Rationales and Evidence of Elastic Taping: A clinician’s perspective.

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Introduction

Coloured elastic tape, as seen globally at sports events and on television, has become very popular. This taping is also being increasingly used in medical and physiotherapeutic practice. Despite the success of this taping, there is academic scepticism on its efficacy. The latest systematic reviews on elastic taping demonstrate insufficient evidence to support the use thereof. Many questions arise and remain unanswered about how the tape works and its effects. This review will address those questions unanswered in systematic reviews to date, based on a clinician’s perspective.

Materials and Methods

The search strategy for this review included a literature search by members of the International Kinematic Academy in 12 countries between January 2014 and February 2015 using PubMed, CINAHL, Cochrane, Google Scholar, websites and national journals. The search words included “Kinesiotape, Kinesio tape, kinesiotaping, elastic taping, taping, functional taping, myofascial taping, sensomotor taping”. The review included all articles, even those published in different languages. These searches resulted in 821 publications.

These articles were reviewed. Articles included in the systematic reviews on patient outcome were excluded as they had been extensively reviewed elsewhere (Bronner 2008, Comploi 2009, Krausse 2010, Optum Health 2011, Schlosser 2011, Wilbacher & Maringer 2011, Moore 2012, Morris et al 2012, Mostafavifar et al 2012, Vercelli et al 2012, Williams et al 2012, do Carmo Silva Parreira et al 2014). Our research was to focus on evidence for rationales, explanations and clinically relevant aspects.

Analysis of the systematic reviews

1. Tapes under investigation:
   None of the systematic reviews critically appraised the Kinesiotape applications used in the studies. As there is no convincing evidence for any Kinesiotaping applications, it does not mean that there is no evidence for other elastic taping concepts in general. The principles and rationales for Kinesiotaping are not in complete agreement with common paradigms in orthopaedic manual therapy, western neuromuscular analysis & management of dysfunctions and pain (Sahrman 2001, Elvey 1998, Hengeveld and Banks 2013, Comerford & Mottram 2012).
2. Incorrect nomenclature of “placebo”, “sham”
   All interventions, taping included, have a placebo effect but one cannot say that tape felt on the skin (which implies afferent input) is a placebo intervention (Yamamoto 2011). Use of the words “non specific” intervention may be more appropriately used than “sham”, compared with a taping application using orthopaedic manual therapy (OMT) principles.

3. Use of colours
   Although colour significantly contributes to the popularity of elastic taping, no study showed evidence for the use or non use of a specific colour for a specific condition and the colour debate was never mentioned in any systematic review. The inventor of the elastic tape material, Kase, revealed that there has not been a specific medical reason for developing different colours (The Observer 2011).

4. Limitations of the systematic review
   Some limitations are recognized by the reviewers e.g. limited to English language or randomized controlled outcome studies, or studies without a control group.

5. Long term follow up
   Reviews criticize the lack of long term follow up but even in the original concept of taping improving lymphatic and blood circulation, it was meant to be an intervention with an immediate and short term effect. On the sports field, time from treatment or training session- to another session may be a few hours while in the clinical setting, treatment time can vary from daily treatments to treatment once a week. Treatment strategies will vary during the course of treatment dependant on the effect and so will taping applications. Therefore it is not appropriate to examine the long term effects of taping, electrotherapy manipulation etc, as they will change as the patient progresses.

Rationales

The original aim of the originator of elastic tape, Kenzo Kase, was to stimulate self healing mechanisms of the body by improving lymphatic and blood circulation without restricting range of motion. It has been demonstrated in single case measurements in normal subjects with Doppler sonography that elastic tape, applied to the skin over a major artery, increased the arterial blood supply in the distal course of that artery (Kase & Hashimoto 1998). An improved blood supply promotes self-healing mechanisms and confirmed an initial research aim of Kase. Despite this initial evidence, rigorous follow up studies to confirm these findings are lacking to date. Miller et al. (2011) demonstrated that there was no difference in blood flow with rigid or elastic tape or conditions. It appeared that the application of either tape
may change blood flow to the targeted area, but most likely as a result of prior exercise.

Shim et al. (2003) demonstrated that taping the hind leg of a rabbit increased the lymphatic flow, however only in combination with passive movement. However, the effect of passive movement alone has not been investigated. Post-partum breast engorgement and mammary gland pain were not influenced by breast lymphatic tapes, as there is no option to add passive or active movement (Brown & Langdon 2014). Lymphatic tape applications as being used in post-traumatic and post-surgical conditions to reduce swelling do not emphasise that movement needs to be added to the application. But there is weak evidence that secondary lymph oedema, e.g. after breast surgery, may benefit from lymph applications, in addition to manual lymphatic therapy (Stockheimer 2006, Heim 2007, 200a, 2008b, Tsai et al. 2009, Bialoszewski et al. 2009, Bosman & Piller 2010, Finnerty et al. 2010, Pyszora & Krajnik 2010).

Nunes et al. (2015) demonstrated that there was no decrease in swelling after kinesiotaping of a swollen ankle after a lateral ankle sprain.

The principles of increasing arterial blood supply and lymphatic drainage are not commonly used by manipulative physical therapists in neuromuscular treatment, thus other rationales (mechanical, neurophysiological) should be considered.

Mechanical correction

In addition to the self healing philosophy, Kase also used a mechanical approach, which, however, does not comply with all OMT principles (Kase, Hashimoto & Tomoki 1998). The McConnell approach, in which rigid taping is one of the management pillars, in contrast, adheres to OMT and neuromusculoskeletal (NMS) rehabilitation principles (Bennell et al. 2006).

Kawabata et al. (2007) could demonstrate with spiral tapes around the lower and upper leg that the rotatory angle between the femur and tibia significantly changed under loading, as with one leg squatting or drop landing (S. Fig. 2a-d). These tests are considered relevant in many patients with anterior knee pain (patello-femoral pain syndrome). Kawabata et al. (2007) are the only researchers to date to demonstrate a change in osseous movements during functional loading with elastic taping.

Further research could reveal that elastic tapes applied according omt principles instead of kinesiotapes could change positional faults of the lateral malleolus or fibular head after an ankle sprain or the clavicle after an acromioclavicular joint sprain.

Neurophysiological processes:
It is the skin that is being taped. The skin is the biggest human organ with countless nerve endings at its layers. Tape on the skin is perceptible. So, there is afferent input in the somatic nervous system. Most patients report that the tactile perception is hardly felt. Possibly the unmyelinated c-tactile (social) afferents are being stimulated (Björnsdotter et al. 2009, Löken et al. 2009). The placebo concept is therefore misleading. Tape can be applied in a general or specific area but whatever the application, there is always an input. In studies, one could compare (so-called) specific with non-specific (and not placebo) tape applications. It is self-evident that, as in any therapy, there is a placebo effect with any tape application. Any placebo effect can be used consciously, as well as simultaneously be minimized with increasing specificity of the treatment. The more precise the examination and treatment is, the more specific a dysfunction is treated and, subsequently taped, the less the placebo effect could be. Studies providing the evidence for this are lacking to date.

Probably the most important explanation for the effect of taping the skin is offered by current fascial research. Taping the skin, with some stretch in a certain direction, aims to change the shearing of the skin and fascial layers. Dynamic mechanoreceptors, such as Ruffini and interstitial receptors, are localized to the border zones of these soft-tissue layers (Garcia 2001, Stecco et al. 2007, 2010, Schleip 2003ab, Melnyk et al. 2007, Schleip et al. 2007, Benetazzo et al. 2011, Corey et al. 2011, Stecco et al. 2011, Schleip et al. 2012). Altered mechanoreceptive afference could alter processing in the dorsal horn and (inter-)segmental interneurons, explaining immediate pain inhibitory effects, increased pain-free range of motion and increased muscle power. Such observable immediate changes can be explained neurophysiologically rather than physiologically by increased arterial blood supply or increased lymphatic drainage. Investigations with somato-evoked potentials (SEP) could support the proposed mechanisms. Yamamato (2011) could demonstrate a change in spinal cord excitability with SEP after taping the skin.

As 50% of interstitial dynamic mechanoreceptors have a high threshold, a sufficient amount of stretch is required to activate them. To avoid rapid adaptation tape has to be applied over the joints and movement of the joint ensures repeated stretch and activation of the receptors.

Tape stretch can vary between 0% (traditionally with lymphatic, but also in facial and anterior neck applications) to 100% (only additionally in some osseous or articular conditions with a mechanical rationale). The most commonly used amount of stretch for mechanoreceptor activation is up to 33%. A helpful clinical guideline is: the softer and more flexible the skin is, the less stretch is to be applied. The beginning and ending of the tape, are always applied without stretch to avoid skin irritation or damage, as well as to stabilize the application. Due to the stretch and the starting position, convolutions of tape and skin are avoided. Despite convolutions being advocated in the literature, they are not desirable if the shearing behaviour of skin and fascial layers is to be changed and the dynamic mechanoreceptor rationale is adopted.
Parreira et al (2013) demonstrated that tape applications with convolutions are not more effective than sham (unspecific) tapes in the treatment of chronic low back pain. Convolutions may only be desirable in lymphatic applications for swelling. However, there is no evidence that these convolutions increase the space between the skin & underlying interstitial space as is assumed. In addition, there is no evidence that this decreases pain by reducing pressure on the nociceptors as assumed by Kase. (Kase, Hashimoto and Tomoki, 1998)

Investigating standardised interventions, including tape applications, in a heterogenous group of patients is unlikely to present convincing evidence for that intervention. Identifying a homogenous subgroup of patients is necessary before investigating the effect of a standardised intervention (e.g. a tape application) on selected outcome tools such as relevant physical tests or muscle activity (with EMG). Systematic reviews to date therefore could not reveal the benefits of taping as seen in daily practice. In contrast, in homogenous subgroups, the effect of a standardized application on selected, relevant variables can be investigated.

Randomized controlled trials should therefore investigate the short-term effect of treatments without, as well as with specific and with sham taping on pain, range of dysfunctional movement patterns and even muscle activity during test movements (EMG) in homogenous subgroup of patients (Berkmiller 2013). A subgroup of patients with the same of pool of relevant positive tests can be considered as homogenous, and can be used for immediate and short-term (24 to 72 hrs) outcome measurement.

### Table 1. Rationales and Evidence for Elastic Taping

<table>
<thead>
<tr>
<th>Rationales</th>
<th>Reference</th>
<th>Remark</th>
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<tr>
<td>Increase of Arterial Blood Supply</td>
<td>Kase &amp; Hashimoto 1998, Miller et al. 2011</td>
<td>Single case examples in normal subjects. No further research or objective confirmation to date</td>
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<tr>
<td>Activation of C-tactile (social) afferents</td>
<td>Björnsdotter et al. 2009, Löken et al. 2009</td>
<td>Neurophysiological investigation needed to demonstrate changes in afferent activity and to provide evidence for a general, unspecific effect of skin taping</td>
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<tr>
<td>Placebo</td>
<td>Yamamoto 2011</td>
<td>Any treatment has a placebo effect. Taping is an intervention with</td>
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mechanoreceptive input. The wording placebo tape is not correct by definition. It is to be differentiated between sham, unspecific and specific tape.

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<tr>
<th>Change osseous positions</th>
<th>Kawabata et al. 2007</th>
<th>Further investigations needed, e.g. for the clavicle after acromio-clavicular joint sprains, for the fibula after ankle sprain</th>
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<tr>
<td>Changing muscle function</td>
<td>Selkowitz et al. 2007 (non-elastic tape) Hsu et al. 2009 Berkmiller 2013</td>
<td>Further evidence for changing action of overactive or underactive muscles is needed. The kinesiotaping approach in changing the direction of application to tonify and detonify is not in agreement with actual paradigms.</td>
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<tr>
<td>Activation of (Ruffini and high-threshold interstitial) Dynamic Mechanoreceptors</td>
<td>Corey et al. 2001 Stecco et al. 2011 Yamamoto 2011</td>
<td>Further evidence on patient groups with Somato-Evoked Potentials (SEP) needed</td>
</tr>
<tr>
<td>Reciprocal Inhibition</td>
<td>Yoshida &amp; Kahanov 2007 Berkmiller 2013 Sazegar 2013</td>
<td>Finger to Floor distance decreased after lumbar tape. Decrease of protective muscle action at a neurodynamic test with movement against tape resistance (EMG). Further studies needed</td>
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Lack of evidence should motivate clinicians to become more precise, to consider further rationales, to apply current principles and guidelines of modern neuro-musculoskeletal rehabilitation, as well as to experiment and innovate. Relevant variables to consider when applying tape may include: the starting position of the dysfunctional structure, the range of the dysfunctional movement, the length, the course and the direction of the tape(s) as well as the amount of tape stretch.
Fig. 2a-d. Tape application to promote internal rotation of the tibia in relation to the femur (modified from Kawabata et al. 2007).

Fig. 3a-c. A patient with low back pain and a flexion pattern (no limitation of lumbar flexion). A basic lumbar application (Yoshida & Kahanov 2007) did not reduce pain or improve finger to floor distance at lumbar flexion. With sound clinical reasoning and differential testing, such a tape application would neither be considered for a clinical intervention nor for a scientific investigation.

Fig. 3d-f. After taping for relaxation of the lateral hamstrings in the above patient: immediate increase in range and decrease of pain on lumbar flexion (Sazegar 2013). This example gives one explanation for the conclusion of many randomised clinical
trials and systematic reviews that standardised interventions for a diagnosis (e.g. non-specific low back pain) do not lead to significant improvements.

Evidence

For some elastic tape applications there is evidence that relevant variables, such as positive tests, may change (Murray 2000, Itoh et al. 2004, Osterhues 2004, Kawabata et al. 2007, Liu et al. 2007, Hsu et al. 2009, Chen et al. 2011). All these studies can easily be criticized from a clinical point of view or a theoretical neuro-physiological perspective. Nevertheless, they confirm regular observations of clinicians. Two EMG studies demonstrated improved scapular motion (Selkowitz et al. 2007 with non-elastic tape, Hsu et al. 2009) and are of importance when considering tape applications in shoulder pain.

Single case reports in paediatrics and central nervous system disorders with spasticity, have suggested that elastic taping can support rehabilitation (Martin et al. 2003, Yasukawa et al. 2006, 2009, Michalak et al. 2009, Cortesi et al. 2011, Simsek et al. 2011). As management in these patient groups is generally very individualized, any study requires investigation of a very limited number of parameters in a relatively homogenous subgroup.

Further possible applications include facial and abdominal taping. For example, it has been shown that taping the lower abdomen with horizontal and vertical tapes decreased primary dysmenorrhea pain as effectively as the best possible contraceptive pill. (Pinsker 2009, Wefers et al. 2009, Schlosser 2011b). Participating in a study comparing a tape intervention with a non-tape intervention control group may have included a significant placebo and/or Hawthorne effect.

Taping has no effect on healthy, normal muscles and joints (Halseth et al. 2004, Fu et al. 2007, Beck et al. 2010, Chang et al. 2010). Nevertheless, taping can be applied preventatively during or after heavy physical loading, e.g. at sports to prevent injuries such as ankle sprains, to prevent or limit fatigue and muscle soreness (Nosaka 1999, Abián-Vicén et al. 2009, Schneider et al. 2010, Marban et al. 2011, Merino et al 2012, Strutzenberger et al. 2014).

Conclusion

The evidence in controlled clinical trials in patient groups is generally weak, as concluded by reviews and systematic reviews. The methodology, as well as the original applications of Kase being used in the studies can be critically reviewed. As outlined, applying the actual principles and evidence of neuro-musculoskeletal therapy to develop tape applications is likely to improve the evidence for a positive short-term effect of elastic taping in homogenous subgroups or selected variables.
Elastic taping with coloured tape cannot be considered evidence-based to date. Therefore it demands a critical clinician’s mind using sound clinical reasoning, current principles of orthopedic manual therapy, (including appropriate re-assessments) and acceptable rationales, for applying tape to enhance treatment. Further research is needed to justify the rationales. Evidence for the explanations could lead to the further development of elastic taping applications.

Clinical success in reflective practice (practice based evidence - PBE) and growing scientific back-up (scientific evidence - SE) will both contribute to establishing elastic tape as a beneficial adjunct in the comprehensive management of patients with movement disorders, beyond the initial hype among consumers and in sports physiotherapy.

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