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Review

Yoga in cardiac health (A Review)

Satyajit R. Jayasinghe

Continuum Heart Institute, Beth Israel Medical Center, First Avenue at 16th Street, New York 10010, USA.

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This review studies the efficacy of yoga in the primary and secondary prevention of ischaemic heart disease and post-myocardial infarction patient rehabilitation. Yoga is an unconventional form of physical exercise that has been practised over a long period of time in the Indian sub-continent. It has gained immense popularity as a form of recreational activity all over the world. Its possible contributions to healthy living have been studied and many interesting revelations have been made. Benefits of yoga in the modification of cardiovascular risk factors and in the rehabilitation of the post-myocardial infarction patient are areas of significant importance. It is important to assess the practical significance and the suitability of incorporating yoga into the comprehensive cardiac rehabilitation programme. Majority of the rehabilitation workers believes that incorporating nonconventional forms of physical exercise such as yoga definitely would enhance efficacy and add value. This article attempts to study the history and the science of yoga and evaluate its effects on cardiovascular health. *Eur J Cardiovasc Prev Rehabil* 11:369–375 © 2004 The European Society of Cardiology

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Introduction

Yoga is described as comprising a rich treasure of physical and mental techniques that can be effectively used to create physical and mental well-being. It is an ancient tradition that finds its roots in the early civilizations of the central Asian regions. Its influence is seen in many cultural traditions of different countries. In India it flourished and evolved as a vibrant way of life and a spiritual practice.

Conventional exercise, particularly moderate intensity-aerobic exercise, is known to be immensely beneficial in the primary as well as secondary prevention of ischaemic heart disease. Gradually incremental activity helps accelerate the initial recovery process after a myocardial infarction. Though not practised universally, there is increasing evidence to support the fact that the forms of exercise that have been practised in the East from times immemorial, such as yoga, are beneficial in the management of ischaemic heart disease. These benefits are not only limited to the primary and secondary prevention of

ischaemic heart disease but also extend to the realms of management of symptoms, modification of risk factors and the regression of atherosclerotic plaques in the diseased arteries. In an age where there is increasing dependency on pharmacotherapy, which is expensive and not always without side effects, for the management of ischaemic heart disease, introduction or integration of alternative forms of exercise such as yoga may be of tremendous benefit. There is little doubt that such a measure would complement the conventional therapeutic protocols and also contribute significantly to reduce the therapy-related expenditure. Yoga essentially involves adopting certain simple to complex body postures (*asanas*) and maintaining the same for set periods of time. In addition yoga involves controlled breathing, voluntary concentration of thoughts (meditation) and/or repeated recital of phrases called mantras. Since its introduction into popular western culture yoga has enjoyed a tremendous growth in popularity as an adjunct to healthy living. In some instances it has become a fashion statement among the urban middle classes.

Yoga history

Yoga is a tradition of lifestyle, health and spirituality that evolved in the Indian peninsula over a period of some

Correspondence and requests for reprints to Satyajit R. Jayasinghe, Continuum Heart Institute, Beth Israel Medical Center, First Avenue at 16th Street, New York, New York 10010, USA.
Tel: 212 725 5717; fax: 212 420 2046; e-mail: superadical@hotmail.com

5000 years. Its rudiments are believed to have emerged from the earliest known human civilizations of the Indus valley region (current day Pakistan). Recorded history of the yoga tradition starts with the *Yoga Sutra*, which is the definitive text on the philosophy of classical yoga. This text, the origin of which is estimated to date back to the period between 200 BC and 300 AD, was written by a historically renowned yoga teacher and Hindu philosopher named Patanjali. Yoga entered the Western mainstream through the work of Swami Vivekananda who popularized Eastern Hindu philosophy in the late nineteenth and early twentieth centuries.

The body postures (Asanas) and breathing

The mainstay of yoga practice involves the adoption and maintenance of specific body postures and the associated controlled breathing techniques. The ancient Indian classic on the practice of yoga, *Gherananda-Samhita*, notes that there are 840,000 *asanas*, though only one ten-thousandth of them, or 84, are used in contemporary common practice. Of these, only 32 are recommended by this ancient text as being useful for regular practice. The classic texts advise each *asana* to be maintained for a period of 5–20 breaths. The yogic breathing technique of *pranayama* involves a slow deep breath inspired with the predominant use of the abdominal musculature and the diaphragm. The breath is held momentarily in full inspiration within the limits of comfort and allowed slow and spontaneous exhalation. Again respiration is paused within the limits of comfort in full exhalation.

Method

A Medline search was launched under the terms 'yoga', 'cardiac health' and 'cardiac disease'. All citations of relevance published over a period of 12 years (1991–2003) were selected and reviewed. Only a limited number of formal scientific studies into the benefits of yoga practice in ischaemic heart disease have been carried out. For the purpose of assessing the efficacy of yoga in the prevention of coronary heart disease, the treatment of coronary risk factors and the management of coronary artery disease all the randomized controlled trials, well-designed experimental studies and well-designed open trials were selected and reviewed. In total 22 papers were selected out of which 21 were in English and one in Russian. Of the 13 studies listed and reviewed in this article six were randomized controlled trials, six were open trials and one was an experimental study. Data on diverse parameters from these published studies were manually extracted and studied. The contents of the selected publications and the outcomes of the studies are analysed, summarized (Table 1) and reviewed. Level of evidence from the studies was graded and classified according to the guidelines of the American College of Cardiology/ American Heart Association writing committee.

Yoga in the primary prevention of ischaemic heart disease

Stressors of urban and modern lifestyle have long been postulated to be major contributors to many an illness including ischaemic heart disease. Mindfulness-based stress reduction (MBSR) such as yoga has been shown to decrease the average number of visits to the primary care physician among middle-class populations in inner city areas in the USA [1]. This observation suggests that yoga may contribute to the general health and particularly to cardiac health in the populations that are subject to significant mental stress.

Reduced heart rate variability and baroreflex sensitivity are powerful and independent predictors of poor prognosis in heart disease. Slow breathing as in yogic practice enhances heart rate variability and baroreflex sensitivity by re-synchronizing inherent cardiovascular rhythms. It has been shown that the recitation of the Holy Rosary and also yoga *mantras* (chanting) slowed respiration to almost exactly six breaths per minute, and enhanced heart rate variability and baroreflex sensitivity. This down-regulatory effect has been observed not only in the respiratory signals but also in the RR interval in the electrocardiogram, systolic and diastolic blood pressures, and in transcranial blood flow signals [2]. Although the beneficial effects of recitations such as in yoga on physiological parameters has been demonstrated, the long-term benefits of such changes in the prevention of ischaemic heart disease are yet to be established, therefore there is need for further investigation and review of such phenomena.

Yoga effects on body physiology in modifying coronary risk factors

Hypertension

The mainstay of hypertension management in current clinical practice involves pharmacotherapy. Many anti-hypertensive agents have been associated with numerous undesirable side effects. Many non-pharmacological measures, such as 100 mmol/day reduction in sodium intake, have been associated with a decline in blood pressure of about 5–7 mmHg (systolic)/2.7 mmHg (diastolic) in hypertensive subjects. In addition moderately intense exercise at 40–60% of maximum oxygen consumption, for example 30–45 min of brisk walking on 4–5 days a week, is well known to lower blood pressure. Although regular aerobic exercise can have a beneficial effect on high blood pressure, this effect is significantly inferior to that produced by pharmacotherapy. Interestingly, it has been very convincingly demonstrated in a randomized controlled study that even a short period (11 weeks) of regular yogic practice at 1 h/day is as effective as medical therapy in controlling blood pressure in hypertensive subjects [3]. As with calisthenic exercise, yoga, together with relaxation, biofeedback, transcendental

Table 1 Studies included in the analysis

Source	Sample Size/Study type	Study population	Intervention	Duration	Outcome variable	Statistical significance of the change	Level of evidence
Murugesan <i>et al.</i> (2002) [3]	33 RC	Healthy adults (33–65 years)	Yoga	11 weeks	Blood pressure	Significant	B
Selvamurthy <i>et al.</i> (1998) [5]	20 OT	Healthy adults (32–53 years)	Yoga vs. body tilt	3 weeks	Blood/Urine catecholamines and renin, Blood pressure and autonomic response	Significant	B
Schmidt <i>et al.</i> (1997) [6]	106 OT	Healthy adults (18–64 years)	Yoga	3 months	Urinary stress hormone levels, body mass index, lipid profile	Significant	B
Konar <i>et al.</i> (2000) [7]	8 OT	Healthy adults (17–18 years)	Sarvangasana yoga	2 weeks	Cardiac dimensions	Significant changes in LVEDV & LVEDVI/ non significant in other LV parameters	B
Bera <i>et al.</i> (1993) [8]	40 RC	Young, healthy (12–15 years)	Yoga	1 year	Body composition, cardiovascular endurance and anaerobic power	Significant	B
Mahajan <i>et al.</i> (1999) [9]	53 RC	Patients with ischaemic heart disease (56–59 years)	Yoga	14 weeks	Body weight and serum lipid profile	Significant	B
Mahajan <i>et al.</i> (1999) [9]	40 RC	Healthy adults (56–59 years)	Yoga	14 weeks	Body weight and lipid profile	Significant	B
Vempati <i>et al.</i> (2000) [10]	35 OT	Healthy adults (20–46 years)	Yoga	14 weeks	Breath volume, oxygen consumption, heart rate and skin conductance	Significant	B
Jain <i>et al.</i> (1993) [11]	149 ES	Diabetics	Yoga	40 days	Blood sugar control	Significant	B
Manchanda <i>et al.</i> (2000) [12]	42 RC	Patients with ischaemic heart disease (32–72 years)	Yoga	1 year	Lipid profile, ischaemic symptoms and angiographic severity of disease	Significant	B
Raju <i>et al.</i> (1994) [15]	16 OT	Healthy adults (17–23 years)	Yoga	2 years	Biochemical and physiological markers of exercise tolerance	Significant	B
Ray <i>et al.</i> (2001) [16]	40 RC	Healthy adults (19–23 years)	Yoga	6 months	Physiological markers of exercise tolerance	Significant	B
Malathi <i>et al.</i> (2000) [19]	48 OT	Patients with ischaemic heart disease (35–50 years)	Yoga	4 months	Psychological status	Significant	B

RC—randomized controlled study, OT—Open trial, ES—Experimental study, LV—Left ventricle, LVEDV—left ventricular end diastolic volume, LVEDVI—left ventricular end diastolic volume index.

*Classification of evidence—Level of evidence A—Data derived from multiple randomized clinical trials, Level of evidence B—Data derived from a single randomized trial, or nonrandomized studies, Level of Evidence C—Consensus opinion of experts [23].

meditation and psychotherapy, has been found to have a convincing antihypertensive effect [4].

The mechanism of yoga-induced blood pressure reduction may be attributed to its beneficial effects on the autonomic neurological function. Impaired baroreflex sensitivity has been increasingly postulated to be one of the major causative factors of essential hypertension [5]. Practice of yogic postures has been shown to restore baroreflex sensitivity. Yogic *asanas* that are equivalent to head-up or head-down tilt were discovered to be particularly beneficial in this regard. Three weeks of specific yogic posturing could bring about significant autonomic readjustments that were tested and proven with a battery of tests that included cold pressor response at 4°C water (CPR), alpha index of EEG (AI), level of blood catecholamines (CA) and plasma renin activity (PRA). These tests proved a progressive attenuation of sympatho-adrenal and renin-angiotensin activity with yogic practice. Yogic practice, through the restoration of baroreceptor sensitivity, caused a significant reduction in the blood pressure of patients who participated in yoga exercise [5,6].

Yoga has proven efficacy in managing secondary cardiac complications due to chronic hypertension. Left ventricular hypertrophy secondary to chronic hypertension is a harbinger of many chronic cardiac complications, such as myocardial ischaemia, congestive cardiac failure and impairment of diastolic function. Cardiovascular response to head-down-body-up postural exercise (*Sarvangasana*) has been shown to be particularly beneficial in preventing and treating hypertension-associated left ventricular hypertrophy and diastolic dysfunction. In one study practice of *sarvangasana* (one of the three best known of all *asanas*) for two weeks caused resting heart rate and left ventricular end diastolic volume to reduce significantly. In addition there was mild regression of left ventricular mass as recorded in echocardiography [7].

Serum lipid profile and body weight

Obesity is a strong independent risk factor for ischaemic heart disease. Weight also has the strongest independent correlation with the risk of hypertension other than age. In many patients attempts at weight reduction have proved to be very challenging and often unfruitful. Yoga has been found to be particularly helpful in the management of obesity. A randomized controlled study revealed that practising yoga for a year helped significant improvements in the ideal body weight and body density [8].

In another study, participants of a comprehensive residential 3-month yoga and meditation training programme showed significant reductions in body mass index, total serum and LDL cholesterol, and fibrinogen in those who had elevated levels [6].

Regular practice of yoga has shown to improve serum lipid profile in the patients with known ischaemic heart disease as well as in healthy subjects [9].

The mechanism of the beneficial effect of yoga in the management of hyperlipidaemia and obesity cannot be explained by simple excess caloric expenditure since practice of *asanas* does not bring about increased, rapid large muscle activity and energy generation. However the efficacy of yoga in the management of hyperlipidaemia and obesity is of significance.

Intrinsic adverse neurohormonal activity

Increased intrinsic neurohormonal activity has been associated with increased predisposition to ischaemic heart disease. This may explain how general stress in life contributes to increased risk of myocardial disease. Level of adverse neurohormonal activity can be quantitated by the measurement of specific markers in serum and urine. It has been described that regular practitioners of yoga *asanas* showed a significant reduction in the markers of intrinsic neurohormonal activity such as urinary excretion of adrenaline, noradrenaline, dopamine, aldosterone, as well as serum testosterone and luteinizing hormone levels. In an experimental study they also showed an increase in the urinary excretion of cortisol [5]. Yoga-based guided relaxation helped in the reduction of sympathetic activity with reduction in heart rate, skin conductance, oxygen consumption and increase in breath volume – the clinical signs of neurohormonal activity, thus facilitating protection against ischaemic heart disease and myocardial infarction [10].

Diabetes mellitus

Yoga has been shown to be a simple and economical therapeutic modality that may be considered as a beneficial adjuvant for NIDDM patients. In a group of diabetics who practised yoga regularly, there was a significant reduction in the frequency of hyperglycaemia and area index total under the oral glucose tolerance test curve. This experimental study showed that there was also a decrease in the need for oral hypoglycaemics to maintain adequate blood sugar control in the population that practised yoga [11]. The mechanism of the anti-glycaemic activity of yoga exercise has yet to be described. A mechanism of neurohormonal modulation involving insulin and glucagon activity remains a possibility.

Although there were no scientific studies found in the literature survey to highlight the effect of yoga in the management of cigarette smoking, the psychological relaxing effect of yoga may be beneficial in this regard. There is a definite need for randomized studies to be carried out looking into the beneficial effects, if any, of yoga as an aid to giving up smoking.

Retardation of coronary atherosclerosis with yoga lifestyle intervention

In a randomized controlled study patients with angiographically proven coronary artery disease who practised yoga exercise for a period of one year showed a decrease in the number of anginal episodes per week, improved exercise capacity and decrease in body weight. Serum cholesterol levels (total cholesterol, LDL cholesterol and triglyceride levels) also showed greater reductions as compared with control groups. Revascularization procedures were required less frequently in the yoga group. Follow-up angiography at one year showed that significantly more lesions regressed (20% vs. 2%) and fewer lesions progressed (5% vs. 37%) in the yoga group compared with the control group. Thus yoga exercise increases regression and retards progression of atherosclerosis in patients with severe coronary artery disease [12]. However the mechanism of this effect of yoga on the atherosclerotic plaque remains to be studied. Lipid-lowering and plaque-stabilizing effects of yoga exercise seem to be similar to that of statin drugs (HMG CoA reductase inhibitors). It is important to carry out biochemical and immunological studies among practitioners of yoga to see whether it has similar mechanisms of action to statins that have favourable effects on atherosclerosis and vascular properties other than those attributed to cholesterol lowering. Statin activity is associated with the increased production of nitric oxide in the vascular endothelium, which has local vasodilator properties in addition to anti-atherogenic, antiproliferative and leukocyte adhesion-inhibiting effects. It is also known to enhance endothelium-dependent relaxation, inhibit platelet function, and inhibit the activity of endothelin-1, a potent vasoconstrictor and mitogen. Statins also reduce inflammatory cytokines [13]. There may be some parallels between the pharmacophysiological effects of statin therapy and the changes brought about by the practice of yoga in the internal milieu. This change in the internal milieu triggered by the practice of yoga may well be mediated by a neurohormonal mechanism.

Post-event rehabilitation

Yoga has shown to be beneficial in the recovery process after a myocardial infarction. It has contributed to sleep, appetite and general well-being and decreased physiological arousal among patients [14].

The ability of yoga to improve the functional capacity of patients could be of benefit in the post-myocardial infarction patient rehabilitation process. Subjects who practised *pranayama* or controlled yogic breathing could achieve higher work rates with reduced oxygen consumption per unit work and without an increase in blood lactate levels. This observation was valid in submaximal as well as maximal exercise. Their blood lactate levels were also significantly low at rest [15]. Another study

further confirmed the above by demonstrating significant improvements in cardiovascular endurance, and anaerobic power upon practising yoga for a one-year period [8]. One hour of yogic exercise each day for 6 months contributed to an increase in maximal oxygen consumption (VO_{2max}) and significant improvements of effort tolerance in healthy young men. Improvements brought about by practising yogic postures regularly were significantly better than those brought about by conventional calisthenic exercise training. Physiological parameters measured were oxygen consumption, carbon dioxide output, pulmonary ventilation, respiratory rate, heart rate and the score of perceived exertion. The yoga practitioners had lower perceived exertion (13.8 ± 1.3) after maximal exercise compared with those who practised conventional exercise (16.1 ± 1.2). Although these findings are taken from the young healthy, it is likely that this has relevance, at least to a lesser degree, to the post-myocardial infarction patient [16].

Evidence of the beneficial effects of yoga to the cardiac patient is outstanding. However, the role of yoga in the management of the cardiac patient should be complementary to the scientifically proven conventional modes of comprehensive cardiac care. Elementary yoga practice involving simple postures, relaxation exercise and respiratory exercise combined with traditional pharmacotherapy and physiotherapy in the post-myocardial infarction patients showed superior clinical benefits over those who did not practise yoga. These benefits were also made manifest in exercise tolerance and psychosomatic conditioning [17].

Control of excess sympathetic activation has become a cornerstone in the management of ischaemic heart disease as well as congestive cardiac failure. Beta-blocker therapy provides this facility through pharmacological means. Yoga is also shown to have the ability to control the sympathetic overdrive thus mimicking beta blockade. Yogic practitioners exposed to acute hypoxia under experimental conditions could maintain better oxygen saturation than controls, despite lack of increase in minute ventilation. Their sympathetic activation during such hypoxia was blunted. The partially maintained oxygen saturation in yoga trainees during hypoxia is considered to be due to more efficient type of breathing typical to yogic practice. The physiological adaptations acquired by the practice of yogic breathing may be helpful in the care of patients with cardiovascular diseases, particularly ischaemic heart disease and chronic heart failure. In cardiovascular disease and hypertension, the importance of sympathetic activation linked to respiratory dysfunction is now well recognized. The chronic hypoxia induced by chronic heart failure can be ameliorated by improved breathing techniques of yogic practice. Training of respiratory muscles can also improve

dyspnoea and exercise capacity. Similarly, the decrease in sympathetic activity seen with slow breathing might be beneficial in hypertension, where sympathetic activation has been linked to disturbed breathing patterns and increased chemoreflex activity [18].

Quality of life in the post-infarction patient

One major objective of post-myocardial infarction rehabilitation is restoration and improvement of the quality of life of the patient. Conventional rehabilitation methods have proven to be efficacious in contributing to improvements in the quality of life of patients. However, practice of yoga for a period of 4 months caused a significant improvement in the subjective well-being of post-infarct patients as measured by the Subjective Well Being Inventory (SUBI) and thus the quality of life, in a recent study [19].

Improvement of the quality of life can be facilitated by the reduction of stress in life. Conventional mind-body therapy has been proven to be a valuable noninvasive way to manage coronary disease. Yoga practice, especially, has been found to be invaluable in preventing adverse outcomes of coronary disease by improving resistance to stress [20].

Risks of yoga practice

The conventional isometric and isotonic exercise have the potential to cause musculoskeletal injury, particularly in those who are physically unfit or weak. Practice of conventional exercise also has the potential to induce arrhythmias, cause dehydration and at times rapid and harmful fluctuations of the haemodynamic parameters. These forms of exercise can place overwhelming demands on the cardiopulmonary system if not performed within strict limits of safety. Only one incident has been reported in the surveyed medical literature associated with the risks due to the practice of yoga. The serious case that has been reported is of a female practitioner developing thrombosis of vertebralbasilar artery due to an intimal tear and subsequent stroke. This was attributed to adopting an unusual neck posture during yoga practice [21]. Yoga, although not entirely risk-free, can be considered a safe form of exercise if practised under the guidance and supervision of a qualified trainer.

Conclusion/discussion

Mind-body exercise such as yoga couples sustained muscular activity with internally directed focus, producing a temporary self-contemplative mental state. Exercises such as yoga have shown significant mental and physical value. It can be postulated that the practice of yoga triggers neurohormonal mechanisms that bring about health benefits. This is evidenced by the suppression of sympathetic activity associated with yoga practice as discussed above. However, there is a definite need for

more directed scientific work to be carried out to elucidate the effects and the mechanisms of such effects of yoga on the human body in health and disease. Considering the scientific evidence discussed thus far, it is fair to conclude that yoga can be beneficial in the primary and secondary prevention of cardiovascular disease and that it can play a primary or a complementary role in this regard [22].

There is tremendous enthusiasm in cardiac rehabilitation circles to incorporate complementary forms of exercise therapy such as yoga to the mainstream practice of cardiac rehabilitation. Lack of infrastructure, expertise and funding seem to be the main hurdles in the implementation of such reform. Therefore more research needs to be carried out at leading rehabilitation centres into the benefits of complementary physical exercise modalities such as yoga and a push for more funding is required, once there is unequivocal evidence of the benefits of its incorporation into the mainstream post- and pre-event cardiac rehabilitation.

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