Effects of Sequential Connective Tissue Massage on Autonomic Nervous System of Middle-Aged and Elderly Adults

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The purpose of this study was to describe autonomic nervous system responses to serial connective tissue massage (CTM) in healthy middle-aged and elderly subjects. Fourteen healthy middle-aged or elderly subjects ($\bar{X}$ age = 61.3 years) were randomly assigned to either a CTM or placebo group. Subjects received nine separate treatments (CTM or placebo) on alternate days over a three-week period. Each treatment was divided into 15-minute control, intervention, and recovery periods. Subjects in the CTM Group (n = 8) were given CTM on the basic section (low back), and subjects in the Placebo Group (n = 6) had sham ultrasound applied to the same area. Variables monitored were skin temperature (right great toe and popliteal fossa), galvanic skin response, mean arterial blood pressure, and heart rate. Variable measurements were made every five minutes. An analysis of variance and single-case analyses showed no changes in the variables measured in the CTM or Placebo Group. The results of this study suggest that CTM has no consistent immediate or long-term effects on the autonomic nervous system in healthy middle-aged and elderly subjects.

Key Words: *Autonomic nervous system; Connective tissue; Geriatrics; Massage, physiological effects.*

Use of connective tissue massage (CTM) in the United States is limited,[1] but the technique is widely used by European physical therapists to treat various somatic and visceral disorders. Connective tissue massage consists of several stroking maneuvers that are both diagnostic and therapeutic in nature. The strokes are applied to defined zones of the body and are believed to cause beneficial reflex effects in the organs and tissues innervated by the zones.[2-4] Strokes are applied in a specific sequence and, for the most part, are oriented perpendicular to and directed at underlying target structures (eg, bone, muscle, or fascial borders). Strokes are applied slowly with the fingertips to create traction between the cutaneous and subcutaneous tissues.[3(p76)] Treatment always begins with the basic section that covers the lumbosacral area of the back.[3(pp81-83)] Treatment can then be expanded to the upper trunk and the extremities, depending on the problem to be treated.

Numerous case studies have documented the apparent beneficial effects of CTM.[3-7] The case studies have involved subjects with such diverse pathological conditions as osteoarthritis, dermatomyositis, and angina[3]; intermittent claudication[3,4]; migraine headache and musculoskeletal sprains and strains[3,5]; fibrositis syndromes (eg, "frozen shoulder")[6]; and Raynaud's disease.[3,7] Connective tissue massage proponents do not claim that CTM will cure all of these disorders, but they do assert that CTM will lessen the severity of symptoms associated with the disorders.[2,3]

The mechanisms of the therapeutic effects of CTM are not well understood, although Ebner[4,6] and Schliack[8] have speculated about possible CTM mechanisms. They point out that, because of the nature of embryological development, innervation of body parts by the peripheral nervous system follows a segmental distribution. Dermatomes and myotomes that are innervated at the same spinal cord level as a malfunctioning organ, therefore, may reflect the malfunction through changes in skin and subcutaneous tissue tension. Connective tissue massage applied to the affected dermatomes may induce reflex effects in the associated organ.[4,8] Ebner hypothesized that CTM produces local mechanical effects on connective tissue and constituent cells (eg, mast cells release histamine, fibroblasts produce glucose-aminoglycands) and causes reflex mechanisms that reduce sympathetic activity to produce vasodilation. The result is that circulation to related tissues, including parasympathetic ganglia, is increased, leading to more normal circulation throughout the body. Such improvement in circulation may promote healing, increase collateral circulation, enhance or normalize connective tissue extensibility, improve response to exercise, decrease muscle spasms, and promote a balance within the autonomic nervous system (ANS).[6]

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LITERATURE REVIEW

The effects of CTM on the ANS have not been validated conclusively to date. Studies by Volker and Rostovsky[9] and Gross[10] showed increased foot skin temperature after CTM in healthy subjects and in some patients with peripheral vascular disease. Because vasomotor control is a function of sympathetic activity, this result seems to indicate a reduction of sympathetic outflow as a result of CTM. Kisner and Taslitz[11] studied the immediate ANS effects of CTM on young healthy subjects by measuring various physiological characteristics under ANS control. They interpreted their findings to indicate that the ANS response to a single CTM treatment is predominantly sympathetic. These findings are surprising, because the neurophysiologic responses to CTM are presumed to be predominantly parasympathetic in nature.[11] A study of the acute ANS effects of conventional massage also found predominantly sympathetic responses.[12] Such sympathetic responses may represent a state of anxiety in the subjects, or in the CTM study, a general pressor response to unusual sensations.

Connective tissue massage is reported to be most effective when sequential treatments are applied over time.[2,3] One study examined CTM intervention over time with respect to toe skin blood flow in patients with arterial occlusive disease.[13] The results did not demonstrate an acute increase in blood flow after CTM, but the researchers concluded that "slight changes in the response to indirect heating [suggested] the possibility of a beneficial effect of long-term treatment with connective tissue massage."[13]

THE PROBLEM

A key question regarding the mechanisms of CTM is whether CTM actually produces ANS effects. Little quantitative documentation has been made of the ANS effects of CTM, and conflicting results exist in the available literature. Some important considerations for studies of the ANS effects of CTM have been overlooked in previous studies. One consideration is subjects' age. Controlled studies generally have not examined the effects of CTM in middle-aged or elderly subjects. Because the incidence of many pathologic conditions increases with age, many candidates for CTM are elderly. Another consideration is that longitudinal studies of sequential CTM treatments are needed. Connective tissue massage is purportedly most effective when given as a series of treatments. Only one study involved CTM treatments over time, and that study did not examine subjects' responses to each treatment.[13]

The purpose of this study was to test the hypothesis that serial CTM treatment would induce changes in physiological functions controlled by the ANS in healthy middle-aged and elderly subjects. We quantified physiological responses to CTM during separate CTM treatments applied over a three-week period. The dependent variables measured were heart rate (HR), galvanic skin response (GSR), mean arterial pressure (MAP), popliteal skin temperature (PST), and toe skin temperature (TST). The skin temperature values were taken as an indirect measure of skin blood flow to the lower extremity. We used healthy subjects to control for differences in severity or presentation of pathological conditions and the confounding effects of other types of treatment. Use of healthy subjects permitted use of a standardized CTM treatment (basic section) rather than a CTM treatment tailored to the needs of individual patients.

METHOD

Subjects

Fourteen subjects (4 male, 10 female) ranging in age from 56 to 69 years ($\bar{X}$ = 61.3 years) who were unfamiliar with the technique of CTM participated in the study. Subjects were randomly assigned to either the CTM (n = 8) or Placebo (n = 6) Group. Each subject read a summary of the study protocol and signed an informed consent form before the study began.

Procedure and Instrumentation

Each subject participated in a total of nine treatments: three treatments a week for a three-week period. Each treatment session was subdivided into a control, intervention (CTM or placebo), and recovery period. The control and recovery periods lasted 15 minutes, and the CTM or placebo treatment lasted about 15 minutes. Each subject was treated at the same time each day throughout the study.

Subjects were positioned and tested in a temperature-controlled room (26° ± 0.6°C) (Fig. 1). Subjects wore a hospital gown and sat on a treatment plinth. During the intervention period, subjects sat erect without back support, with their hips, knees, and ankles positioned at 90 degrees and with their thighs and feet fully supported. A pillow was placed on subjects' lap for forearm support. During the control and recovery periods, subjects reclined against a back support positioned about 20 degrees from the vertical plane. We attached electrocardiographic lead II surface electrodes to the subjects' wrists and connected the electrodes to a direct current preamplifier on a polygraph.* Active and indifferent electrodes of a GSR meter† were attached to the second and fourth digits of subjects' right hand. We placed a sphygmomanometer cuff around subjects' left arm and connected it to an automatic recycling mercury sphygmomanometer.‡ Thermocouples§ were attached to the volar surface of the right great toe and right popliteal region. Measurements of the five dependent variables (HR, GSR, MAP, PST, TST) were made every five minutes throughout the study and were recorded manually.

For subjects in the CTM Group, treatment was administered by one of two physical therapists trained in CTM technique. Only the basic section of CTM was applied to ensure consistency in the experimental intervention. The area covered in the basic section and the stroke locations are shown in Figure 2. The sequence of strokes was 1) short strokes toward the border of the sacrum; 2) long strokes along the border of the sacrum; 3) gluteal strokes around the buttocks to the anterior superior iliac spine; 4) long strokes to fill the triangular space between the iliac crest, the spinous processes, and the 12th rib; 5) short strokes toward the lumbar spine; and 6) long strokes beneath the 12th rib.

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* Model 79D, Grass Instrument Co, 101 Old Colony Ave, PO Box 516, Quincy, MA 02169.

† Model HT3, Autogen Systems Inc, 809 Allston Way, Berkeley, CA 94710.

‡ Arteriosonde Model 1216, Roche Medical Electronics Div, Hoffman-LaRoche, Inc, Cranbury, NJ 08512.

§ Model TMB, Tri-R Instruments, Inc, 48 Merrick Rd, Rockville Centre, NY 11570.

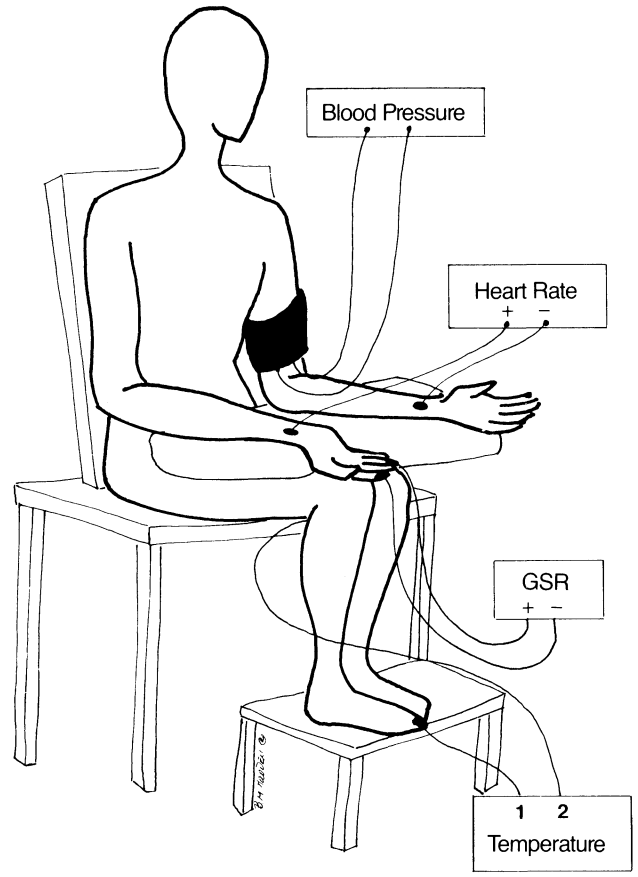

Fig. 1. Experimental setup for measuring autonomic nervous system responses to serial connective tissue massage and placebo treatments. Data were displayed on analog instruments and recorded manually every five minutes. (GSR = galvanic skin response.)

Subjects in the Placebo Group received sham ultrasound treatment to the same area of the low back where the CTM basic section is normally performed: from the base of the buttocks to just below the 12th rib, bilaterally (Fig. 2). Standard clinical procedure for ultrasound was simulated. A coupling medium (gel) was spread over the area, and a nonactivated ultrasound transducer was moved across the area in a regular pattern of loops. The timer on the ultrasound machine was activated to duplicate the auditory and visual aspects of ultrasound treatment. Sham ultrasound was analogous to CTM in that it provided continuous physical contact with the subject, but the directed, shearing strokes of CTM were absent. Any observed differences in responses between the CTM and Placebo Groups presumably would be due to the unique effects of CTM.

Data Analysis

The dependent variable data (HR, GSR, MAP, PST, TST) were analyzed using a 2 × 9 × 3 × 3 factorial analysis of variance (ANOVA) for repeated measures on the last three factors. The first factor was intervention (CTM or placebo); the second factor was treatment session (1–9); the third factor was period (control, intervention, or recovery); and the fourth factor was time of measurement within each period (1–3). Individual *post hoc* comparisons were performed with Tukey's Honestly Significant Difference test.[14] Results were deemed significant at the .05 level.

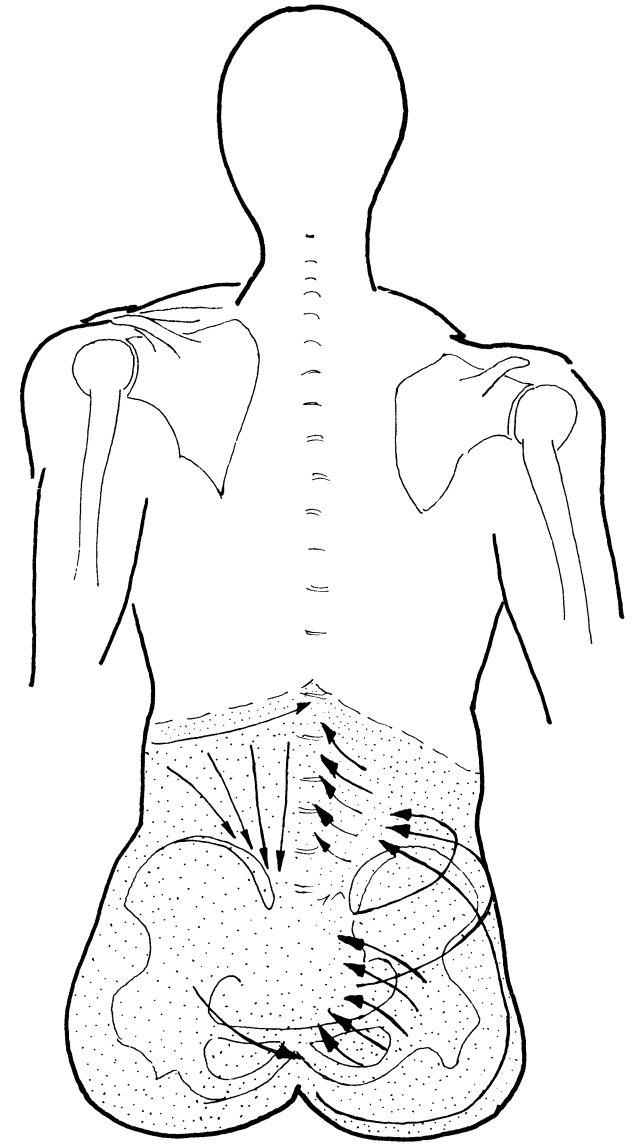

Fig. 2. Location of connective tissue massage strokes in the basic section area. (Strokes are illustrated unilaterally but were administered bilaterally.) Shading indicates area covered by the deactivated ultrasound head in the Placebo Group.

We performed single-case analyses because we believed that the effects of CTM in certain subjects might have been obscured in the grouped data. Each case was analyzed separately with a 9 × 3 ANOVA for repeated measures on the last factor. The first factor was treatment session (1–9), and the second factor was period (control, intervention, or recovery). To justify the first factor as a grouping factor, Lag-1 autocorrelations[15] within each treatment session were calculated and found to be nonsignificant.

RESULTS

Group Comparisons

Analysis of the dependent variables (HR, GSR, MAP, PST, TST) revealed no significant differences between the CTM and Placebo Groups. No significant main effects of intervention existed for any of the dependent measures. No meaningful interaction of any of the other factors (treatment session, period, or time of measurement) occurred with intervention.

Few other main effects were demonstrated on any of the dependent variables. Because the effects of treatment session, period, or time of measurement without an interaction with intervention group have no clinical meaning, these effects are not reported.

Single-Case Analyses

All subjects demonstrated changes in all dependent measures over the nine treatment sessions regardless of their treatment group. The directions and patterns of change, however, were not consistent within subjects or groups.

Results were similar for the effects of period and interactions of period and session. Most subjects showed changes across periods (significant main effects of period, $p < .05$) and different patterns of change between periods across sessions (significant interactions between period and session, $p < .05$), but the patterns were not consistent within subjects who received CTM or those who received the placebo intervention. This result was true on all dependent measures.

DISCUSSION

Based on the empirical evidence in case reports and on our visual observations of the responses of healthy individuals to CTM, we suspected that CTM would have ANS effects. The anecdotal reports of Ebner suggested decreases in sympathetic activity and increased parasympathetic activity with sequential CTM treatments.[3–6] Students commonly learn the CTM technique by practicing on healthy individuals (each other). Healthy subjects often display autonomically controlled reflex responses to CTM. These responses include diaphoresis, flushing of the face and extremities, and subjective feelings of warmth. We believe that the results of previous investigations of the effects of CTM on the ANS were inconclusive because of inadequate experimental control and failure to study the effects of treatment longitudinally (over time).

This study was a longitudinal study and was controlled more carefully than previous studies. Laboratory temperature was closely regulated, and although humidity was not directly controlled, central air conditioning and ventilation kept humidity within a comfortable range. Furthermore, whereas subjects in Kisner and Taslitz's study[11] changed position (from sitting to lying) during the recovery period, a removable backrest allowed our subjects to remain upright throughout the study. This factor is important because it prevented posture-related changes in autonomically controlled functions (eg, HR and blood pressure). This study also was the first controlled study of the effects of CTM on the ANS of healthy middle-aged and elderly subjects.

The results of this study showed no meaningful differences in the ANS responses of healthy middle-aged and elderly subjects who received CTM compared with subjects who received a placebo treatment. Single-case analyses revealed no differences in response between CTM- and placebo-treated subjects over the course of serial treatments. The results suggest that CTM has neither distinct acute nor cumulative ANS effects in healthy middle-aged and elderly subjects. This finding was unexpected, because we had performed a longitudinal study under controlled conditions. The results of this study raise the question of whether CTM actually affects the ANS.

Whether CTM has autonomic or beneficial effects in patients remains to be answered. The homeostatic mechanisms of healthy individuals may buffer the induced effects of CTM. Where overt pathological conditions exist, however, CTM may assist homeostatic mechanisms in restoring the body to a balanced state. The subjects in this study were similar in age to many CTM-treated patients; however, our subjects' lack of ongoing pathological conditions may have precluded consistent response patterns. Connective tissue massage may have beneficial effects that are mediated in ways other than through the ANS. The beneficial effects of CTM could be mediated by some other physiological mechanism or may simply be placebo-related phenomena—the result of patients' expectations. Quantitative study of the effects of CTM in specific pathological conditions (eg, arterial occlusive disease) is an important area for further research, and the results of this study will provide a useful baseline for comparison.

Two factors limit the degree to which the results of this study can be generalized. First, we measured cutaneous blood flow indirectly as a function of skin temperature. This measurement, therefore, is not quantitative in nature, and conclusions about blood flow to the deeper structures (eg, muscles) during the study cannot be drawn. Second, the lack of skin temperature responses in the subjects' right leg cannot be generalized to other regions of the body because changes in ANS function can occur in one part of the body distinct from ANS regulation in other parts of the body.

CONCLUSION

The results of this study suggest that CTM has neither distinct acute nor cumulative ANS effects in healthy middle-aged and elderly subjects. Further study is needed to document the ANS and clinical effects of CTM in the various pathological conditions that it is purported to benefit.

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