A Preliminary Investigation into the Effect of Kinesio and Athletic Tape on Skin Blood Flow Changes

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A PRELIMINARY INVESTIGATION INTO THE EFFECT OF KINESIO AND ATHLETIC TAPE ON SKIN BLOOD FLOW CHANGES

by

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A PRELIMINARY INVESTIGATION INTO THE EFFECTS OF KINESIO AND ATHLETIC TAPE ON SKIN BLOOD FLOW CHANGES

Ryan Klawon, M.S.
Western Michigan University, 2010

This research tested the effectiveness of a relatively new therapeutic product called Kinesio tape. One of Kinesio tape's therapeutic claims is increased blood flow to the taped area and thus expediting the body's healing process (Fu et al., 2007). The purpose of this study was to compare the effects of Kinesio tape versus athletic tape on blood flow in the upper arm during rest and immediately following submaximal exercise. Certified athletic trainers (ATC) often use regular athletic tape to limit the range of motion and stabilize a joint as opposed to providing therapeutic benefits such as increasing blood flow.

Research on this topic is very limited, which made it imperative to conduct this study and provide scientific evidence to allied health professionals. Kinesio tape has thus far gained popularity through mainstream events such as the Olympics and college basketball and not on empirical evidence. An example of Kinesio tape's growing popularity on an experimental basis is its use as a therapeutic treatment in lymphedema patients following breast cancer (Williams, 2006). The research I conducted will help provide scientific evidence in the support or nullification of Kinesio tape's uses, specifically for increasing blood flow.
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Ryan Klawon
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INTRODUCTION

Certified athletic trainers (ATC) use various types of athletic tape along with many different taping techniques to help provide support and stabilization of joints in the body. Research has shown that Athletic Tape (AT) decreases the range of motion (ROM) of a joint due to its stiffness and non-elasticity (Bragg, MacMahon, Overom, Yerby, Matheson, Carter, et al., 2002). ATC's often use AT to limit the ROM of an injured or previously injured joint such as the ankle to prevent further injury from occurring. Research shows that using AT on an ankle can decrease ankle inversion from $32.9^\circ \pm 6.2^\circ$ to $21.5^\circ \pm 5.2^\circ$ (Pederson, Ricard, Merrill, Schulthies, Allsen, 1997). Athletic tape is not waterproof and is generally worn for only one practice, game or session and then removed due to loosening from activity by up to 21% (Pederson et al, 1997). If not applied properly, athletic tape can constrict an area and decrease circulation to the taped region of the body (Prentice, 2003) which can lead to serious implications.

A relatively new product, Kinesio Tape (KT), was introduced in the 1970's. Kinesio Tape has been used more frequently in countries such as China and Japan, but has only been recently used in the United States after exposure at the 2008 Summer Olympics in Beijing and at the 2009 NCAA Men's Basketball Tournament. Kinesio Tape claims to have more benefits and uses compared to athletic tape. Kinesio Tape is reported to strengthen weak muscles, increase blood and lymphatic flow, decrease pain, reposition subluxed joints and increase proprioception of a body part (Fu, Wong, Pei, Wu, Chou, & Lin, 2007). Moreover, KT is elastic, waterproof, and can be worn for three to four days at a time, giving it additional benefits over AT
(Thelen, Dauber, Stoneman, 2008). However, specific research on the aforementioned claims is limited. Thelen et al. (2008) found that KT can increase shoulder ROM when limited by musculoskeletal pain. Fu et al. (2007) found that KT does not enhance nor inhibit muscle strength when applied to the thigh and knees of healthy subjects.

Aside from the athletic scene, KT is being tested in the management of other health conditions such as lymphedema following breast cancer. Again, KT is gaining popularity as a management tool, but there is little published research to support its use in breast cancer patients (Williams, 2006). Experimentation is being done in this area based on the theory that KT “creates space underneath the skin to improve circulation and lymphatic drainage” (Authentic Kinesio, 2009). This is an example of how KT is growing in popularity and usage by the day without sound evidence supporting its claims.

In theory, KT claims to increase blood flow based on the above concept, thus increasing the amounts of red and white blood cells, platelets, plasma and antibodies into the taped area and expediting the healing process (O’Neil, 2009). With KT’s ability to be worn for multiple days at a time, it sounds reasonable for KT to produce longer, lasting effects in regards to blood flow; however, the claim that KT can increase blood and lymphatic flow has very little support and no research was found by the authors on the effects of blood flow. The purpose of this study is to compare the effects of KT on blood flow in the upper arm at rest and during exercise with regular athletic tape. It is hypothesized that KT will produce a greater volume of superficial blood flow for a longer period of time when compared to AT.
METHODS

Subjects

Ten healthy subjects (age: 21.1 ± 1.62 yrs; height: 172.21 ± 13.43 cm; weight: 72.3 ± 23.95 kg) were recruited and volunteered for this study. Inclusionary criteria included: 18 years of age, no upper extremity injury in the past 6 months, and no allergies to adhesives. All subjects also had to pass a PAR-Q questionnaire and sign an institutionally approved consent form.

Instrumentation

Blood flow was measured non-invasively through the use of a MoorLab LASER Doppler blood flow meter (Moor Instruments Ltd., Wilmington, Delaware). The LASER probe was adhered to the surface of the skin with a small circular piece of double-faced tape over the belly of the biceps brachii muscle, emitting LASER light into the superficial tissues. When red blood cells travel beneath the LASER light the light reflects back to the probe and produces a blood flow flux value. According to Moor Instruments Ltd. (2009) the term flux is defined as the quantity proportional to the product of the average speed of the blood cells and their number concentration (often referred to as blood volume).

Procedures

Subjects attended an individual introductory meeting to discuss the requirements of the study and determine the dumbbell weight required for exercising the biceps brachii. Subjects performed standing preacher bicep curls with their dominant arm, which was determined by each subject's self-reported throwing arm. Each subject piloted by picking a weight and performing three sets of 10 repetitions
with a one-minute rest between each set and fatigue occurring at the end of the third set. Each subject’s determined weight was then used throughout each trail of the study. Following the orientation visit, subjects returned to the laboratory on two more occasions for each of the taping trials. Each subject completed both conditions (KT and AT) in a counterbalanced design with each trial approximately 5-7 days apart. The data collection process occurred in four sequential 20 minute periods, for each taping condition, either AT or KT.

During each trial, the subject had the entire area of the biceps brachii muscle on the dominant arm cleaned with an alcohol prep pad. After cleaning, a measurement was taken from the center of the cubital fossa to the axillary crease. The center of the cubital fossa was defined as the middle of the lateral and medial epicondyles of the humerus. This measurement was then divided by two to find the approximate middle of the biceps brachii muscle and marked with a single dot with an indelible marker. The LASER probe was placed on the skin’s surface on top of the dot. Upon securing the LASER probe, the subject was asked to sit in a neutral sitting position designed by the researchers to provide consistent blood flow measures in the biceps brachii muscle. This neutral sitting position required the subject to rest the testing arm on the table in a supinated position with 150º of elbow flexion. This angle was measured with a goniometer in which the fulcrum was placed at the lateral epicondyle of the elbow, the stationary arm in line with the radial styloid process and the moveable arm in alignment with the acromion process. The subject was placed in this exact sitting position before each 20 minute data collection period for both taping trials. This angle was consistent with all subjects in each trial within ±3 degrees.
After the neutral sitting position was established, the LASER probe cord was taped with surgical tape to the subject’s arm in a straight line. Four strips of surgical tape secured the LASER probe cord to the skin from the belly of the biceps brachii to the wrist, preventing any artifact in the LASER signal which would lead to an inaccurate blood flow measure. After securing the probe, a 20 minute baseline blood collection was recorded. Subjects were asked to refrain from laughing, sudden movements, moving the testing arm, touching the probe or touching the area around the probe.

Following completion of the baseline period, one of the taping conditions was applied. The KT and AT were both applied according to the KT biceps brachii taping protocol (Figure 1).

Figure 1: Kinesio Tape Application With Elbow Straight

This KT application method is designed to mimic the long head and short head of the biceps brachii muscle. To apply the designated tape the LASER probe was removed from the arm and the subjects were asked to stand. With the subject standing, the tape was unrolled to the approximate length of the subject’s upper arm. This distance
was designated as the distance from the center of the cubital fossa to the acromion process. The tape was then cut to its approximate length and then cut down the middle leaving approximately 1-1/2 inches uncut, producing 2 tails of tape as shown in the diagram. To ensure the proper taping technique and application method, the researcher completed and passed the KT home study program.

Before applying the designated tape to the subjects, they were placed in a neutral standing position, which exposed the biceps brachii muscle and followed KT recommendations (Kase, Wallis, & Kase, 2003). The standing position required the subject to stand with the testing arm at 45° shoulder abduction, 25° extension and forearm supination (Figure 2).

Figure 2: Standing Position for Tape Application

The measurements were taken with the stationary arm of the goniometer along the lateral aspect of the thorax with the fulcrum in the axillary region. The moveable arm was then moved with the arm to the specified arm angle. Once in this position, the designated tape was applied from origin of the biceps brachii to insertion (Figures 1 and 3).
Figure 3: Kinesio Tape Application With Elbow Bent

Applying the tape from origin to insertion followed Kinesio Tape’s guidelines for support or chronic muscle weakness set forth in the Clinical Kinesio Taping Video Home Study Exam.

The KT was applied with approximately 15-20% of the stretch removed from the tape. This elastic quality is essential because it creates convolutions that are theorized to lift the skin and take pressure off the interstitial fluid, providing better drainage (Kahanov, 2007). Though removing 15-20% of the stretch could not be achieved exactly, an approximation was achieved by the researcher through practice as directed in the Clinical Kinesio Taping Video Home Study Exam. Once on the skin, the AT and KT was rubbed to activate the adhesives in the material and ensure proper adhesion. This rubbing was performed for 10 seconds over the strips of KT and AT to create equal stimulation to the area in each taping trial. With the designated tape applied and proper adhesion achieved, the LASER probe was again placed on the skin over the pre-determined location that was marked previously. The
subject was placed in the neutral sitting position with the testing arm at the exact same angle and the LASER probe cord taped in the same manner as the baseline collection period. Immediately following the 20 minute tape application period, the LASER probe was removed from the subject’s test arm. Standing, the subject performed three sets of 10 repetitions of preacher bicep curls with the pre-determined dumbbell weight. Subjects began by holding the dumbbell with their palms toward their body, and then proceeding to perform 10 preacher bicep curls. Between each set of 10 reps, subjects received a one-minute rest before starting the next set. Upon completion of all 3 sets, the LASER was immediately re-attached and the subject was placed in the neutral sitting position for the recovery period data collection. After the 20 minute recovery period, the tape was removed while the subject remained seated. The tape was peeled off by the researcher with one hand and holding the skin adjacent to the tape with the other hand to limit the amount of irritation and stimulation to the area. Immediately following the tape removal, the LASER was re-applied and data was collected for another 20 minutes for the post-taping period.

STATISTICAL ANALYSIS

Percentages and standard errors were calculated for the first five minutes of the baseline, tape application and exercise. We did not include the post-taping period under the assumption that blood flow will return to normal during the post-taping period. A repeated measures analysis of variance (ANOVA) was used to test for difference in blood flow measures with two within group factors (time x condition). If significant interactions were found, pairwise comparisons using LSD adjustments were calculated. There were three time points (the first 5 minutes of the three
different treatments: baseline, tape application, and recovery). The dependent measures included blood flow at the three different time points. Statistical analysis was performed using SPSS (version 17.0; SPSS Inc, Chicago, IL). The $\alpha$ was set a priori at $\leq 0.05$ for all statistical analysis.

RESULTS

Mean Percent Change and SEs can be seen in Table 1. There was no group X time interaction or main effect for group; however there was a main effect within time points ($F_{1.3.9.3} = 4.34, P = 0.05$). Pairwise comparisons using a LSD adjustment showed that there was a significant difference ($P = 0.05$) in blood flow between the tape application (-4.9%) and recovery periods (36.0%). Pairwise comparison also showed a strong tendency between the baseline (0%) and recovery periods (36.0%) (Figure 4).

Table 1

<table>
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<th>Condition</th>
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<th>Standard Error</th>
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<td>0</td>
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<tr>
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<td>0</td>
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DISCUSSION

The purpose of this study was to determine if the application of KT caused an increase in blood flow as specified in the literature (Fu et al., 2007). The findings in
this study suggested that KT does not significantly increase the amount of blood flow under the taped area. As seen in Table 1 and Figure 4 it actually appears that AT had

Figure 4: Percent Change for Each Tape During Each Period

![Graph showing percent change for each tape during each period.](image)

a greater effect on blood flow. With each tape blood flow decreased during the tape application period when compared to baseline measures. Blood flow measures then increased above baseline measures during the recovery period. Research done by Ohmori et al. (2007) showed that a single muscular contraction can produce increased blood flow to the area for up to five consecutive cardiac cycles, implying that multiple contractions would produce even greater blood flow increases. The evidence in the present research supports that of Ohmori et al. (2007) that blood flow was more dependent on exercise and contraction of the test limb as opposed to a particular tape on the skin's surface. For KT to fulfill the claim of increasing blood flow, each subject should have had greater blood flow increases during the KT application over
the AT application; however, the results showed neither tape to be significantly different than the other.

Each tape was applied in the same manner with the expectation that KT would maintain complete adherence to the skin, whereas it was expected that AT may peel or lift off the skin upon moving the test arm. This was shown to be true throughout the study however KT was still no more effective than AT in increasing blood flow. When applied with stretch, KT claims to “create space underneath the skin to improve circulation and lymphatic drainage” (Authentic Kinesio, 2009). The data analysis showed that even though KT maintained complete adherence to the skin, the pull on the skin evidently wasn’t great enough to decrease the amount of muscle/tissue adhesion to allow for a significant blood flow increase. It is possible that for KT to be effective in increasing the amount of space beneath the skin, KT may need to be applied with a greater amount of stretch to create a greater amount of pull on the skin and promote increased blood flow.

In a study conducted by Newman, Adler and Rubin (1997), exercise-induced changes in blood volume were measured through the use of a Doppler sonography unit. Their study tested 10 volunteers and a total of 20 bicep brachii muscles in which subjects performed bicep curls with either a five or 10 pound dumbbell weight that was chosen by the subject. The results of their study showed that an increase in vascularity was evident in all 20 bicep brachii muscles tested. There was no subjective significant difference between subjects who used the five pound dumbbell and 10 pound dumbbell (Newman et al., 1997). The significance of this is that the methods and findings of Newman et al. (1997) are very similar to those of the current
study where blood flow also increased following bicep curls during the KT and AT application. Clinically, the evidence supports exercise alone has a much greater effect on blood flow than the application of either tape, especially KT.

Kinesio tape is often used in the rehabilitation of an injury to increase the amount of blood flow to the area to expedite the healing process. Performing three sets of 10 bicep curls was chosen because it’s similar to what is done during a progressive resistive exercise (PRE) rehabilitation session for an injury to the upper extremity. PRE is the most commonly used strengthening technique in a rehabilitation program which includes the use of free weights, exercise machines or rubber tubing (Prentice, 2004). It is this reasoning that the researchers expected KT to have its greatest impact on blood flow immediately following the three sets of 10 bicep curls, also evident in the findings of Newman et al. (1997). A study conducted by Ahlborg & Jensen-Urstad (1991) showed that 30 minutes on an arm bicycle at 30 W can increase blood flow up to 1 L/min. When comparing the results of Ahlborg & Jensen-Urstad (1991) and those of Newman et al. (1997) to the present findings, again one can conclude that exercise alone has a greater affect on blood flow than exercising with KT applied. It is possible that the exercise or the intensity may not have been enough to elicit a significant increase in blood flow however the application of KT should have produced significant blood flow increases when compared to baseline measures.

Another study was conducted in a pediatric population who all had decreased muscle strength and/or decreased muscle tone in the upper extremity. The results of this study suggested that KT had a positive effect on the functional status of the upper
limb, but it was stated that the effects of KT may be so subtle as to be observed only in cases where movement disorders are present (Yasukawa, Patel & Sisung, 2006). While the results and sample population of this study differ than that of the current study, it shows that a great amount of uncertainty continues to surround KT and its clinical applications.

The current study measured superficial blood flow as opposed to intramuscular blood flow. The researchers chose superficial blood flow measurements because each tape was applied topically, therefore affecting superficial blood flow before reaching the intramuscular level. For KT to increase intramuscular blood flow, as it claims, KT would also have increased superficial blood flow. Again, it’s possible that KT needs to be applied with a greater amount of stretch than first thought by KT creators or possibly the thickness and strength properties of KT need to be increased. This idea was also suggested by Fu et al. (2007) during the testing of KT’s affect on muscle strength in which they found that KT did not inhibit or facilitate increased muscle strength in any of the tested muscles.

There were two uncontrollable variables in this study, but they were taken into account as best as possible. One variable was the time of day that each trial took place for each subject. Most subjects had both testing trials either in the morning or the afternoon, but some subjects had one trial in the morning and the other in the afternoon. This could have had an effect on their state of being during the testing trial due to changes in circadian rhythms. During the circadian rhythm of the human body it is important to understand that during hours of sleep, activities such as blood pressure, respiration rate, heart rate, metabolic rate and body temperature all decrease.
This means that a morning trial could result in a lower baseline blood flow measure than an afternoon baseline measure due to the body being more active later in the day. Lastly, there was the lack of physical activity limitations placed on the subjects outside of the testing trials. This means that a subject could have exercised on the day of one trial and not on the other. Exercising on the day of a trial could elevate baseline measures and potentially limit any blood flow increases with the bicep curls.

**FUTURE RESEARCH**

In regards to this study, due to KT’s lack of effectiveness, one may want to try doing a longer, more intense exercise or an aerobic exercise such as arm cycling. One could use the model of Ahlborg & Jensen-Urstad (1991) applying KT and AT to compare each application and which tape increases blood flow the most. The findings of Yasukawa, Patel & Sisung (2006) could also be followed up with research comparing healthy subjects to subjects who have conditions where KT would be recommended. Each KT claim could then be tested and compared between the two groups to determine KT’s effectiveness.

Other future research regarding KT should include testing that measures KT’s effect on blood flow intramuscularly versus superficially to validate the efficacy of KT. Future research should also measure blood flow using KT and another form of elastic athletic tape such that produced by Elastikon. As previously theorized an elastic tape such as Elastikon’s product is thicker and stronger than KT and may provide a greater amount of lift and pull on the skin achieving a greater increase in
blood flow. When conducting this future research, researchers may want to use a between groups design where each tape group contains different subjects.

It is also important for researchers to test KT's other various claims such as strengthening weak muscles, decreasing pain, repositioning subluxed joints and increasing proprioception of a body part because this product as a whole lacks scientific validity. KT has thus far made its name through the media and nationally televised events causing a whirlwind of curiosity, in which allied health professionals are trying the product based on their curiosity and not evidence.

CONCLUSION

In regards to increasing blood flow, KT has not been shown to provide significant changes with application or immediately following submaximal exercise. For KT to benefit a patient and expedite recovery a majority of the increase in blood flow needs to occur intramuscularly. Therefore, with little to no increase in superficial blood flow it is unlikely that any increase took place intramuscularly. The findings of this study are important to allied health professionals because KT is designed and created to increase blood flow and is becoming more widely used. In reality though, KT is no more effective than putting a product like AT, which is not created to increase blood flow, on an injured area. Due to the uncertainty around KT and at least one unfulfilled claim, KT needs to scientifically validate its other claims before becoming a mainstay in allied health professional facilities throughout the world.
REFERENCES


