Effects of Soft Tissue Mobilization (Rolfing Pelvic Lift) on Parasympathetic Tone in Two Age Groups

JOHN T. COTTINGHAM, STEPHEN W. PORGES, and TODD LYON

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The effects of a soft tissue mobilization procedure, the Rolfing pelvic lift, on parasympathetic tone was studied in healthy adult men. Parasympathetic tone was assessed 1) by quantifying the amplitude of the respiratory sinus arrhythmia from the heart rate pattern and 2) by measuring heart rate. Heart rate patterns were assessed during the pelvic lift and during the durational touch and baseline control conditions. Two groups of healthy subjects were tested: Group 1 contained 20 subjects aged 26 to 41 years, and Group 2 contained 10 subjects aged 55 to 68 years. In Group 1, the pelvic lift elicited a somatovisceral •parasympathetic reflex characterized by a significant increase in parasympathetic tone relative to durational touch and baseline conditions. Group 2 did not exhibit a parasympathetic change during the pelvic lift. The results of this study contribute to our understanding of pelvic mobilization techniques and may help to explain why these techniques have been clinically successful in treating myofascial pain syndromes and other musculoskeletal dysfunctions characterized by reduced parasympathetic tone and excessive sympathetic activity.

Key Words: Autonomic nervous system; Cardiac, general; Manual

therapy; Physical therapy.

J, Cottingham, MS, is Certified Advanced Rolfing Practitioner, Staff Manual Therapist, and Research Associate, Frances Nelson Health Center, 1306 Carver Dr, Champaign, IL 61820 (USA).

S. Purges, PhD, is Director, Developmental Assessment Laboratory, and Professor, Department of Human Development, College of Education, University of Maryland at College Park, College Park, MD 20742.

T. Lyon, MD, is Medical Director, Frances Nelson Health Center, and Associate Instructor of Family Practice Medicine, College of Medicine, University of Illinois, 190 Medical Science Bldg, 506 S Mathews Ave, Urbana, IL 61801.

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Mobilization of the bony pelvis and the surrounding soft tissues has been used in medical practice since the beginning of recorded history, Ancient

Chinese, Egyptian, and Greek medical accounts all describe pelvic manipulations and associated changes in breathing, arterial pulse, body temperature, and muscle tone.(1) Several schools of manual therapy, including chiropractic, osteopathic, and Rolfing, have rediscovered and further developed these mobilization practices in the United States in the last century.(2•4) A resurgence of interest in soft tissue manipulative techniques is evident in the physical therapy and medical literature of the last two decades.(5-7) Advocates of these techniques have recommended pelvic mobilization for various clinical problems that involve autonomic nervous system (ANS) dysfunctions.

Scientific evaluation of soft tissue manipulative treatments is difficult because of the scarcity of experimental studies, the difficulty in quantifying treatment outcomes, and the speculative nature of the neurophysiological mechanisms of ANS action.(8,9) Homogeneous subject samples undergoing standardized treatment procedures must be examined to establish the ANS responses associated with a given manipulation. Such information will allow more appropriate selection of manual therapy for specific conditions.

This study examined the pelvic lift mobilization procedure and associated changes in ANS tone. Pelvic lift is a soft tissue manipulation from the Rolfing method of manual therapy and movement education. It involves a combination of posterior tilting and pelvic traction with concurrent moderate pressure to the epigastrium. (4,10) Lumbosacral decompression, a similar technique, is involved in osteopathic manipulative techniques.(11) Both the pelvic lift and the lumbosacral decompression maneuvers have been associated with an increase in parasympathetic nervous system (PNS) tone and a corresponding decrease in sympathetic nervous system (SNS) activity.(10,11)

Pelvic lift also is comparable to the facilitated pelvic tilt exercise described in the physical therapy and occupational therapy literature. (12,13) The pelvic tilt originally was devised by Paul Williams as part of a series of back exercises.(13) The facilitated pelvic tilt and related pelvic mobilization techniques, however, currently are used with adults, children, and infants in various therapeutic contexts: **1)** to activate selected thoracic and abdominal breathing patterns,(1,14) **2**) to inhibit hyperactive behaviors, (1,14) **3)** to inhibit shoulder elevation and retraction (14•17) **4)** to reduce hyperextensive neck and back patterns (6,7,15•17) and **5)** to reduce chronic soft tissue pain associated with excessive SNS activity.(1,14,16,17) The posterior pelvic tilt has been demonstrated to reduce electromyographic activity in the lumbosacral regions of healthy young adults when compared with anterior pelvic tilt and baseline measurements.(13)

The results of experimental investigations of ANS reflexes and tactile stimulation also support the clinical observations that pelvic mobilization appears to be correlated with increased PNS activity. Overall, the studies indicate that deep mechanical pressure to the abdominal region, slow stroking to the back, and sustained pressure to the pelvis produce increases in PNS reflex responses, including increased electrical activity in sacral and vagal fibers increased peripheral skin temperatures, synchronous electroencephalographic patterns. and decreased EMG activity.(14•22) These studies have also demonstrated that autonomic and somatic responses are integrated, not two independent motor systems.(22)

Age also appears to be an important factor in determining the responsiveness of the ANS of human subjects to a given stimulus (eg, tactile). Studies on aging have demonstrated that subjects over 60 years of age show slower and diminished ANS than younger subjects. (23)

We decided to measure PNS tone in this Study because tactile stimulation of the pelvis, back, and abdominal regions enhances PNS activity. The method we selected to assess PNS activity involved the analysis and isolation of rhythmic variations in the heart rate pattern that are correlated with PNS cardiac innervation through the vagus nerve, Katona and Jih.(24) in a study of anesthetized dogs. and Eckberg, (25) in a study of conscious human subjects. demonstrated that measuring the amplitude of the heart rate oscillations associated with respiration could be used as an index of cardiac PNS tone. Respiratory sinus arrhythmia (RSA) is the rhythmic increase in heart rate associated with inspiration and the decrease in heart rate associated with expiration (Fig. 1).

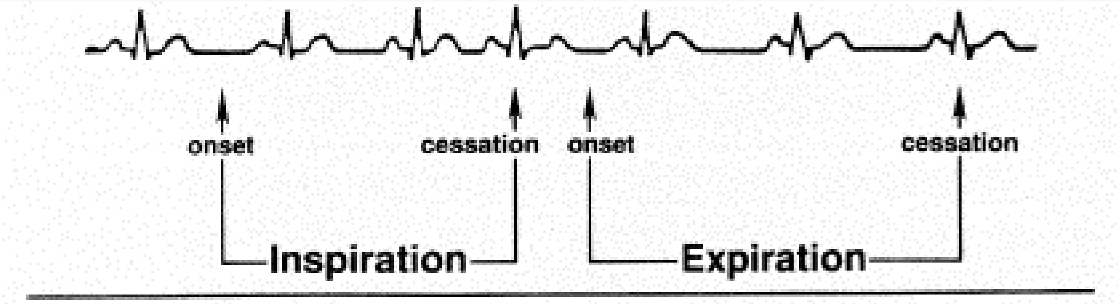

Fig. 1. Electrocardiogram exhibiting respiratory sinus arrhythmia. Heart rate increases rhythmically at inspiration and decreases at expiration.

Complex mechanisms control the relationship between RSA and cardiac vagal tone. Some cardiovascular physiologists traditionally have considered RSA to be produced by nonneural factors rather than by cardiac vagal reflexes. Strong evidence currently exists, however, that respiration, through either a central mechanism or a peripheral feedback loop to medullary areas, phasically inhibits, or "gates,'" the source nuclei of the vagal cardioinhibitory fibers. (24•27) Respiration is involved in the phasic modulation of the vagal influences to the heart, with the maximal inhibition occurring during the mid• to late•inspiratory phase and the maximal output occurring during the expiratory phase. (28•31) Because the vagal Cardioinhibitory neurons by definition slow the heart rate and exhibit a respiratory frequency, their impact on heart rate should be a slowing of heart rate during the expiratory phase of respiration, The greater the vagal efferent output to the heart, the greater the slowing of heart rate during expiration. Thus, RSA is a peripheral manifestation of the influence of the vagal cardioinhibitory neurons on the heart (le, cardiac vagal tone), and a strong argument can be made that quantification of the amplitude of RSA is an accurate index of cardiac vagal tone. (32) Porges developed a unique method of accurately quantifying RSA with timeseries procedures. (33) This method of assessing cardiac PNS activity has been validated experimentally. Pharmacological and electrophysiological manipulations of cardiac vagal efferent tone in rats, cats. and humans were found to be reliably reflected in the amplitude of RSA. (32, 34•36) Because of the direct relationship between this method of quantifying RSA and cardiac PNS tone, the statistical description of the RSA amplitude has been termed vagal tone.

The purpose of this study was to examine the immediate PNS responses of two age groups of healthy male subjects to 1) the application of a single soft tissue pelvic procedure, the Rolfing pelvic lift, and 2) a control manipulative procedure involving sustained tactile pressure, durational touch.

We formulated two hypotheses based on the literature review. First, the pelvic lift would elicit a somatovisceral•PNS reflex and increase PNS tone, but the durational touch would not produce such an increase. Second, a group of young, healthy male subjects would demonstrate greater autonomic responsiveness (ie, larger increases in PNS tone) to the pelvic lift than a group of older healthy male subjects.

METHOD

Subjects

Two groups of men were selected for this study. Group I consisted of 20 healthy men aged 26 to 41 years (X = 32 years), and Group 2 consisted of 10 healthy men aged 55 to 68 years (X = 63 years). All subjects were nonsmokers and reported no known health problems. The subjects were oriented to soft tissue therapy before testing. All subjects were selected on a volunteer basis from the professional practice of the primary investigator (J.T.C.). Each subject signed an informed consent form to participate in the study. The study procedure was approved by the Frances Nelson Health Center Board of Directors. Two subjects from Group I and one subject from Group 2 were eliminated from the data analysis because of problems with the ECG signal.

Materials

We placed electrodes bilaterally on the ventral wrists of the subjects and monitored ECG activity with an ECG amplifier.[1] The output of the ECG amplifier was fed into a Vagal Tone Monitor[2] a microcomputer that calculates vagal tone and heart rate. A quiet envi-ronment was maintained with an average temperature of 24°C (range = 23°•25°C).

Procedure

During each testing session before data collection, the subjects were positioned supine on a treatment table with the electrodes placed on their wrists. Five minutes was allowed for adaptation to the environment. We gave the subjects instructions about the testing procedure during this interval.

We monitored the subjects' ECG activity during five consecutive three •minute conditions: 1) baseline, 2) manipulation, 3) baseline, 4) manipulation, and 5) baseline. The vagal tone monitoring device was located in an adjacent room so that the investigator did not have access to the heart rate data during the testing session. Fifteen subjects experienced the pelvic lift manipulation first, and the other 15 subjects experienced the durational touch manipulation first. We administered the pelvic lift with the subjects in a Supine position with their knees flexed. The experimenter placed one hand under the subject's sacrum so that his fingertips rested on the lumbosacral junction. He then applied traction to tilt the pelvis in a posterior direction (ie, tilting the anterior superior spines posterior to the pubic symphysis in the sagittal plane). The experimenter placed his other hand on the subject's epigastrium with moderate pressure. The control manipulation of durational touch involved moderate bilateral pressure by the experimenter's hands to the subject's anterior deltoid muscles. The manipulative techniques were administered by the primary investigator (J.T.C.), a certified advanced Rolfing practitioner.

Data Quantification and Analysis

We assessed the dependent variables of vagal tone and heart rate during sequential 30•second periods within each three•minute condition. Heart rate in beats per minute was calculated as; twice the number of interbeat intervals within each 30•second period. We calculated the vagal tone index by extracting the amplitude of RSA from the beat•to•beat pattern. This procedure necessitated the following steps: 1) conducting a timeseries analysis, I•) applying a moving polynomial filtering procedure that removes the heart rate variability associated with baseline trends and periodic activity slower than respiration, 3) band•pass filtering the residual series to allow only the heart rate pattern 'in the frequency band associated with spontaneous respiration to pass, 4) calculating the variance of band•pass series that represents the RSA amplitude, and 5) calculating the natural logarithm of this variance to normalize its distribution. (37)

We calculated analyses of variance (ANOVAs) for vagal tone and heart period with age group and order of treatment as between•subject factors and treatment as a within•subject repeated measure.(37) An alpha level of .05 was used for statistical significance.

RESULTS

For the dependent variable of vagal tone, the ANOVA demonstrated a Significant group by treatment interaction ($F = 2.7$; df = 4,92; $p < .05$) (Table).

Simple•effects •post hoc tests of univariate ANOVAs For Groups 1 and 2 demonstrated that only Group I exhibited significant differences among the five treatment conditions ($F = 12.5$; df = 4,64; $p < .0005$). Examination of the treatment means and standard errors in Group I clearly indicated that this significant variance was related solely to the increase in vagal tone during the pelvic lift (Fig. 2). The control treatment of durational touch did not significantly influence vagal tone. A significant group effect ($F = 8.4$; df = 1,23; $p < .01$) that the young subjects in

Group I had a higher overall vagal tone than the older subjects in Group 2.

Heart rate as a dependent variable was not sensitive to the manipulations (Fig. 3). A significant group effect ($F = 7.7$, df = 1,23; $p < .05$) demonstrated that the young Subjects in Group I had a lower heart rate than the older subjects in Group 2. The order of manipulation did not significantly influence the two dependent variables.

TABLE
Analysis of Variance for the Effects of Group Classification, Order of Treatment, and Treatment on Vagal Tone and Heart Rate

Source	df	SS	MS	F
Vagal tone				
Between subjects				
Order	1	0.04	0.04	0.01
Group	1	34.10	34.10	8.39[a]
Order × group	1	0.29	0.29	0.07
Error	23	93.49	4.06	
Within subjects				
Treatment	4	3.53	0.88	4.49[a]
Order × treatment	4	1.27	0.32	1.62
Group × treatment	4	2.11	0.53	2.69[b]
Group × order × treatment	4	2.69	0.67	0.61
Error	92	18.03	0.20	
Heart rate				
Between subjects				
Order	1	7443.4	7443.4	0.10
Group	1	585802.1	585802.1	7.68[a]
Order × group	1	64753.9	64753.9	0.85
Error	23	1685318.1	73274.7	
Within subjects				
Treatment	4	2119.2	529.8	1.02
Order × treatment	4	1296.8	324.2	0.62
Group × treatment	4	2577.2	644.3	0.30
Group × order × treatment	4	3288.4	822.1	1.58
Error	92	47702.0	518.5	

[a] $p < .01$.
[b] $p < .05$.

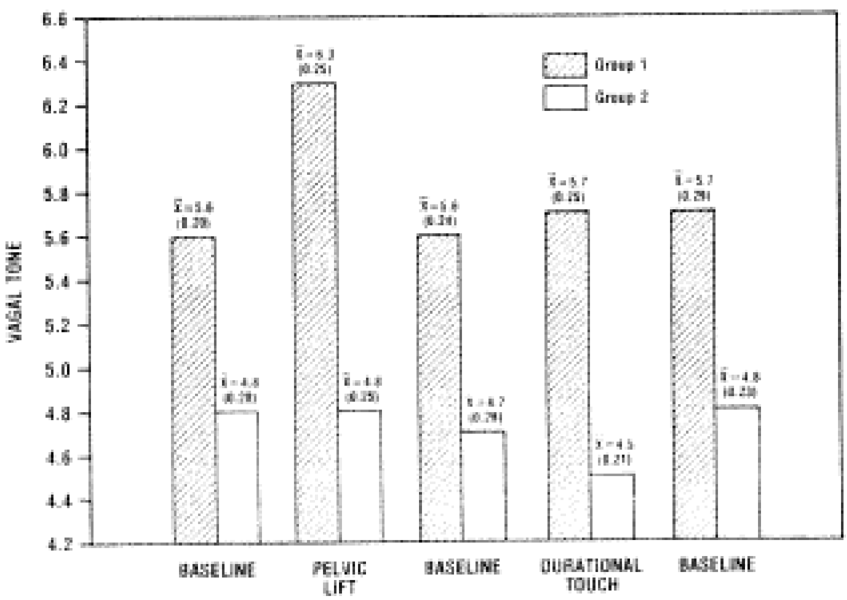

Fig. 2. Mean vagal tone (with associated standard error in parentheses) as a function of the treatment conditions for Group 1 (young men) and Group 2 (older men).

DISCUSSION

To our knowledge, this study represents the first attempt to quantify the effects of a soft tissue mobilization procedure on AN'S function tie, cardiac vagal tone) Linder controlled conditions. The data clearly demonstrate that the Rolfing pelvic lift produces an increase in cardiac vagal tone in young, healthy male subjects. Neither durational touch nor the baseline conditions influenced the level of PNS tone. The increased vagal tone during the pelvic lift returned to the initial baseline level upon cessation of the maneuver, indicating that the elicited response did not persist after removal of the stimulus. This finding supports the initial hypothesis that a somatovisceral•PNS reflex would be elicited by the pelvic lift. (22)

The study results also demonstrate that vagal tone is a more sensitive ANS index for assessing pelvic lift than heart rate. This finding may be due to the specificity of the vagal tone assessment. Vagal tone was defined as the component of the heart rate variability that is associated with respiration's phasic modulation of the vagal cardioinhibitory efferents (ie, RSA amplitude). (28•32) Heart rate, in contrast, is a more global ANS index of heart rate variability that involves PNS and several other (eg, SNS, intrinsic, and mechanical) components. (32)

In the older age group, the pelvic lift did not elicit an ANS response. This finding is supported by studies on aging and ANS activity. Elderly subjects have shown more difficulty than younger subjects in responding to changes in ambient room temperature and in recovering resting pulse rate and respiratory volume after displacement by exercise. (23) Subjects over 60 years of age also have exhibited less predictability in the ANS reflexes that control heart rate, pupil size, and gastrointestinal tract.(23) Other research has demonstrated that the aging process is associated with less sudomotor activity (ie, sweating), progressive increase in rigidity of the aorta and peripheral arteries, and reduced ANS conditionability. (38) The older subject group may have exhibited reduced sensitivity in receptor response to the tactile stimuli provided by the pelvic lift. (23, 38) Another possible explanation, supported by the significantly lower levels of vagal tone found in Group 2 than in Group 1, is that aging is associated with a general reduction in brain stem cardiac vagal outflow, which limits the somatovisceral•PNS response to the pelvic lift.(26,27,32)

What aspects of the pelvic lift account for its somatovisceral•PNS consequences? The pelvic lift has two distinct mechanical components: 1) moderate sustained pressure to the epigastrium and 2) firm posterior tilting and traction to the pelvis. Experimental studies on ANS reflexes have demonstrated that both deep pressure to the abdominal region and tactile stimulation to the back and sacral nerve roots produce PNS cardiovascular reflexes and alterations in respiratory patterns. (14, 18•20) Both mechanical components of the pelvic lift, therefore, probably contribute to the somatovisceral•PNS response. Additional experimental investigation is needed to evaluate the relative importance of the two mechanical elements and whether they act synergically to elicit the observed somatovisceral•PNS reflex.

Although we conducted this study on healthy adults, the results have possible clinical implications, Our Finding that the older subjects did not exhibit a vagotonic reflex response to the pelvic lift implies that elderly clinical populations may not be as responsive to soft tissue mobilization as younger populations. The assessment of a patient's PNS tone to a given soft tissue procedure may provide a useful criterion for determining the appropriateness of manual therapy.

Another clinical implication of' this study pertains to the finding that in the younger subjects, pelvic lift produced a transient increase in PNS tone. suggesting a relaxed, nurturing physiological state. This finding contrasts with the heightened arousal and "fight•flight" activity associated with increased SNS tone.(14,18) Furthermore, ANS investigations by Gellhorn have demonstrated a general law of reciprocity: When one ANS division is excited, the other division is inhibited to maximize the response of the stimulated branch.(18) The increased PNS tone elicited by the pelvic lift in our study may be associated with a corresponding reduction in SNS tone. From a therapeutic perspective, this combination of enhanced PNS activity and suppressed SNS tone may explain in part the successful clinical reports of pelvic mobilization as a treatment modality. (1,6,7, 14 •17) Such an ANS response would indicate favorable conditions for the reduction of muscle spasm and peripheral vasoconstriction commonly correlated with myofascial pain syndromes (eg, primary fibromyalgia). (39) Other musculoskeletal disorders in infants, children, and adults that involve autonomic stress Lee, chronic SNS) may benefit from pelvic mobilization, including the treatment of restricted breathing patterns, hyperactive behaviors, and hyperextensive neck and back patterns.(40) We must emphasize, however, that this study demonstrated only a transient, reflexive increase in vagal tone in young, healthy adults to a single pelvic mobilization technique. The long•term ANS effects of pelvic lift and other soft tissue mobilization techniques can be established on a scientific basis only through additional research. We currently are designing a study that will compare two matched groups of healthy adults. One subject group will receive a sequence of Rolfing sessions. and the other group will receive a series of control treatments We will assess both

ANS activity and joint range of motion.

CONCLUSION

With a group of Voting, healthy adult male subjects a soft tissue mobilization procedure, Rolfing pelvic lift, was found to significantly increase PNS tone (car- diac vagal tone) for the duration of the manipulation, followed by a return of vagal tone to baseline levels. A control manipulation, durational touch, pro- duced no change in PNS tone. A second group of older, healthy male subjects did not demonstrate a significant vago-tonic response to pelvic lift. Possible neurophysiological mechanisms of the pelvic lift effect were discussed in terms of a somatovisceral•PNS reflex.

The increase of PNS tone produced by the pelvic lift in the group of younger subjects and the probable concurrent reciprocal Inhibition of SNS tone may explain why pelvic mobilization techniques have been used successfully in various clinical applications for musculoskeletal disorders associated with ANS dysfunction.

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