference in the blood circulation of the gastrocnemius muscle between their KT group, and sham or no tape groups in a healthy active population.

It is also conceivable that the applied KT reduces pain by stimulating the descending pain inhibitory mechanism from the higher centres of the brain.[19] This is corroborated, at least in part, by the significant reduction in pain observed in three[30 32 42] of six placebo-controlled studies.[30–32 38 41 42] Other proposed mechanisms include the lifting of the skin by the applied KT, resulting in a reduction of pressure on the subcutaneous nociceptors.[57] Apart from the aforementioned bioneurophysiological explanations, it is plausible that KT may exert its effect via the bioneuropsychological pathway.[58] Recently, Montalvo *et al*[19] drew attention to the probable

Table 3 Predictors for Kinesio taping treatment effect size in chronic musculoskeletal pain conditions

		Unstandardised coefficients		95% CI for B		Standardised coefficients		
Dependent variables	Independent variables	B	SE	Lower	Upper	β	t Value	Significance
Standardised mean difference of reported pain score	Amount of tension applied (% stretch)	0.038	0.011	0.008	0.067	0.796	3.524	0.024
	Duration of each tape applied in situ (days)	0.255	0.089	0.007	0.503	0.644	2.853	0.046
	Constant	−3.577	0.563	−5.139	−2.014		−6.357	0.003

95% CI, 95% CI for regression coefficient; β, β coefficient; B, regression coefficient; SE, SE of B; t, t statistics.

release of analgesic neurotransmitters due to the placebo effect, that is, patient's expectations.[59–61] It remains uncertain to what degree the KT serves as a psychological crutch.[62] Further research is warranted to confirm these postulated mechanisms.

Application of KT

Our review of the literature revealed variability in KT application and that it is uncertain if the tape can be applied with a greater pain-relieving effect. Importantly, five studies[33–36 40] did not report the amount of tension applied while two[34 36] did not report the duration of each tape worn in situ. Notwithstanding, our review suggests that the effect size (SMD) for pain reduction was lower when the studies applied more tension and left the applied tape in situ longer.

Our finding extends that of Kase *et al*[53] who specified that excessive tension may diminish the beneficial effects of KT.[53] In addition, they mentioned that the longitudinal elasticity of the KT is effective for 3–5 days;[53] implying that the applied tape should be replaced, at the most, every 5 days. However, these parameters were not identified as predictors of effect size (SMD) for pain reduction in ad hoc univariate meta-regression analyses. Moreover, the results are limited to associations rather than causations between the variables, and this may act as a caveat on inferences drawn from our findings.

Limitations of the review include the small number of studies and relatively small sample size used in the multivariable meta-regression analysis. Also, our results are drawn from studies with somewhat varying methodology and treatment 'dosage' of KT application. For example, eight studies[22 26 35 36 39 41–43] applied the KT from the insertion to the origin of the muscle, four studies[30 31 34 40] taped it from the origin to insertion direction, while the remaining studies[29 32 33 37 38] did not report details regarding the taping direction. Such variation may have influenced, at least in part, the outcome measures since a muscle facilitatory or inhibitory effect would be elicited depending on the taping direction.[53] Furthermore, the individuals with musculoskeletal pain >4 weeks in the included studies received a single to 12 treatments sessions[22 26 30–43] of KT at a frequency of one to five times per week,[22 26 29 32–35 37–43] over a span of 1–6 weeks.[22 26 29 32–35 37–43] There is a need for the use of standard application procedures (by body parts) to determine the efficacy of KT in future studies.

Future studies may consider recruiting patients who respond to KT prior to randomisation. On another methodological note, it is worth mentioning that none of the included trials measured the patient's expectations or beliefs regarding the benefits of Kinesio taping with the use of simple validated questionnaires. This would be pertinent to therapy studies as it has been reported to greatly influence the outcomes among those with musculoskeletal pain.[58 63] Publication bias might account for the effect size we observed in this review. However, a symmetrical funnel plot suggests that missing studies or even selective reporting within included studies are unlikely. Moreover, we did not apply language restriction during our search. The high level of clinical heterogeneity among the trials, with respect to the different clinical conditions, poses a challenge during this review. In addition, musculoskeletal pain may not be sufficiently representative in this review because knee OA was represented by only one paper[30] and many other musculoskeletal pain states have not been evaluated. Therefore, variations in KT application across the studies may limit overall conclusions.

In conclusion, this review highlights that KT is superior to minimal intervention for pain relief. Existing evidence does not establish the superiority of KT in reducing disability when compared to either minimal or other forms of intervention. Taken together, our review indicates that KT, when used in combination with conventional therapy, may be effective in reducing pain.

What are the new findings

- Kinesio tape (KT) is superior to minimal intervention for pain relief.
- Our evidence does not establish superiority of KT over other treatment approaches in reducing pain and disability for individuals with musculoskeletal pain >4 weeks.
- The amount of tension applied and duration of applied tape left in situ may influence the effect size for pain reduction.

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Kinesio taping in musculoskeletal pain and disability that lasts for more than 4 weeks: is it time to peel off the tape and throw it out with the sweat? A systematic review with meta-analysis focused on pain and also methods of tape application

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Notes