DRAFT

TITLE: Numerical modeling of the subcutaneous compartment in the thigh following application of kinesiology tape in human subjects.

OVERALL HYPOTHESIS: The form of the subcutaneous compartment of the thigh is altered as a result of Kinesiology Tape application in human subjects.

HYPOTHESIS SPECIFIC TO THIS PROPOSAL: An isolated region of the subcutaneous compartment can be identified and changes in its form can be quantified within and between individuals over time.

RATIONALE: Kinesiology Tape (KT) is designed to stretch up to 40% its static length. When applied to the skin, it recoils and it is theorized to alter the structure subcutaneous compartment facilitating increased cardiovascular flow, lymphatic drainage extracellular fluid movement. The tape is thought to mimic the human epidermis and does not affect range of motion. It gained popularity following the 2008 Olympics in Beijing and now is commonly used even though its functional mechanism remains unclear. A few short-term studies have been conducted, but without conclusive results, in part, since these only addressed the subjective responses of test subjects using the KT. Currently, no reports have addressed concerning the underlying biological mechanism of KT.

To test the hypothesis, our group will apply the tape consistently to a region of the anterior thigh of healthy human subjects who will be subjected to MRI before and after tape application. The subcutaneous compartment will be extracted digitally and assessed morphometrically to determine whether the tape alters the size and/or shape of the corresponding subcutaneous compartment. Results of this study should determine whether application of KT could alter the subcutaneous compartment consistent with increased cardiovascular and extracellular fluid exchange. This proposal will focus on developing a novel approach for the numerical assessment of change in the subcutaneous compartment of the thigh. It is expected that a new approach for quantifying anatomical regions of interest (ROI) based on MR images will be developed. This proposal is a collaborative effort across several UH Manoa units bringing expertise together from the Department of Mathematics, Department of Anatomy, Biochemistry & Physiology, Department of Kinesiology and Rehabilitation Science and the Radiology Unit at St. Francis Hospital.

BACKGROUND INFORMATION: Kinesiology Tape is theorized to enhance the circulatory and lymphatic flow through the subcutaneous compartment by harnessing the connective tissue component of the epidermis and dermis. KT is applied stretched to approximately 140% of its resting length. As a result, it pulls on the connective tissues and it is believed to exert a pressure that serves to expand the space deep to the skin. During this process, it is thought to restore epidermal tissue homeostasis while increasing fluid movement, diminish pain by decreasing pressure on associated receptors an possibly facilitate improved tensile properties of the deep fascia enveloping muscles. However, whether KT alters the subcutaneous compartment remains unknown and the proposed study will address this question.

To test this hypothesis, it is necessary to quantitatively define a subcutaneous region and track its change over time and within an individual based on MR imaging. The proposed research depends on précised identifying a region and then mapping its form during the experimental period. Typically morphometric analysis is achieved by recording linear measurements between selected points. However, this approach falls short since only distances between those points are examined and the remaining region of interest (ROI) is discarded. Thus a considerable amount of information is lost in an analysis using linear measurement approaches. The current proposal will introduce a novel method for tracking change in the entire subcutaneous compartment by retaining the entire ROI within an individual over time and then comparing maps among individuals.

METHODS AND SAMPLE SIZE

Human Subjects: All activities have been submitted for review by the IRB oversight committees at UH Manoa.

Specific Aims (SA)

SA1: *Obtain MR images of a ROI in the thigh of healthy adults.* MR images of 20 adults will be utilized in this study. KT will be applied to the left thigh. Placement will be achieve by positioning the lower end of a 20-cm tape at the level of the adductor tubercle and the stretched and additional stretched 8 cm (40%) in a vertical direction, perpendicular to the femoral condyles. Small oil beads will be placed at each corner of the tape to provide reference points on the MR images. Subjects will be scanned at time 0 (T_0), 24 hours (T_1) and 48 hours (T_2) following placement of the tape. Following scanning, additional landmarks will be identified as perpendiculars projected internally from the surface landmarks to subcutaneous-muscle compartment interface (figure 1A). The ROI will be segmented and this model will represent the region for analysis (figure 1B,C).

SA2: *Quantify the ROI within the individual and track its change over the test period.*

PLAN FOR DATA ANALYSIS

Numerical Descriptions of the ROI

Numerical Comparisons of the ROI

Possible Pitfalls. This project brings together a wide range of experts across various academic units at UH Manoa. We have extensive experience in all aspects of this work and our preliminary trials demonstrate that we can apply KT, successfully obtain MR models and segment the relevant ROI. It is possible that healthy individuals may show very few (no?) effects from the KT. If this is the case, we have access to a large group of athletes through the KRS department and we will be able to recruit subject with various muscle injuries. Thus, we will be able to determine the effect of KT with respect to altering the subcutaneous compartment in subject with injuries where it could be expected to have a much more significant impact. *It is noted that we believe it is critical to utilize healthy individuals initially so that we can determine a baseline effect prior to application for injuries.*

STUDENT'S ROLE

1) The student will provide critical contributions with respect to the numerical analysis of subcutaneous compartment. The student will be supervised directly by Dr. Yuriy Mileyko. Specifically, the student will assist with development and testing of a numerical mapping system for tracking changes in the subcutaneous compartment.

2) The student will

3) The student will also have exposure to all aspects of this study. In addition to Dr. Mileyko, several faculty mentors will be available to the student. Research activities will expose the student to applying KT tape in a systematic and repeatable fashion as well as other aspect of human performance testing routinely conducted by Dr. K. Tamura and Dr. Y. Oba, co-PIs (Department of Kinesiology and Rehabilitation Sciences). MRI of human subjects at St. Francis Hospital will be conducted by Dr. E Wong (Radiologist at St. Francis). Anatomical assessment of the subcutaneous compartment will be identified and assessed by Dr. S. Lozanoff (Dept. Anatomy, Biochemistry & Physiology, JABSOM). Thus the student will have ample opportunities to learn a wide range of interdisciplinary research approaches.

ESTIMATE OF TIME: MR will be conducted in the fall semester. However, the student can begin immediately on developing numerical assessment of the ROI based on preliminary MR scans already obtained. Assessment of the MR scans will be conducted between January-March, 2015. Preparation of the report will be completed in March for presentation in April, 2015.

Figure 1. A) MR model of the left thigh with segmented subcutaneous region underlying the KT. B) Segmented ROI with surface registration points. C) Eight registration points of the ROI. The purpose of this proposal is to quantitatively track changes this region over the experimental period (T_0,T_1,T_2).