



What is the current level of evidence and the efficacy of medical taping on circulation, muscle function, correction, pain, and proprioception?

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Abstract

Objective: Medical taping claims to have positive effects on circulation, muscle function, correction, proprioception, and pain. Since there are no published reviews to the authors knowledge so far, the quantity and quality of available literature is unclear. This review of literature, is the first attempt to report current level of the available evidence about medical taping, and secondly, its efficacy.

Methods: Computerized bibliographic databases (PubMed, PEDro, Cochrane Library, Medline, Cinahl, Google Scholar, Trip Database, and National Guideline Clearinghouse) were searched up to 28th November 2009. Two reviewers conducted study selection, data extraction, categorization, and methodological quality assessment.

Results: The search revealed 200 possibly interesting articles from which 17 articles were used to make final conclusions. Methodological quality assessment was carried out and articles were distributed over five categories: *Circulatory* (n = 3) with a grade B recommendation, *Muscle Function* (n = 9) with a grade A recommendation, *Correction* (n = 1) with a grade E of recommendation, *Pain* (n = 5) with grade A recommendation, and *Proprioception* (n = 2) with a grade D recommendation.

Conclusion: Moderate evidence level suggest medical taping has positive effect for *Circulatory* disorders; Strong evidence show a tendency for positive change in *Muscle Function*; too little evidence was found to suggest positive effects on *Correction*; contradictory evidence was found in the field of *Proprioception* ; *Pain* reducing effect is supported by strong evidence.

Keywords: Review, Medical Tape, Kinesio Tape, Kinesiotaping, Taping Concept, Circulation, Muscle, Correction, Pain, Proprioception

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Background

The basis of the medical taping principle was developed in the 1970s in Korea and Japan (Kase et al. 2003; Gwang-won. 2005). Since then, different organizations evolved and therefore modified concepts with similar techniques were developed. Medical tape has about the same elasticity and thickness as human skin and is made from 100%

cotton fabric with antiallergenic hypoallergenic acrylic glue. In the beginning, the tape with its elastic properties seemed to be the missing link in the recovery of soft tissue injuries that were considered to be healing faster in an active rehabilitation setting (Gwang-won. 2005). Afterwards, more and more fields of application were discovered. Meanwhile, medical tape is distributed by over 60 synonyms (Kumbrink. 2009)

with names as Curetape®, Elastictape, Kinesio Tex® Tape, Kinesiotape®, Kintape, K-Tape®, Physiotape®, etc. In addition each company follows different steps in quality control which leads to differences in properties and quality amongst the tape (Kumbrink. 2009).

The variety where medical tape could be applied soon expanded to other areas of health care. At this point in time, claimed effects of medical tape include from removing congestions in blood circulation and lymphatic drainage, improvement of muscle function by regulating its tone, alleviating pain, correcting the direction of movement, supporting joint function by the stimulation of proprioception, correcting the direction of movement, increasing stability; and neuro-reflexive manipulation. Consequently, the range of application is very wide, from follow-up treatments, reducing inflammation or accumulation of fluid, correction of posture, and treatment of symptoms caused by overuse or as prophylactic measure (Gwang-won. 2005).

The medical tape became popular all over the world after the 2008 Summer Olympic Games, where colorful tape was seen on a number of athletes (Hancock. year unknown). Popularity, widespread possibilities of application, and promising expert opinions are indicative of using it in daily practice. Nevertheless, the value of taping in clinical practice and the scientific proof for it does not stand in proportion to each other. As a result, taping treatment as a whole is undervalued (Gwang-won.

2005). This shows in an absence of published literature such as reviews or guidelines using an evidence-based approach. The relevance of this review emerges out of the fact that there is an urgent need to collect evidence based literature on this topic to prove the efficacy of the tape and its techniques. This step is absolutely essential to establish this treatment technique as valid tool amongst clinicians.

Based on the previously described features of the medical tape and the necessity of proving its efficacy, this review is supposed to connect the existing scientific knowledge about medical tape and create a basis for future use. In the end, this review should provide the reader with information about the quantity and quality of evidence for medical taping and its effect. This collection of evidence for the use of medical tape finds its purpose in practice, with clinicians using an evidence-based approach or planning future research.

According to the described purpose, the following research question leads the process of this review: What is the current level of evidence and the efficacy of medical taping on *Circulation, Muscle Function, Correction, Pain, and Proprioception*?

Methods

Eligibility Criteria for Search

The search was conducted to find published and unpublished literature including any type of review, trial, cohort study, case control study, case series, case report, and expert opinion; with healthy or unhealthy, male or female human subjects of any age. Studies were included which used any type of medical tape with elastic properties. All languages were accepted. Studies that seemed to be promising after screening, but title or abstract lacked information for clarification, were retrieved, and then checked according to the above mentioned criteria. There was no exclusion regarding the publication date of the studies.

Eligibility for Grade of Recommendation

Any outcome measure was accepted. Outcome measures not suitable for a previously set category were discussed separately. Only studies written in English were included. Studies using medical tape as a treatment adjunct were excluded.

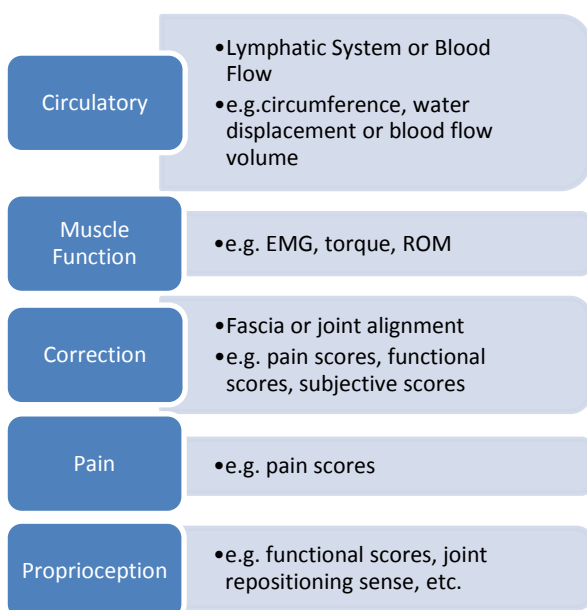


Figure 1 Categories

Level	Type of Study
Level 1a	Systematic Reviews of RCTs
Level 1b	Individual RCT
Level 2a	Systematic Review of cohort studies
Level 2b	Individual Cohort studies (incl. low quality RCTs; e.g., <80% follow up)
Level 3a	Systematic Review of Case-Control Studies
Level 3b	Individual Case-Control Studies
Level 4	Case-Series (low quality Cohort Study / Case-Control Study)
Level 5	Case study, expert opinion

Table 1 Levels of Evidence (CEBM)

Search Strategy for Identifying Studies

The following databases were searched from their respective beginnings to 28th November 2009: PubMed, PEDro, Cochrane Library, Medline, Cinahl, Google Scholar, Trip Database, and National Guideline Clearinghouse. Clinicaltrials.gov was used to identify current running clinical trials on the subject of medical taping and their contact person was contacted. Screening of references and personal communication with client and external advisors working in the field of medical taping were performed to identify potential references and to retrieve articles.

The key words: KINESIOLOGY, KINESIO, K, MEDICAL, K-ACTIVE, PHYSIO, CURE, ELASTIC, EASY, MEDI, ATHLETIC, THERAPEUTIC were combined either by space, no space, or a dash with TAPE and TAPING in quotation marks. No Boolean operators were used. There are no MESH terms on this topic, therefore a Mesh search could not be completed. The search was not limited to studies written in English to detect worldwide publications distribution. Detailed elucidations of the search strategy are available as *online appendix*.

Method of Review

Two undergraduate physiotherapy students, under supervision of Jesse Aarden (Pt / MSc) and Marc van Zuilen (Pt / Ba), conducted the search, study selection, citation identification, data extraction, and assessment of the level of evidence. Categorization of studies, assessment of methodological quality, and final grading for recommendations were then carried out.

Methodological Quality Assessment

Both researchers independently assessed all retrieved studies for quality of methodology and classified all selected studies into the levels of evidence (see **Table 1**) validated by the Centre for Evidence Based Medicine (CEBM) (Philips et al. 2009). If results were heterogeneous, the article was assessed again and the result revised. Upon further disagreement, the lower level was determined due to unclear methodological description of the article. To reach final conclusions, qualitative analysis was carried out, using the levels of evidence listed above; which, as a result, lead to the following grades of recommendation modified from the CEBM (see **Table 2**) (Philips et al. 2009).

After the grading of the level of evidence, the

Grades of Recommendation	Quantity of Evidence
A. <i>“Strong evidence”</i>	Supported by two consistent level 1 studies
B. <i>“Moderate evidence”</i>	Supported by two consistent level 2 or 3 studies or two extrapolations from level 1 studies
C. <i>“Limited evidence”</i>	Supported by two level 4 studies or two extrapolations from level 2 or 3 studies
D. <i>“Conflicting evidence”</i>	Level 5 evidence or troublingly inconsistent or inconclusive studies of any level
E. <i>“No evidence”</i>	Only one or no studies were identified

Table 2 Grades of Recommendation

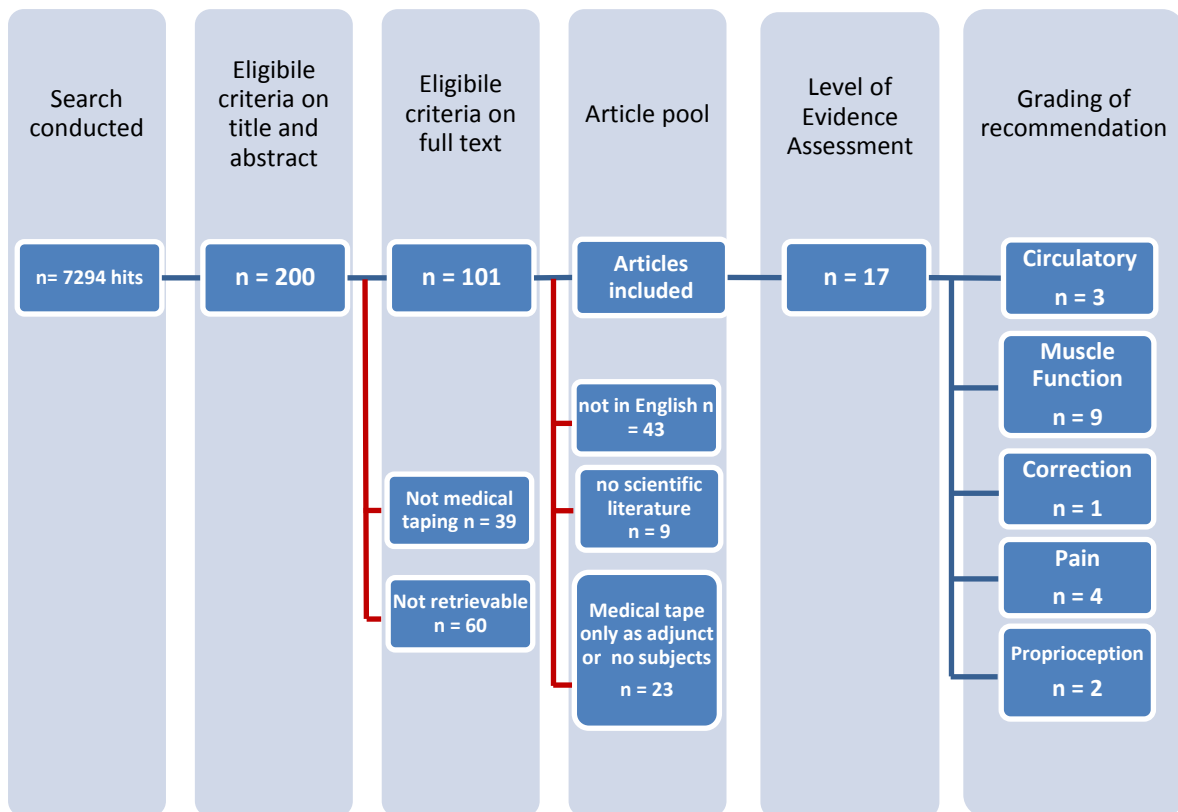


Figure 2 Article Flow

Retrieved articles were sorted into categories according to the outcome measurements used (see **Figure 1**). Articles which used outcome measurements suitable for more than one category were used in each category respectively. Two consistent studies of one level qualify for corresponding grade of recommendation. Two consistent studies of different levels end up in a grade recommendation of the lower level, e.g. one level 1 study and one level 2 study of similar conclusion will end up with a grade B recommendation. An inconclusive outcome in different studies of the same level, automatically lead to the lowest grade of recommendation. However, high-quality studies out-value low-quality studies in the case of inconclusive findings; two level 1 studies similar conclusions and one contradicting level 4 study is determined as grade A recommendation for this category.

Results

Search Results

The search resulted in 200 potential articles for the review. After application of the eligibility criteria for search 101 articles about medical taping were

remaining. The eligibility criteria excluded 39 articles which were not discussing medical taping and 60 articles because there was no possibility of retrieving these articles. After application of the eligibility criteria for the grade of recommendation, 42 articles were not included, because they were not written in English and 32 articles due to the reason that medical tape was only used as a treatment adjunct, the publication did not discuss subjects or inappropriate scientific presentation of content. The remaining 17 articles were included for this review (**Figure 2**). Detailed elucidations of the search results are available as *online appendix*.

Description of Studies

From the 42 full-text articles about medical taping not written in English 5 articles were studies of level 3 and higher, the remaining 39 articles not in English were of level 4 and 5 including case series, case studies, newsletters, and expert opinions about medical taping. Retrieved English articles about medical taping, but excluded due to eligibility criteria for grade of recommendation, were of level 4 and lower presenting as case series, case studies, and expert opinions about medical tape. Included for this review were 17 studies of all five level of

Level	Authors	Year	Category	Study design	Subjects	Taping technique	Outcomes measured
1b	Gonzalez-Iglesias et al.	2009	Muscle, Pain	RCT	WAD II (<i>n</i> = 41), age = 32,5	I → O / Y-tape on cx. extensors, Space-tape on C3-C6 (KK)	NDI, NPRS, cx. AROM
1b	Hsu et al.	2009	Muscle	RCT	Shoulder impingement (<i>n</i> = 34), age=23	O → I / Y-tape on lower trapezius /slight tension (KK)	Electromagnetic tracking system to collect 3D data, EMG
1b	Thelen at al.	2008	Pain	RCT	Rotator cuff tendonitis / impingement (<i>n</i> = 42), age = 20,6	I → O / Y-tape supraspinatus / 15%-25%, I → O / Y-tape deltoid / 15%-25%, Space-tape painful area / 50%-75% (KK)	SPDI, VAS, pain-free AROM,
1b	Tsai et al.	2009	Circulation	RCT	Breast-cancer-related lymph edema (<i>n</i> = 41), age = 54,6	Not described	Limb size, water composition, lymph edema symptoms, QoL, subjects' response
2b	Bialoszewski et al.	2009	Circulation	RCT	Lower limb lengthening (<i>n</i> = 24)	Wavy fork cut, no tension	Circumference measures at 5 described landmarks
2b	Fu et al	2008	Muscle	RCT ¹	Healthy athletes (<i>n</i> = 14), age = 19,7	Y-tape quadriceps tape (KK)	Isokinetic muscle strength
2b	Gonzalez	2009	Pain	RCT*	Chronic a-specific low back pain (<i>n</i> = 8), age = 39,5	O → I, two I-shaped lx. erector / slight tension, I-shaped Space-tape area of pain / light to moderate tension (KK)	Quebeck Back Pain Disability Scale, Oswestry LBP Disability Questionnaire, Roland Disability Questionnaire
2b	Halseth et al.	2004	Proprioception	RCT ¹	Healthy subjects (<i>n</i> = 30)	Ankle tape / 115%-125% (KK)	Reproduction of joint positioning sense

2b	Yoshida et al.	2007	Muscle	RCT	Healthy subjects ($n=30$)	O → I, Y-shaped lx. erector / no tension (KK)	Lower trunk ROM
3b	Chen et al./ Chen et al.	2007 / 2008	Muscle	Case-control study	PFPS ($n = 15$), healthy subjects ($n = 10$)	“pulling VMO up”, “pulling VL down” (KK)	GRFs, EMG (VMO / LM)
3b	De La Motte	2008	Proprioception	Case-control study	Uni-lateral FAI ($n = 20$), healthy subjects ($n = 20$), age = 24,9	Kinesio method ankle (KK), I-shaped along peroneal tendon	Lower extremity kinematics 3D data, subjective outcome scores
4	Hsieh et al.	2007	Muscle	Case-series	Healthy subjects ($n = 31$)	Not described, two different elastic tapes	GRF, EMG, jump height
4	Kase et al	-	Circulatory	Case-series	Different disorders ($n=9$)	Not described (KK)	Diagnostic UltraSound
4	Liu et al	2007	Correction	Case-series	Epicondylitis lateralis ($n = 2$)	Y-shaped along affected muscle (ext. carpi radialis)	longitudinal scan of ext. carpi radialis
4	Murray	2000	Muscle	Case-Series	After ACL rupture ($n = 2$)	Not described (KK)	AROM, EMG
4	Slupik et al	2007	Muscle	Case-series	Healthy subjects P1: ($n = 27$), age = 23 P2: ($n = 9$), age = 24,9	O → I / Y-shaped on VMO	Peak torque
5	Garcia-Muro et al	2009	Pain	Case study	Shoulder pain with myofascia origin ($n = 1$), age = 20	I → O / Y-shaped for deltoid / I-shaped above trigger points	VAS, flex. / abd. AROM, functionality, active trigger points

Abbreviations: * = unpublished; ¹ = cross-over design; KT = Kinesio Tape; ST = Sham Tape; KK = Kenzo Kase; NT = No Tape; AT = After Tape; AROM = active range-of-motion; cx. = cervical; lx. = lumbar; PFPS = patella-femoral pain syndrome; O → I = Origin to Insertion; VMO = m.vastus medialis oblique; VL = m.vastus lateralis; GRF = ground reaction force; FAI = functional ankle instability; WAD = whiplash associated disorders; VAS, NPRS = pain scores; SPDI = shoulder pain and disability index; EMG = electromyography

Table 3 Descriptions of Studies

evidence. On one study (Chen, et al., 2007) two articles with the same results were written, but different volume, and therefore processed as one. The data extraction of these articles (see **Table 3**) provides details on level of evidence, author name, year of publication, study design, study population, and taping technique. Included articles were distributed to each category according to the outcome measurements reported.

Circulatory

The literature search revealed 5 publications, one level 1b study, one level 2b, and three level 5 publications on the lymphatic system and one level 4 study on blood flow.

Tsai and colleagues (2009) conducted a RCT to study whether K-tape could replace the bandage in decongestive lymph drainage (DLT) for breast-cancer-related

<i>Circulatory</i>	Articles n
Level 1	1
Level 2	1
Level 3	0
Level 4	1
Level 5	3
Recommendation	B

lymph edema. The study showed no significant difference between the bandage and the Kinesio taping group as part of a treatment for lymphoedema, with DTL and pneumatic compression (PT). The time of application and the compliance of the tape with patients were better than in the bandage group. Their study results suggest that Kinesio Tape could replace conventional compression bandaging in the treatment for lymphoedema.

Bialoszewski and colleagues (2009) conducted a RCT, which tried to evaluate the clinical efficacy of Kinesiology Taping in comparison to conventional DLT in reducing edema of the lower limbs. The study assessed differences in leg circumference after a surgical leg extension procedure (Ilizarov method). The article concluded, that both forms of treatment for lymph drainage significantly reduced lower leg circumference.

Kase and a colleague (year unknown) conducted a study about volume changes of the peripheral blood flow by using Kinesio Taping. The Study results were based on measuring the volume of blood flow with a Doppler US machine in cm/s. The unhealthy subjects showed significant increase ranging from 20.6 to 60.7% in peripheral blood flow. Healthy

subjects showed differences ranging from -2.9 to -5.5 which were not considered significant by the authors.

Muscle Function

The function itself can be divided into stimulating muscle tone and decreasing muscle tone. Kase et al. claim that depending on the direction of application, either stimulation or inhibition of muscle function can be accomplished.

The literature search revealed 9 publications for this category, two level 1 studies, two level 2 studies, one level 3 study, and four level 4 studies.

One study performed by Hsu et al. (2009) used a tape to increase the function of the lower trapezius, found a significant increase in EMG measurements between 60°-30° of abduction. Another study conducted by

<i>Muscle</i>	Articles n
Level 1	2
Level 2	2
Level 3	1
Level 4	4
Level 5	0
Recommendation	A

Gonzalez-Iglesias et al. (2009) found a statistically significant increase in ROM in the cervical spine after application of Kinesio Tape post- whiplash injury.

A study conducted by Yoshida et al. (2007) about ROM in the lower trunk showed a statistically significant increase in flexion direction with a Kinesio Tape application on the lower trunk, but not in extension, or side flexion. Another study by Fu et al (2007) found no significant changes in muscle performance in young healthy athletes with a Kinesio Tape applied to the rectus femoris.

Chen et al. (2007/2008) found statistically significant differences in the EMG activity between VMO and VL in participants with PFPS, but not in healthy subjects.

A study organized by Slupik et al. (2007) reported firstly a statistically significant increase in bioelectrical activity at 24 and 72 hours of continuous Kinesio Taping use and secondly also in a different protocol a statistically significant increase in bioelectrical activity after 48 hours following Kinesio Taping for 24 hours. The study by Hsieh et al. (2007) suggests a significant increase in the ground reaction force (GRF) in a vertical jump after applying an elastic tape to the m. triceps surae. The study by Murray (2000) showed a significant effect of Kinesio Tape in active ROM

and an approximately 150% increase in the EMG amplitude in leg extension.

Correction

For this category of medical taping, the search only revealed weak evidence with one level 4 study.

Liu et al. showed in a case series of 2 subjects, a constraining effect of Kinesio Tape, displayed in a longitudinal scan of the m. extensor carpi radialis, which led to a correction of the tracking of the muscle directly after applying the tape in cases of epicondylitis lateralis.

Correction	Articles n
Level 1	0
Level 2	0
Level 3	0
Level 4	1
Level 5	0
Recommendation	E

Pain

In this category two level 1 studies were analyzed. The other two studies created low level of evidence due to one level 2 with low methodological value, one level 4 study, and one level 5 case study.

A study by Gonzales-Iglesias et al. (2009) showed a statistically significant reduction of neck pain immediately post-application and at a 24-hour-follow-up.

Pain	Articles n
Level 1	2
Level 2	1
Level 3	1
Level 4	1
Level 5	0
Recommendation	A

Another study conducted by Thelen et al. (2008) found a significant increase of pain-free shoulder abduction for KT group in comparison to KT sham group at 1-day-follow-up. Both groups, KT and KT-sham, show significant improvement of VAS and SPDI (shoulder pain and disability index) by day 6.

The study by Gonzalez (2009) found no statistically significant differences in function (The Quebec Back Pain Disability Scale, Oswestry Low Back Pain Disability Questionnaire, Roland Morris Disability Questionnaire) over 4 weeks in the medical taping group.

The case study by Garcia-Muro et al. found immediate increase of pain-free active shoulder ROM. Further improvements after 2 days were observed in decreased VAS scores from 10 to 2,7, on functional level and general well-being.

Proprioception

The literature search revealed one level 2 study and one level 3 study with an outcome measurement of proprioception.

Halseth et al. conducted a randomized crossover study with pre- / post-test design with healthy subjects and stated that there was no significant

Proprioception	Articles n
Level 1	0
Level 2	1
Level 3	1
Level 4	0
Level 5	0
Recommendation	B

difference in reproduction of joint position sense (RJPS) between taped and non-taped conditions.

De la Motte (2008) also used a pre- / post-test design, but had different outcome measurements concludes that Kinesio Taping might have a positive effect on lower extremity kinematics, relatively greater effect in unhealthy than in healthy subjects. Subjective secondary outcome measurements showed a group main effect of the Kinesio Taping in ankle stability.

Discussion

The presented results show that the research conducted so far lacks in quantity as well as quality seeing 17 studies about medical taping included in this review overall and 4 studies of level 1, respectively. In terms of efficacy, medical taping shows tendencies towards a positive effect and low grades of recommendation rather point to a lack of evidence than no efficacy of medical taping.

Medical taping concepts only shifted into the focus of scientific research in the last decade, as the technique is still relatively new. Physiotherapeutic taping is often part of a complex treatment based on clinical reasoning and practical experiences what makes research difficult. The concepts developed by practitioners are mostly based on physiological knowledge of body function, tape properties, trial-and-error results, and do not have their source in profound scientific work. Books in the format of practical guidelines were derived from the same origins (Kase et al. 2003, Gwang-won. 2005, Kumbrink. 2009).

Methodological quality

In all screened studies it was obvious that the transferability of these studies to a general population is difficult to perform. First, in six out of 16 studies, the average age of population was below 25 years. There arises the question, if the efficacy of medical tape would be the same in older generations considering, for example, the differences in skin texture or other physiological mechanisms. Secondly, in 4 studies (Halseth et al. 2004, Hsieh et al. 2007, Slupik et al. 2007, Yoshida et al. 2007) medical tape was successfully applied to healthy subjects, but it is difficult-to-impossible to transfer these findings to patients regarding their dysfunction. These findings are supported by two studies with a case control design that found no significant differences after applying medical tape to healthy subjects (Chen et al. 2007, Fu et al. 2008). Thirdly, most of the conducted research only investigated short-term effects (12h – 6 days); also those findings are not generalizable to long-term therapeutic effects. The reason for the lack of study designs with long-term measurements could be accounted by the fact that medical taping is often used as an adjunct to other treatment forms and therefore makes it difficult to investigate it in isolation. Generally speaking, the findings of all studies are limited to a great extent to a narrow, homogenic population group and study designs do not correspond well to daily practice.

Regarding the validity of conclusions of the included studies, a widespread picture is identifiable. Whereas recent studies lack in a sufficient number of participants, they are designed better, using the RCT design. Older studies tend to use a less reputable design: the cross-over design. The cross-over designs are often insufficiently described to provide optimal reproducibility. A great number of case control studies and case series are available which lead to lower validity due to absence of control groups. All studies had a small number of subjects which could lower external validity. Another factor concerned the blinding of assessor and participants, whereas the blinding of assessors was performed in more studies, the blinding of participants was more difficult to ensure. Recent studies effectively blinded their participants with, for example, sham tape. It is questionable whether or not sham taping also has influence on physiology, as there is definitely

mechanical input from the tape. Considering the reliability and validity of measurement tools and outcome measures used in the included studies, there is tendency towards subjective measurements such as VAS or disability / functionality indexes. Objective measurements were sufficiently described and cited, however, some of them were doubtful regarding their reliability and validity, for instance, when measuring a complex mechanism, such as proprioception done by Halseth et al. (2004). In the authors' opinion, it is inappropriate to only measure the joint repositioning sense and conclude on proprioception.

Descriptions of Taping

Evolving from different concepts, studies lack in sufficient and comprehensive description of the application of medical tape. In some studies the taping concept was mentioned, but the technique was not (Murray. 2000, Garcia-Muro et al. 2009) and vice versa (Slupik et al. 2007, Bialoszewski et al. 2009). Proper descriptions of tape brand, taping techniques anatomic start and ending point, tension used, and positioning of the body are essential for reproducing the taping application in practice or in future research. If correct citations on concept or techniques were stated, it was considered as reproducible. However, concepts develop further and recently applied medical taping techniques may differ from older cited descriptions.

Throughout retrieved publications, descriptions of tape brand and used tape tension were not always mentioned. Tape produced by different companies varies, for example, in tape. Low quality tape may influence the treatment outcome and can also, in the worst case scenario, have adverse effects (Kumbrink. 2009). About the type of tape brand another problematic fact occurs. For instance, Kinesio Tex® Tape is applied to the paper substrate with approximately 25% tension, which is considered as paper-off tension (Kase et al. 2003). As soon as the tape is removed from the substrate paper it retracts to 0% tension which is also considered the resting length. From that resting length, Kinesio Tex® Tape can be stretched additional 55-60%. Full stretch, for example, can be described as 100% tension (of available stretch or of tape), 155-160% tension (of resting length), 55-60% tension (added to resting length), and 35% tension (added to paper-off tension). In the

literature, different ways of presenting the tensions and terminology were used and makes it unnecessarily difficult for reader, practitioner or researcher.

From the beginning of conducting this review, categorizing the different features of medical taping was difficult. The authors analyzed three different medical taping concepts in the attempt to combine their approaches and categories together into a system which covers every field of application. The authors of this review are still not fully satisfied with the categories and the distribution of selected studies into these categories.

Lymphatic System

The study performed by Tsai et al. (2009) is of high methodological quality, except that the taping technique is not described sufficiently enough for reproducing the study. The study used $n = 42$ subjects for randomization which is considered a small sample size in the conclusion of the article, but no study matching the criteria for this review had a bigger study population.

The study by Bialoszewski et al. (2009) described study design differs in abstract and article. In the result section not all outcome measures are mentioned. The conclusion is not solely based on the results of the study mentioned in the article; additional to the small population two different leg extending surgeries were combined into one analysis. One method used the femur elongation and the other one the crus. Therefore also outcome measures were chosen differently and one could argue about the homogeneity at baseline.

Both previously discussed studies show significant results and are of a high level of evidence. A general efficacy of edema reduction with medical taping is not proven by these articles, but the study results show a promising tendency. In clinical practice also the better compliance of the tape will play an important role. Compression bandaging is not a very pleasant treatment whereas the medical taping can have the same effect without the negative aspects of compression bandaging.

The only study about blood flow was performed with a small study population ($n = 9$) (Kase et al. 2003). The subjects had five different chronic disorders with poor circulation. The significant changes claimed by the authors have not been validated with statistical analysis for the scientific

significant level. Methods and materials are not described in a satisfying extend.

Muscle Function

The study of a high level of evidence by Gonzalez-Iglesias et al. (2009) found statistically significant changes in cervical ROM and Thelen et al. (2008) a significant increase in pain-free active ROM in shoulder abduction. This was supported by the earlier findings of Yoshida et al. (2007) that show an increase in lumbar flexion in healthy subjects. The methodological quality in all three studies is sufficiently described to trust the results of these trials. These findings all support the hypothesis that a detonizing application of medical tape on a muscle, as it was used in these studies, could lead to an increase of ROM and therefore may regulate the tonus of a muscle. However, it is still questionable if this increase of ROM is only triggered by the regulation of tonus or if other effects like decrease of pain and increase of proprioception could also lead to this improvement of ROM.

Hsu and colleagues (2009) concluded that medical tape shows significant change in muscle activity between $60^\circ - 30^\circ$ of shoulder abduction and may help in scapular motion and muscle performance. This was supported by Slupik et al. (2007) who showed an increase of muscle activity on the VMO; however, the non-transparent study procedure lowers the validity. Chen and colleagues (2007/2008), Hsieh et al. (2007), and Murray (2000) also showed promising findings for the effect of medical tape on muscle activity but due to a lack of sufficient volume of the article no value could be given to the outcome. The conclusion on general efficacy by Hsu and colleagues (2009) is too far-fetched considering that the medical tape application showed only statistically significant increase in muscle activity effects between $60-30^\circ$ of shoulder abduction.

The effect of medical tape on muscle strength remains controversial. The pilot study by Fu et al. (2008) could not find any significant improvement of muscle strength in 14 healthy subjects. To mention is an inexplicable study design and the fact that healthy subjects cannot prove its inefficacy in unhealthy subjects. Additional findings by Chen et al. (2007/2008), Hsieh et al. (2007), and Murray (2000) show an increase of ground reaction forces (GRF) in different settings. An increase of GRF can

be gained by improving up to ten different factors (Yi. year unknown) and up to now, no clear description for the mechanism how medical tape may improve that is given.

Correction

Regarding the use of medical tape for corrections purposes, there is little research to support it. The evidence found was of the lowest level. A first attempt to show a corrective change in the tissue was made, but only two subjects and little information about the application of tape leave this case series conducted by Liu et al. (2008) also on a low level. The other four case studies which were found are either lacking in scientific quality or using Kinesio Tape only as a treatment adjunct, consequently no absolute result of the medical tape can be extracted (Barnes. 2008. Lin. unknown year, Parmentier. 2008, Pyszora et al. 2009).

It seems to be difficult to conduct studies using the correction method of medical taping because every problematic tracking or joint-alignment differs from patient-to-patient, thus consistency within and between study groups are difficult to maintain. In addition, it is very difficult to have an outcome measurement for a correction of joint, fascia or other tissue.

Pain

Gonzalez-Iglesias et al. (2009), Thelen et al. (2008) and Garcia-Muro et al. (2009) consistently find a reducing effect of medical taping on some level of pain. All three published studies were conducted with high quality, without any obvious methodical mistakes. However, no comparable outcome measurements are given what makes a generalized conclusion difficult. Gonzalez-Iglesias et al., for example, concludes a reduction of neck pain, whereas Thelen et al. only found an increase of pain-free in active shoulder abduction range of motion. The methodical quality of Gonzales-Iglesias et al. (2009, Thelen et al. (2008) and Garcia-Muro et al (2009) are very high, without any obvious mistakes.

The only contradicting study carried out by Gonzalez compares exercise therapy with medical taping and ended up with no effect of the medical tape condition (Gonzalez. 2009), but with the addition that the methodological quality is low, with only a group size of $n = 4$ and the fact that the

article was unpublished make the publication highly questionable.

Proprioception

In this field of medial taping, insufficient research with only three studies was documented. Researchers already found evidence for the positive effect of classic taping on proprioception in patients with knee instability (Callaghan et al. 2008), but in case of medical taping, still no conclusive answer can be given. The first study was conducted in 2001 by Murray et al. and showed a positive effect of Kinesio Taping on ankle proprioception in healthy subjects; however only the abstract was available, therefore this article could not be given any value in this review. Regarding the outcome of the two screened articles, no final result can be stated. Halseth et al. (2004), based on the study design of Murray et al., showed no effect and therefore presents contradictory outcomes. The study done by De La Motte (2008) showed that Kinesio Taping might have an positive effect on the kinematics, more in unhealthy than in healthy subjects, which results in an increase of overall proprioception. These two studies, conducted more recently, lead to the assumption that the application of tape only has a positive effect when there is instability due to insufficient proprioceptive input in unhealthy subjects.

Current research

The ongoing study by Enix (2010) investigates the "Effect of Kinesio Taping on Ankle Proprioception" and hypothesized that proprioception (knee repositioning error) and balance (sway velocity and center of pressure) will improve significantly after intervention in participants with a history of acute or chronic ankle sprains/strains. The principal investigator was contacted but no data was available yet. Another article, which could not be processed due to not meeting the deadline of literature search, by Wefers et al (2009) shows that Cure tape ® appears to be effective in providing pain relief in woman with primary dysmenorrhage.

Limitations

While performing the literature search, a publication bias was detected. This can be seen in the overall found articles in comparison to the

articles which were finally screened for this review. Reasons for this bias are irretrievable articles (n = 61) and studies written in a language other than English (n = 44). Therefore the reader is advised to use caution while reading this review and to keep in mind that not all available evidence could be used for making conclusions.

Another publication bias occurs in the relation of studies with positive and negative outcome. It is questionable if negative results of studies are as frequently published as positive results (Higgins, et al. 2009).

Conclusion

Circulatory

The application of medical tape to reduce edema seems to have promising results and therefore this category receives a **B recommendation**. Medical tape's effect on blood circulation was only documented in one study, and is therefore not well enough researched thus far. The category receives its recommendation therefore with reservation for the theory of enhanced blood flow as it is too early to speculate.

Muscle Function

Outcome measurements in this category are not comparable throughout findings and therefore only a tendency towards the fact that medical tape may have a positive effect on muscle function can be stated. Due to high quality evidence this category receives a grade of **A recommendation**.

Correction

The importance of medical taping in the field of correcting joint mal-alignment in practice is very high, as is suggested by practice based books (Kase, et al. 2003, Gwang-won. 2005, Kumbrink. 2009). The only study published was of a low level and therefore this category receives a grade **E recommendation**.

Pain

Two studies of a high level of evidence and good methodical quality with a positive effect in the short-term lead to a grade of **recommendation A** for this category.

Proprioception

In this category, the two contradicting studies result in a **recommendation D**, with the suggestion that the tape might have influence in subjects with decreased proprioceptive abilities, but not in healthy subjects.

Implications for Practice

This review is the first attempt to collect available scientific literature to base medical taping techniques on evidence. The recommendations given in this review should be handled with caution because taping techniques with a low or no recommendation can have positive effects in practice, just do not have sufficient evidence. Furthermore, in all studies, except the studies about the lymphatic system, only effects for short-term were considered. Every health care professional trying to use evidence in practice is therefore asked to specifically evaluate the evidence of concepts, tape brands, and techniques when applying medical tape in practice.

Implications for Future Research

This review provides an overview of past research and indicates/denotes categories that still lack in quantity and quality. There is a need of independent level 1 research in all categories to either confirm current findings in the categories circulation, muscle, and pain or find final conclusion for the efficacy of medical taping in blood circulation, mechanical and fascia correction, and proprioception. Future research should consider randomized controlled trials, including longer lasting follow-up, and reliable and validated outcome measurements. A definite absence of research is found in specific physiological and biochemical processes of the effect of medical tape on skin, fascia, and muscle to fully understand the mechanism of the medical taping concepts. Another difficulty occurs in the different terminology in clearly reporting the application of the medical tape in the found evidence. This leads to the urgent advice to clearly describe taping techniques to increase the clinical implication of future studies. The authors advise not to use the term "paper-off tension" as it can be confused with resting length of the tape.

Key Points

- Medical taping is a new treatment option and grows in popularity
- Different concepts, tapes, and techniques are available and lack in transparency
- 200 articles were found about medical taping, 17 were screened for final recommendations
- Medical taping might have a positive effect on circulation of the lymphatic system, muscle function, and pain levels
- There is little evidence to support the application of medical tape for correcting mal-alignments of joint or mal-tracking of muscle / fascia, and proprioception
- There is a need for higher quality research including controlled trials, better techniques, and long-term effect outcome measurements

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