Kinesiology Tape Modestly Increases Skin Blood Flow Regardless of Tape Application Technique

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Background and Purpose: Kinesiology tape (KNT) is commonly used for prevention of injury and as part of rehabilitation to treat muscle and joint pain. KNT is purported to increase local blood flow by reducing local pressure. Whether skin blood flow is increased by KNT is not presently known.

Methods: We conducted 2 experiments to elucidate the effects of KNT on skin blood flow as follows: in protocol 1, KNT was applied to the skin at 0%, 25%, 50%, and 100% relative tension, and in protocol 2, KNT was applied to the skin with and without convolutions. Red cell flux, an index of skin blood flow, was measured by laser Doppler flowmetry at each site and at a no-tape control site.

Results: For protocol 1: there was an overall effect of tape on cutaneous vascular conductance (CVC: laser Doppler flowmetry/MAP; KNT: 0.12, 95% confidence interval: 0.10, 0.14; control: 0.08, 95% confidence interval: 0.07, 0.10 flux·mmHg⁻¹; \( P < .01 \)), but no effect of tension (all \( P > .05 \)). KNT was retained for 3 days after which the patients returned for follow-up testing. CVC remained unchanged after 3 days of KNT application (\( P = 0.07 \)). For protocol 2: there was an overall effect of tape on CVC (KNT: 0.30, 95% confidence interval: 0.21, 0.39; control: 0.15 (0.09, 0.21 flux·mmHg⁻¹; \( P = .03 \)), but there was no difference between KNT applied with or without convolutions (all \( P > .05 \)).

Conclusion: These data suggest that KNT modestly increases microvascular blood flow regardless of tension or presence of convolutions.

Keywords Skin blood flow; kinesiology tape; kinesiotape

Key Point: Kinesiology tape increases skin blood flow regardless of the amount of tension applied, with or without convolutions.

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PURPOSE

In recent years, kinesiology taping has emerged as a common therapy to treat musculoskeletal injuries.¹ Application of kinesiology
tape (KNT) is purported to have numerous beneficial effects including neuromuscular re-education, reduction of inflammation, delayed muscle fatigue, and injury prevention. KNT is also purported to improve blood and lymphatic circulation by reducing pressure, and increasing interstitial space, thus facilitating improved flow. When applied with this intention, it is usually the practitioner’s goal to reduce swelling or edema. Therefore, validating whether KNT increases blood flow is important for determining its therapeutic efficacy.

Few studies have examined the effects of KNT on blood flow and lymphatic drainage. A randomized controlled trial by Tsai et al. compared KNT and decongestive lymphatic treatment with standard compression and decongestive lymphatic treatment in the treatment of breast cancer-related lymphedema. No difference was found in the measures of lymphedema between the use of KNT and standard compression, indicating that KNT was no more or less effective in eliciting lymphatic drainage. Woodward et al. found that KNT did not alter skin blood flow in the forearm of young soccer players; however, the authors only evaluated KNT applied with 1 technique (10% stretch). Miller et al. examined the effects of KNT compared with that of standard athletic tape on skin blood flow before and after upper body exercise and found that there was no difference between the tape treatments and that changes in skin blood flow were likely exercise-mediated. Although these studies suggest that KNT may not alter lymph or blood flow, the effect of KNT application on skin blood flow requires further elucidation.

Numerous techniques for KNT application are also purported to alter KNT function. In particular, tape tension and the presence or absence of convolutions are considered vital for KNT efficacy. Convolutions are created when KNT is applied over a stretched muscle and the muscle is returned to the resting position. A few studies have investigated the importance of KNT applied with convolutions. Parreira et al. found that convolutions in KNT neither improved nor impaired the analgesic effect of KNT on low back pain, whereas Vercilli et al. found that KNT-induced changes in hematoma color were not affected by convolutions. Similarly, the few studies examining the clinical importance of KNT tension are limited in scope and examination of the underlying mechanism. Bravi et al. found that KNT improved sensorimotor coordination regardless of application tension, noting that there was no difference in performance when KNT was applied at either 25% or 50% relative tension. In a systematic review, Lim and Tay found that the effect size for KNT-mediated pain reduction reduced when KNT was applied at higher tensions. The importance of KNT tension or convolutions in facilitating skin blood flow is yet to be determined.

It is unknown if KNT increases blood flow and if certain application techniques are required to elicit changes in blood flow. The purpose of this study to:

- determine the effect of KNT on skin blood flow; and
- to determine how convolutions, tension, and time alter the effects of KNT on skin blood flow.

We hypothesized that KNT would increase skin blood flow, with the effects most apparent when applied at 25% relative tension and with convolutions, and that the effects of KNT would persist 3 days after application.

**METHODS**

This study was approved by the institutional review board at The Pennsylvania State University and complied with the Declaration of Helsinki. Subjects provided written and verbal informed consent before participation. Subjects were young, healthy adults, non-smokers, and free of chronic disease. Women were not pregnant or breastfeeding. All protocols took place in a thermoneutral room with subjects in a semi-supine position. Subjects refrained from strenuous exercise and from...
consuming caffeine or alcohol for 12 hours before the study. In all protocols, blood pressure was measured via brachial auscultation in 5-minute increments throughout the protocol (Cardiocap/5, General Electric, Fairfield, CT). TheraBand® Kinesiology Tape (Performance Health, Akron, OH) was used for all protocols.

**Protocol 1. Tape Tension**

The goal of this protocol is to determine the effects of relative KNT tension on skin blood flow. For each study, 4 strips of KNT were prepared. KNT was cut into 16 cm in length and rounded at the corners to promote adhesion, and a small (0.5-cm-diameter) hole was cut in the middle of the tape to measure skin blood flow. The 4 KNT strips were applied to the skin above the rectus femoris (2 strips per leg, with knee in a fully extended position) separated by ~3 cm. KNT was randomly applied at 0%, 25%, 50%, and 100% relative tension (0% equals resting length, 100% equals the length of maximum stretch) using the stretch indicators on the tape. To apply the tape, the researcher held the most proximal and distal end of tape to keep it free of tension. The proximal end of the tape was anchored to the skin without tension. The tape was then stretched to the appropriate tension and applied to the skin, and the distal end was anchored to the skin without tension. The researcher then rubbed the tape to improve adhesion. Relative tension was verified by measuring tape length after application.

Local heating units were placed in the hole in the middle of each KNT strip. A local heating unit was also placed on the skin in a tape-free area of the leg to serve as control. Laser Doppler flowmeter probes (Moor Instruments, Axminster, UK) were placed into each local heater to measure red cell flux, a relative measure of skin blood flow. Local heaters were switched off so that local skin temperature could fluctuate. After stable measures of red cell flux were obtained (~20 minutes), local heaters were set to 33°C to control local skin temperature. Red cell flux was measured until a new stable baseline was obtained (~20 minutes).

Local heaters and laser Doppler flowmeters were then removed. Subjects kept the KNT on and went about their normal activities for 3 days. After 3 days, subjects returned to the laboratory and underwent an identical protocol to determine the time-dependent effects of KNT on skin blood flow.

**Protocol 2. Convolutions**

The goal of this protocol is to determine if convolutions in KNT alter skin blood flow. Two 16-cm KNT strips were prepared as described in protocol 1. One KNT strip was stretched to 25% relative tension and applied over the rectus femoris with the knee in a fully extended position. The second KNT strip was stretched to 25% relative tension and applied over the opposite side rectus femoris with the knee flexed to 90°. After KNT application, the knee was fully extended to cause convolutions in the KNT. A local heater was placed in the hole in the middle of each strip of KNT and on a tape-free area of skin to serve as control; the temperature of the local heaters was set to 33°C. Laser Doppler flowmeters were placed in each local heater to measure red cell flux. Red cell flux was measured for ~20 minutes.

**Data analysis**

Data were collected at 40 Hz with Windaq Data Acquisition Software (DataQ Instruments, Akron, OH) and stored offline for later analysis. Red cell flux was normalized to cutaneous vascular conductance (CVC: flux·mean arterial pressure⁻¹). Data were analyzed with Prism 7.01 software (GraphPad Software, La Jolla, CA). In protocol 1, a 2-way ANOVA was used to detect tension–time interactions. In protocol 2, a 1-way ANOVA was used to detect differences in tape application technique. Tukey multiple
comparisons tests were conducted where appropriate. Significance was set a priori at $\alpha = 0.05$. Effect size (ES, $d$) is reported for mean differences. Interpretation of ES follows the convention of Cohen: 0.2, 0.5, and 0.8 correspond to ES of “small,” “medium,” and “large,” respectively.\(^{10}\)

**RESULTS**

Subject characteristics are presented in Table 1. Subjects are young, healthy, and free of overt cardiovascular disease risk factors.

### Protocol 1: Tape Tension

CVC measured immediately post-KNT application is depicted in Figure 1. There were no differences in CVC between control and KNT applied at any tension, either with the local heaters turned off (Figure 1A) or set to 33°C (Figure 1B) (all $P > .05$).

The change in CVC after 3 days of wearing KNT is depicted in Figure 2. CVC did not significantly change at the control site or with any KNT tension either with local heaters turned off (Figure 2A) or set to 33°C (Figure 2B) (all $P > .05$).

Because there were no differences in CVC with KNT tension, protocol 1 data from the KNT sites were pooled together and compared with the protocol 1 control site data. With local heaters turned off (Figure 3A), CVC was significantly higher with KNT compared with control (KNT: 0.12, 95% confidence interval: 0.10, 0.14; control: 0.08, 0.07, 0.10 flux-mmHg\(^{-1}\); $P = .004$) and the ES was large (0.80). When local heaters were set to 33°C (Figure 3B), there was no difference between KNT and control (KNT: 0.17 [0.13, 0.21]; control: 0.13 [0.10, 0.17 flux-mmHg\(^{-1}\)]; $P = 0.09$). There was no difference in ΔCVC between control and KNT when all KNT sites were pooled either with local heaters turned off (KNT: 0.04 [0.00, 0.09]; control: 0.02 [−0.01, 0.04 flux-mmHg\(^{-1}\)]; $P = .58$) or local heaters set to 33°C (KNT: 0.07 [−0.03, 0.06]; control: 0.02 [−0.02, 0.16 flux-mmHg\(^{-1}\)]; $P = 0.53$) (data not shown).

### Protocol 2: Convolutions

CVC data for KNT applied with and without convolutions are presented in Figure 4A. There were no differences in CVC between control and KNT with convolutions or without convolutions (all $P > .05$). Because there were no differences between the KNT sites, KNT data from protocol 2 were pooled and compared with protocol 2 control data (Figure 4B). CVC was greater with KNT compared with

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**Table 1. Subject characteristics**

|          | Sex (M, F) | Age (y) | BMI (kg·m\(^{-2}\)) |
|----------|------------|---------|---------------------|
| Protocol 1 | 4, 6       | 22 ± 1  | 22.5 ± 0.7          |
| Protocol 2 | 8, 4       | 23 ± 1  | 22.5 ± 0.7          |

Note: Data are mean ± SE.
Abbreviation: BMI, body mass index.

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**Figure 1.** Skin blood flow in protocol 1 measured at the control site and all tape tensions. Skin blood flow was measured immediately after KNT application with local heaters off (A) and set to 33°C (B).
control (KNT: 0.30 [0.21, 0.39]; control: 0.15 [0.09, 0.21 flux·mmHg⁻¹]; P = .03) and the ES was medium.

DISCUSSION

The main findings from this study included the following:

- KNT modestly increased skin blood flow; and
- convolutions, time, or tension did not significantly alter the effect of KNT on skin blood flow.

In combination, these findings suggest that the application of KNT modestly increased skin blood flow, regardless of the specific manner in which it was applied.

This is one of the first studies to empirically show that KNT can increase skin blood flow. We consistently found, in protocols 1 and 2, that skin blood flow was higher with KNT compared with that in control. However, the increase in blood flow was modest, and whether this small rise in skin blood flow produces therapeutic benefits remains to be elucidated.

Similar to other investigations on the influence of KNT tension or convolutions, we found that neither tension nor convolutions of KNT altered skin blood flow. Cumulatively, our data and those of others suggest that the vasoactive and analgesic properties of KNT are inherent to KNT application and not because of a specific method of application. We also failed to observe a time effect, as skin blood flow measures calculated immediately after application were not different from those calculated 3 days after application. The lack of intermediate measures means that we cannot

Figure 2. Skin blood flow from protocol 1 measured 3 days after KNT application and presented as a change from day 1 blood flow with local heaters off (A) and set to 33°C (B).

Figure 3. Skin blood flow measured immediately after KNT application in protocol 1 with local heaters off (A) and local heaters set to 33°C (B). Data from all the tape sites are combined regardless of tension. *P < .05 compared with control.
rule out changes in skin blood flow occurring over shorter (ie, hours) time periods; however, this possibility is unlikely, as skin blood flow changes to most stimuli occur on the order of minutes.\textsuperscript{11,12}

**Limitations**

The main limitation of this study is that we could not measure skin blood flow through intact KNT. Small holes had to be cut in the tape to allow placement of laser Doppler flowmeters. However, these holes were small and surrounded closely by tape on all sides, so any effect of KNT on skin blood flow should still have been apparent. This study was conducted entirely in young, healthy participants. We cannot directly extrapolate these data to other populations, such as older adults, who exhibit attenuations in skin blood flow.

**CONCLUSION**

We found that KNT modestly increased skin blood flow. However, this effect appears to be an intrinsic property of the tape being applied to the skin, and not affected by the method of application (ie, convolutions or tension). This suggests that KNT has some efficacy in locally increasing skin blood flow. When combined with menthol, skin blood flow underneath the KNT induced a robust increase for a short period of time.

**CLINICAL RELEVANCE**

KNT is a commonly used product with numerous purported benefits. Although augmentation of skin blood flow is often reported as a benefit of KNT, limited scientific data exist to support this claim. We found that KNT modestly increases skin blood flow, suggesting some validity to this claim; however, the clinical importance of this minor increase is unknown and likely minimal.

**Conflict of Interest:** Lacy M. Alexander is a member of the Performance Health Scientific Advisory board.

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