CYCLIC MEDITATION – A 'MOVING MEDITATION' – REDUCES ENERGY EXPENDITURE MORE THAN SUPINE REST

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Running title: Metabolic changes in yogic relaxation techniques

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ABSTRACT

Cyclic meditation (CM) is a technique which combines ‘stimulating’ and ‘calming’ practices, based on a statement in ancient yoga texts suggesting that such a combination may be especially helpful to reach a state of mental equilibrium. The energy expenditure (EE), respiratory exchange ratio (RER) and heart rate (HR) of 50 male volunteers (group mean ± SD, 27 ± 6.3 years) were assessed before, during, and after the sessions of CM and sessions of supine rest in the corpse posture (shavasana, SH). The sessions were one day apart and the order was alternated. The energy expenditure, RER, and heart rate increased during the ‘stimulating’ practices of CM, returned to the baseline during the ‘calming’ practices, and the energy expenditure decreased by 19.9 percent below baseline values after CM. During the SH session the energy expenditure reduced; however the decrease in energy expenditure after SH was less than after CM (i.e., 5.1 percent). The results support the idea that a combination of yoga postures with supine rest (in CM) reduces the energy expenditure more than resting supine alone does.

KEY WORDS: yoga; postures; relaxation; energy expenditure; respiration.

INTRODUCTION

Yoga is an ancient Indian Science and way of life, which includes the practice of specific postures, regulated breathing, and meditation (Taimini, 2001). Based on changes in oxygen consumption, carbon dioxide elimination, breath rate and the electroencephalogram, the practice of Transcendental meditation was reported to induce a 'wakeful hypo-metabolic physiologic state' (Wallace, Benson, & Wilson, 1971). Similarly, a decrease in metabolic rate occurred following meditation on the Sanskrit syllable, *'OM'* (Telles, Nagarathna, & Nagendra, 1998).

In contrast to meditation, the metabolic rate increased both during a sitting (Rai, Ram, Kant, Madan, & Sharma, 1994) and a standing yoga posture (Rai, & Ram, 1993), when these postures were compared with supine rest and with sitting in a chair. In particular, the standing yoga posture (*virasana*) induced a hyper-metabolic state with increased sympathetic activity, which disappeared when the subject adopted a supine posture (*shavasana*). Hence, while energy expenditure decreased following meditation, an increase in energy expenditure occurred during or after yoga postures. This difference may be related to the fact that meditation decreases muscular effort, whereas yoga postures, though practiced while relaxed, may increase muscular effort relative to supine rest or sitting in a chair.

These results suggest that meditation may be associated with greater mental calmness compared to yoga postures. It is worth noting that a traditional yoga text (the *Mandukya Upanisad*) says that it may sometimes also be desirable to stimulate the mind (Chinmayananda, 1984). The verse states: 'In a state of mental inactivity awaken the mind, when agitated, calm it; between these two states realize the possible abilities of the mind. If the mind has reached a state of perfect equilibrium do not disturb it again'. For most persons routinely, the mental state is somewhere between the extremes i.e., ‘inactive’ or ‘agitated’. Hence, a combination of ‘awakening’ and ‘calming’ practices may be better suited to reach a balanced, relaxed state.

Cyclic meditation is a technique derived from the above idea which is drawn from traditional texts and includes the practice of four yoga postures interspersed with supine rest, hence consisting of a combination of both ‘stimulating’ and ‘calming’ practices (Nagendra, & Nagarathna, 2003).

A single study evaluated the physiological effects of cyclic meditation (CM) compared to supine rest in the corpse posture (*shavasana*, SH) in forty male volunteers aged between 20 and 47 years (Telles, Reddy, & Nagendra, 2000). Each individual was tested before and after both cyclic meditation and *shavasana* sessions, and the order of the sessions was altered for alternate subjects. Assessments of oxygen consumption as a measure of the metabolic rate, breath volume and breath frequency, were made before and after each session while breathing oxygen through a closed circuit Benedict-Roth apparatus. There was a significant decrease in the amount of oxygen consumed and in breath rate and an increase in breath volume after both types of sessions. However, the magnitude of change of all three measures was greater after CM: (i) oxygen consumption decreased by 32.1 percent after CM compared with 10.1 percent after SH suggesting that CM reduced the metabolic rate more than SH; (ii) breath rate decreased by 18.0 percent after CM and 15.2 percent after SH; and (iii) breath volume increased by 28.8 percent after CM and 15.9 percent after SH.

However, the study on CM had two main drawbacks (i) assessments were made before and after, but not during the practice and (ii) the measurements were made using a closed-circuit apparatus. While breathing through the Benedict-Roth closed circuit apparatus some people find it hard to breathe normally (Judy, 1982). Another criticism of the method is that accuracy depends on the ability of a subject to breathe regularly. If the rate or amplitude (or both) of respiration are irregular it is difficult to decide precisely where to draw the sloping line which determines the oxygen consumption. In the closed circuit system, the person breathes from a reservoir of one hundred percent oxygen and the resistance offered by the apparatus to increase the volume of breathing required during physical activity is high so that the rate of carbon dioxide removal by absorption may be inadequate for accurate results during even moderate activity (American Association for Respiratory Care, 1994).

It has also been shown that the resistance to breathing is increased, inspiratory time is prolonged and the work of breathing may be increased by as much as 10 percent in closed-circuit systems (Branson, 1990). Generally, the open-circuit system is regarded as more accurate since the person breathes ambient air and the apparatus does not offer resistance to the flow of air (Matarese, 1997).

With this background the present study was planned to record the energy expenditure (using an open circuit apparatus) before, during and after CM compared to an equal duration of *shavasana*, to understand the changes during the actual practice of CM.

METHODS

Subjects. Fifty male volunteers with an age range between 18 and 48 years (group mean age ± S.D., 27.0 ± 6.3 years) took part in the study. Respiratory and metabolic variables have been shown to vary with the phases of the menstrual cycle (Das, & Jana, 1991), hence the study was restricted to males. The subjects were undergoing yoga training at a yoga center. All of them were in normal health based on a routine clinical examination and none of them had a history of smoking or respiratory ailments. None of them was taking any medication and they did not use any other wellness strategy. They had experience of practicing both yoga techniques (i.e., cyclic meditation and s*havasana*) ranging between 3 and 60 months (group mean ± S.D., 15.3 ± 13.3 months). The aims and methods of the study were told to them and their consent to participate was obtained.

Design. The participants were assessed in two types of sessions, namely cyclic meditation (CM) and *shavasana* (SH). For half the subjects the CM session took place on one day, with the SH session the next time, with a one day gap between sessions. The remaining subjects had the order of the sessions reversed. Subjects were alternately allocated to either schedule to prevent the order of the sessions influencing the outcome. The subjects were not aware of the hypothesis of the study but were told about the variables to be recorded and their consent was obtained. Assessments were made throughout the sessions. Each session lasted for 33 minutes of which 22 minutes 30 seconds was spent in the practice of either CM or SH, preceded (pre) and followed (post) by 5 minutes of supine rest.

Assessments. The assessments of energy expenditure, respiratory exchange ratio and heart rate were made with the subject breathing ambient air while wearing a mask, using an open circuit apparatus (OxyconPro system, Model 2001, Jaeger, Germany). The system was calibrated for ambient temperature, humidity and barometric pressure, flow rate; and gas analysis.

Interventions.

Cyclic meditation: Cyclic meditation lasted for 22 minutes 30 seconds. Throughout the practice subjects kept their eyes closed and followed instructions from an audiotape. The instructions emphasized carrying out the practice slowly, with awareness, and relaxation. The four phases of cyclic meditation consisted of the following practices.

Phase 1 (5 minutes): The practice began by repeating a verse (1 min) from the yoga text, the *Mandukya Upanishad* (Chinmayananda, 1984); followed by isometric contraction of the muscles of the body ending with supine rest (1 min 30 s): slowly coming up from the left side and standing at ease (called *tadasana*) and 'balancing' the weight on both feet called 'centering' (2 min 30 s); Phase 2 (5 minutes): Then the first actual posture, bending to the right (*ardhakatichakrasana*, 1 min 20 s); a gap of 1 min 10 s in *tadasna* with instructions about relaxation and awareness; bending to the left (*ardhakaticakrasana*, 1 min 20 s); a gap of 1 min 10 s in *tadasana*; Phase 3 (5 minutes): Forward bending (*padahastasana*, 1 min 20 s); another gap (1 min 10 s); backward bending *(ardhacakrasana*, 1 min 20 s); a gap of 1 min 10 s in *tadasana*; Phase 4 (7 min 30 s): Slowly coming down to a supine posture for rest with instructions to relax different parts of the body in sequence (Telles, Reddy, & Nagendra, 2000).

Shavasan: During the 22 minutes 30 seconds of 'supine rest' subjects lay in the corpse posture (shavasana) with their legs apart and arms away from the sides of the body, with eyes closed. The state of shavasana was considered for analysis as four phases (the first three phases of 5 min each and the fourth phase of 7 min 30 s) to make it comparable to the state of CM practice, during the CM session. However, throughout the four phases, the subjects lay in the same posture.

Data extraction. The contiguous data obtained from breath-by-breath sampling were averaged for the 'pre', 'during' and 'post' states of each session. The 'during' state of the CM session had four 'phases' detailed above. These were analyzed separately and to make the analyses uniform, the 22 min 30s of the 'during' phase of the SH session was also considered as four phases of comparable duration.

Data analysis. The data were analyzed using SPSS Version 10.0. Repeated measures analyses of variance were performed with two Within Subjects Factors. These were (i) Factor 1: Sessions, two levels, i.e., CM and SH, and (ii) Factor 2: States, six levels i.e., pre, during 1 (D1), during 2 (D2), during 3 (D3), during 4 (D4), and post.

Comparison between the 'during' values and 'post' values with the respective 'pre' values were made with the t–test for paired data.

RESULTS

Repeated measures Analysis of Variance (ANOVA). For energy expenditure the repeated measures ANOVA showed a significant difference between the two Sessions ($F = 164.28$, $DF = 1$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.00), between the six States ($F = 128.05$, $DF = 2.60$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.520), and the interaction between Sessions and States ($F = 185.95$, $DF = 2.80$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.570).

Also, for the Respiratory Exchange Ratio there was a significant difference between the two Sessions ($F = 6.09$, $DF = 1$, $P < 0.05$, Greenhouse-Geisser epsilon = 1.000), between the six States ($F = 6.29$, $DF = 1.52$, $p < 0.01$, Greenhouse-Geisser epsilon = 0.309), and the interaction between Sessions and States ($F = 8.49$, $DF = 1.59$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.319).

For the heart rate as well, the repeated measures ANOVA showed a significant difference between the two Sessions ($F = 186.90$, $DF = 1$, $p < 0.001$, Greenhouse-Geisser epsilon = 1.000), between the six States ($F = 135.06$, $DF = 2.93$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.587), and the interaction between Sessions and States ($F = 152.64$, $DF = 3.05$, $p < 0.001$, Greenhouse-Geisser epsilon = 0.610).

Paired t- test. The paired t–test showed a significant increase in energy expenditure in the D1, D2, and D3 phases of the 'during' state compared to 'pre' for the CM session while there was a significant reduction in energy expenditure after cyclic meditation compared to the 'pre' state ($p < 0.001$, for all comparisons). The energy expenditure also significantly reduced in the D1, D2, D3 and D4 phases and the 'post' phase of the SH session ($p < 0.001$) compared to 'pre'.

There was a significant decrease in respiratory exchange ratio in D2 and D3 phases of the ‘during’ state compared to ‘pre’ for the CM session ($p < 0.001$). In addition, there was significant increase in respiratory exchange ratio in D1 and D4 phases of the ‘during’ state compared to ‘pre’ for the CM session ($p < 0.01$). There was no significant change in SH session.

There was a significant increase in heart rate in D1, D2 and D3 phases of the ‘during’ state compared to the ‘pre’ for CM session ($p < 0.001$). The heart rate also slightly increased in D3 and D4 phases of SH session ($p < 0.05$) compared to ‘pre’.

The group average values ± SD for energy expenditure, respiratory exchange ratio and heart rate for CM and SH sessions are given in Table 1.

DISCUSSION

The present study evaluated the changes in energy expenditure, respiratory exchange ratio and heart rate before, during, and after the practice of cyclic meditation compared to a comparable period of supine rest in the corpse posture (or *shavasana*). The practice of CM was considered as four phases, of which the first three included the actual practice of yoga postures, while the fourth phase consisted of supine rest.

The energy expenditure increased in the first three phases of CM, returned to the baseline in the fourth phase and reduced by 19.9 percent compared to the baseline after the practice. The respiratory exchange ratio increased in the first and fourth phases of CM and reduced during the second and third phases of CM. The heart rate increased in the first three phases of CM, and returned to the baseline in the fourth phase. In the *shavasana* session of supine rest there was a significant reduction in energy expenditure during and after the practice, while respiratory exchange ratio showed no change. The heart rate slightly increased in third and fourth phase of *shavasana.*

The energy spent by the body in a particular activity is measured by the amount of oxygen consumed by the body per minute or indirectly by heart rate and ventilatory changes (Rai, & Ram, 1993). The respiratory exchange ratio (RER) is the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed per unit of time. During exercise the RER increases due to hyperventilation and blowing off carbon dioxide while contracting an Oxygen debt (Ganong, 1987). In the present study, the RER changed alternately (increase followed by decrease) in the four phases of CM. This suggests that the 'exertion' incurred during the first phase of CM was compensated for by an increase in RER, which hence reduced in the second phase. The same sequence repeated in the third and fourth phases. There was no change in RER after CM, suggesting that no oxygen debt was incurred (Ganong, 1987).

It is recognized that ventilation increases in a linear relationship to oxygen intake and carbon dioxide output upto approximately 60 percent of the maximal oxygen consumption (Jones, 1997). Also the fact that even moderate exertion increases sympathetic activity makes it not surprising that, the direction of change in energy expenditure and heart rate during cyclic meditation were similar, with an increase during the phases of practicing yoga postures, a return to baseline values during the fourth phase of supine rest and a decrease in energy expenditure and heart rate at the end of practice of cyclic meditation.

The main difference between the two sessions (CM and SH) was that the energy expenditure increased during the practice of postures in CM, and after the practice decreased below the ‘pre’ value by 19.9 percent. In contrast the energy expenditure decreased throughout the SH practice, but the decrease after the period of SH (i.e., 5.1 percent) was less in magnitude compared with the decrease after CM.

These results are similar to those of an earlier study in which a decrease in oxygen consumption (as an indicator of energy expenditure) of 32.1 percent followed the practice of by CM, as compared to a 10.1 percent decrease after SH practice (Telles, Reddy, & Nagendra, 2000). While the present study and the earlier study showed a similar trend (i.e., a greater decrease in energy expenditure after CM compared to SH) the earlier study reported a greater magnitude of increase. This may possibly be due to two factors: (i) the meditators in the previous study had an average experience of meditation of 32.9 ± 19.8 months compared with the meditators of the present study whose experience was 15.3 ± 13.3 months, on an average, and (ii) in the earlier study the measurements were made using a closed-circuit apparatus, which has been described as less precise (Judy, 1982; American Association for Respiratory Care, 1994).

The fact that the increase in energy expenditure which occurred during the first three phases of CM practice, stopped, and in fact was lower in the ‘post’ period, suggests that no oxygen deficit or oxygen debt occurred during the practice.

The changes during CM may be compared with the metabolic changes reported during Tai Chi Chuan practice (Lan, Chen, Lai, & Wong, 2001). Tai Chi Chuan (TCC) is a branch of traditional martial arts, which consists of complex postures practiced so that they are slow, harmonious, and relaxing. The practice was for 24 minutes and during the practice of TCC the oxygen consumption was close to ventilatory threshold level. The changes after the practice were not reported. The greater reduction in energy expenditure and the changes in heart rate after CM (compared to *shavasana*) suggested that in spite of the practice of yoga postures, which may be expected to be more stimulating than the supine rest, the effects suggested a decreased need for energy. These findings may be related to the fact that during CM the yoga postures are practiced with an emphasis of being relaxed during the practice and following the practice with a period of supine rest.

It is already known that interspersing exercise with periods of rest is likely to enhance enjoyment of exercise and improve compliance with the exercise plan. Yoga postures have been shown to serve as a form of mild exercise (Rai, & Ram, 1993). The yoga postures practiced in CM may not have served as an ‘exercise’ (however mild), but would be more physically activating than supine rest.

In summary, the findings support the idea that cyclic meditation, which combines ‘stimulating’ and ‘calming’ techniques, may reduce energy expenditure to a greater degree than supine rest, even though the energy expenditure increases during the actual practice of yoga postures.

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REFERENCES

- American Association of Respiratory Care. (1994). AARC Clinical Practice Guidelines for metabolic measurement using indirect calorimetry during mechanical ventilation. *Respiratory Care, 39 (12),* 1170-1175.
- Branson, R.D. (1990). The measurement of energy expenditure: instrumentation, practical considerations, and clinical application. *Respiratory Care, 35,* 640-659.
- Chinmayananda, S. (1984). *Mandukya upanisad*, Bombay: Sachin Publishers.
- Das, T.K., & Jana, H. (1991). Basal oxygen consumption during different phases of menstrual cycle. Indian Journal of Medical Research, 94, 16-19.
- Ganong, W.F. (1987). *Review of Medical Physiology*. San Francisco: Prentice-Hall International Inc.
- Jones, N.L. (1997). *Clinical Exercise Testing*. Philadephia: W.B. Saunders.
- Judy, W.V. (1982). Energy expenditure, metabolism, temperature regulation and exercise. In: E.E. Selkurt, (Ed.), *Basic Physiology for Health Sciences*. (pp 521-522). Boston: Brown and Company.
- Lan, C., Chen, S.Y., Lai, J., & Wong, M.K. (2001). Heart rate responses and oxygen consumption during Tai Chi Chuan practice. *American Journal of Chinese Medicine. 20(3),* 400-408.
- Matarese, L.E. (1997). Indirect Calorimetry: technical aspects. *Journal of the American Dietetic Association, 11(2),* 154-160.
- Nagendra, H.R., & Nagarathna, R. (2003). *New perspectives in stress management*. Bangalore: Swami Vivekananda Yoga Prakashan.

- Rai, L., & Ram, K. (1993). Energy expenditure and ventilatory responses during virasana - a yogic standing posture. *Indian Journal of Physiology and Pharmacology, 37(1),* 45-50.
- Rai, L., Ram, K., Kant, U., Madan, S.K., & Sharma, S.K. (1994). Energy expenditure and ventilatory responses during siddhasana - a yogic seated posture. *Indian Journal of Physiology and Pharmacology, 38(1),* 29-33.
- Taimini, I.K. (2001). *The Science of Yoga*. Madras: The Theosophical Publishing House.
- Telles, S., Nagarathna, R., & Nagendra, H.R. (1998). Autonomic changes while mentally repeating two syllables – one meaningful and the other neutral. *Indian Journal of Physiology and Pharmacology, 42(1),* 57-63.
- Telles. S., Reddy, S.K., & Nagendra. H.R. (2000). Oxygen consumption and respiration following two yoga relaxation techniques. *Applied Psychophysiology and Biofeedback, 25(4),* 221-227.
- Wallace, R.K., Benson, H., & Wilson, A.R. (1971). A wakeful hypometabolic physiologic state. *American Journal of Physiology, 221,* 795-799.