Yoga and the Cardio-Vascular System

by

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Basic aims of Yoga include control of the body, of the emotions and of the intellect. For a long time in the West, voluntary control of autonomic functions of the body were regarded as improbable; and against this background of belief, it was not surprising that reports reaching Western countries of such control were regarded as grossly exaggerated or else purely imaginary. With the development of objective methods of recording physiological activity and with the increased availability of Yogic practitioners willing to become subjects for experiments in laboratories in Western countries, it has become quite clear that many autonomic functions of the body can be controlled to a significant extent by the voluntary part of the nervous system. This is not only interesting to workers in pure physiology, psychology and neurology, but is of potentially great practical importance in fields such as clinical medicine.

As regards Yoga and the heart, many English doctors during the days of the British Empire reported instances of Yogis being able to stop their hearts. However, these doctors used stethscopes only to monitor the heartbeat and this introduced a subjective element into their observations. Again, Dr. A. R. LURIA in his book "The Mind of a Mnemonist" (1969) described a subject with remarkable powers of memory, who could also voluntarily increase his resting heartbeat from 72 per minute to 100 per minute (by imagining that he was running) or else slow it down to 64 per minute (by imagining that he was falling asleep). He could also produce a difference in temperature of 2°C between the right and the left hands, at will; he could control his perception of pain; and he could vary the adaptation of his eyes under constant conditions of lighting. Since, as far as is known, Dr. Luria's subject had not studied Yoga but seemed to have been naturally endowed with these remarkable powers, it is likely that an inherited neural basis existed for the voluntary control of these autonomic, perceptive and reflex activities. It is further probable that similar neural pathways exist in all humans, with the natural degree of response being high only in some rare gifted persons, whereas in most of us the ability is latent and requires Yogic or other techniques to develop and make demonstrable. Recent work has tended to support this hypothesis.

Objective evidence of voluntary cardiac arrest was provided by workers of the Kaivalyadhama Institute at Lonavla, Poona, in India where in 1971 an ECG recording showed a Yogi producing at will an isoelectric trace for 3 to 5 seconds, as he temporarily stopped the beat of his heart by using Kumbhaka with Uddiyana and Jalandhara bandhas. Nine separate instances were recorded and X-Ray studies done at the same time.

Yogic techniques of controlling autonomic functions to such an overt extent take a long time to learn and also call for a change in life-style. Besides, control of the body is considered by advanced Yogis to be only an elementary achievement; the important and worthwhile goal is considered to be the attainment of that degree of control of the mind which brings the detachment and mental equilibrium thought necessary for taking unemotional objective decisions, uninfluenced by selfish considerations, and with due regard for the absolute rights of all fellow creatures.

The impatient West could not easily utilise the unabridged techniques of the ancient Yogis, and Western workers began to devise methods for producing quick and measurable results, even if these were inferior in magnitude and duration than those obtained by traditional methods. Based on Yogic principles, three modern experimental techniques have emerged. They overlap to some extent, and are:- 1. Relaxtion. 2. Relaxation/Concentration. 3. Operant conditioning.

1. **Relaxation and the Cardiovascular System.**

In 1969, K. K. Datey et al. (Angiology 20 325) of the KEM Hospital of Bombay successfully treated 53% of 47 patients suffering from hypertension, by the use of this method. Systolic blood pressures ranged from 160 to 270 with an average of 186 mm Hg, and diastolic pressures ranged from 90 to 145 with an average of 115 mm Hg. The subjects were taught the Yogic relaxation exercise known as Shavasana for half an hour every day for 3 weeks, muscular relaxation being monitored by the EMG recorded from the frontalis muscle of the forehead. Breathing was deep, slow, rhythmic with a short pause after each inspiration and a longer pause after expiration. Patients were followed up weekly and the blood pressure measured. At the end of 6 months the results were as follows:- Of 10 patients not on any form of drug treatment for their hypertension, 6 had a significant fall in their mean blood pressures (diastolic plus one third of the pulse-pressure). Of 22 other patients whose blood pressures were adequately controlled by drugs, 13 could reduce the dose by an average of 33%. In yet another group of 15 patients whose blood pressures were not adequately controlled by drugs, 6 were able to achieve control on drug doses 30% less than at the start of the experiment. In all of the 47 subjects symptoms had markedly diminished.

During the relaxation exercise the subjects were inwardly alert but less conscious of external distractions. Dr. Datey thought that relaxation and slow rhythmic diaphragmatic breathing decreased the frequency and intensity of proprioceptive and enteroceptive impulses, and thus decreased the tonic activity of the ascending reticular activating system which influences the centres in the hypothalamus dealing with blood pressure. In Croydon, England, Dr. C. H. PATEL (Lancet 10 November 1973, 1053) also used the Shavasana relaxation posture to treat hypertension in 11 female and 9 male subjects all already on drug treatment. To speed up the training process she used a Biofeedback method. In BIOFEEDBACK, certain normally

involuntary functions of the body are converted to continuous external auditory or visual stimuli. The subject then tries to influence these involuntary functions by mental, emotional or somatic means and can monitor his approach to set targets by means of the sound or the visual displays. Dr. Patel used Galvanic Skin Resistance (GSR) as the index of relaxation. Low skin resistance (perhaps due to sweating) is taken to indicate relaxation. Transducer/amplifier circuits converted the GSR into an audio signal, and the patient tried to decrease or to stop this sound by relaxing physically and mentally. The systolic blood pressures of the patients ranged from 130 to 190 with a mean of 160 mm Hg, and the diastolic blood pressures ranged from 88 to 113 with a mean of 102 mm Hg. Of the 20 cases, 17 had essential hypertension, 2 had hypertension due to renal causes and 1 due to intracranial causes. The patients attended Dr. Patel's surgery thrice weekly for 3 months and were made to lie on a couch and to relax in Shavasana until they were able to stop the audio signal. During the experiment, she adjusted the dose of the drugs according to the response of the blood pressure. At the end of 3 months she found that 5 patients could stop drugs entirely, 7 more were able to decrease their drugs by 33 to 60%, and 4 others remained on the same dose of drugs but with better control of the blood pressure. Thus 16 out of 20 patients obtained direct benefit and the overall mean blood pressure dropped from 121 to 101 mm Hg. There were no significant changes in pulse, respiration or weight. The improvement in blood pressure control lasted for at least 6 months.

In the Lancet of 11 January 1975, Dr. C. Patel and a colleague carried out a similar experiment on 20 patients with average systolic blood pressure of 159 and diastolic of 100 mm Hg., but now she used a control series of patients matched as regards sex, age, average duration of hypertension and original systolic and diastolic blood pressures. To eliminate the argument that increased medical attention and repetitive blood pressure measurements might significantly influence the results in the treated group, these doctors subjected the control group to the same conditions as regards history-taking, investigations, number of attendances, time spent at each session and procedures for blood pressure measurements. Whilst the treatment group was taught to relax in Shavasana using Biofeedback (as before), the control group was asked merely to rest on the couch. After a 3-month training period both the treatment and the control group of patients were followed up once monthly for at least 9 months. At the end of this time it was found that 12 out of the 20 treated patients had been able to decrease their tablets by 42% whereas the patients of the control group continued to require the same or slightly increased doses of anti-hypertension drugs as before. Some patients found it difficult to do the relaxation for 20 minutes once or twice daily; but Dr. Patel advised that an effective substitute was for these patients to incorporate relaxation into everyday activities, that is, to relax consciously during the day and to use red traffic-lights or the ringing of the door-bell or telephone as a signal to check for tension or relaxation. Dr. Patel claimed that a suitable programme of relaxation can decrease resting blood pressure, can diminish anti-hypertension drug requirements, and can decrease the duration

and magnitude of the rise of blood pressure associated with everyday emotional stresses. She quoted from a paper of N. A. LOVE presented at the Biofeedback Research Society Meeting in Colorado Springs in 1974 where it was stated that blood pressure decreased in hypertension due to profound relaxation of muscles with much decrease in EMG activity. However, she thought that the effect was maintained because of an altered habitual interaction with the environment, thus preserving the initial lowered sympathetic tone and consequent decrease of blood pressure.

2. **Relaxation/Concentration Methods.**

H. BENSON et al. in Lancet of 23 February 1974 described 22 patients with untreated borderline hypertension averaging 146.5 systolic and 94.6 mm Hg. diastolic pressure. They were treated by the "relaxation response" produced by a relaxation/concentration method, and after 6 months the average systolic blood pressure had fallen to 139.5 and the diastolic pressure to 90.8 mm Hg. This was a statistically significant fall from the pre-treatment levels. In another group of 14 hypertensives on treatment with drugs, during the control period of 6 weeks the average blood pressure was 145.6/91.9. After at least one year of using the relaxation/concentration method for 20 minutes twice daily together with a constant dose of anti-hypertension drugs, the average blood pressure was 135/87. Dr. Benson concluded that the method was effective in borderline hypertension whether the patient was on drug treatment or not.

The relaxation/concentration method was described as follows: sit quietly and comfortably in Padmasana or even on a chair. Close the eyes and deeply relax all muscles. Breathe through the nose and become aware of breathing. During expiration, concentrate on silently saying the word 'one'. Keep a passive attitude and let relaxation occur at its own pace. Ignore distracting thoughts and keep repeating 'one'. Do the relaxation/concentration for 20 minutes each day.

This method combines a lesser degree of muscular relaxation, combined with some measure of introspection and detachment from external stimuli. Dr. Benson thought this simple non-cultic mental technique induced the "wakeful hypometabolic state" described in an earlier paper as an integrated hypothalamic response, a "relaxation response" consistent with a state of decreased sympathetic nervous system activity. This relaxation was thought to be the counterpart of another hypothalamic response, namely, the emergency response of CANNON (1914) popularly known as "fight or flight reaction". The relaxation response consists of a decrease in Oxygen use, Carbon Dioxide elimination, respiratory-rate, minute-ventilation, blood-lactate, arterial blood-pH, and base-excess. He thought that unlike the muscular relaxation method, this relaxation/concentration method called for a passive attitude, so that attention to the external stimulus in biofeedback might interfere with the elicitation of the response.

M.P.H.Y. Sec(S) Meditation

3. **Operant Conditioning Techniques.**

Here the subject is induced to learn to influence autonomic functions by positive or negative reinforcement. With humans, positive reinforcement has been used in experiments usually in the form of a reward. After the initial work on animals by Professor Neal MILLER of New York around 1968. G. E. SCHWARTZ of Harvard University (Science 175, 92, 1972) investigated control of heart-rate and blood-pressure by instrumental learning of visceral responses. He used 40 normo-tensive males aged 21 to 30 years in a sound-proof, temperature-controlled room. They were told to be quiet and to breathe regularly. They were given as feedback, a light and tone; and the reward was a money bonus for the desired pattern of response. He found that they learned to integrate the blood pressure and heart rate, increasing and decreasing both simultaneously as called for by the feedback. They also learned to differentiate the blood pressure and heart rate, and could increase or decrease the one whilst simultaneously decreasing or increasing the other. When both blood pressure and heart rate were voluntarily increased the effect could not be sustained; however, both could be decreased and sustained at the lower level. Dr. Schwartz thought that in the treatment of angina pectoris patients might be taught to decrease the blood pressure and heart rate, voluntarily, and so reduce the pain.

D. A. KRISTT (Circulation 51 370 1975) reviewed the literature on learned control of blood pressure. He taught 5 patients with essential hypertension of 10 years duration, whilst in hospital, each in the first week to increase his blood pressure, then in the second week to lower his blood pressure, and finally in the third week to raise and lower his blood pressure alternately in the same single session. A system of coloured lights provided feedback, red requesting decrease in blood pressure, green requesting increase in blood pressure, and yellow indicating success. The reward was satisfaction obtained from a visible digital counter which scored successes. In 3 weeks of about 14 sessions per week, all five subjects learned to control their blood pressure, and this control was maintained for up to 3 months at home, during which time the baseline systolic blood pressure fell from an average of 153 to 135 mm Hg. Dr. Kristt showed that these blood-pressure changes were not associated with changes in muscle tension nor in the EEG nor in the pulse-rate. The effects seemed due to alterations in peripheral resistance; and the mechanism appeared to be a different one from that operating in the muscular relaxation or the relaxation/concentration methods.

In most of these experiments parallel matched controls were not used. Dr. B. L. Frankel of the National Heart and Lung Institute, Bethesda, USA, in a letter to the Lancet of 13 March 1976 drew attention to errors which might arise from this omission in the design of the experiments. He found that 3 out of 7 essential hypertensives subjected to 20 minutes of shamblood-pressure biofeedback over 4 months, showed important decreases in diastolic blood pressure. He also stated that date (not given) suggested strongly that whilst a hypertensive patient's blood pressure

might drop significantly during feedback and relaxation exercises in the laboratory, it often quickly returned to previous levels when the patient attended to other matters. He made a plea for better controlled studies in future, using portable devices allowing for 24-hour casette recording of blood pressure.

The results of biofeedback methods of influencing the cardio-vascular system have caught the attention of the orthodox medical establishment in the UK. A leading article in the British Medical Journal of 17 August 1974 reviewed the literature on the control of human autonomic functions, including control of blood-pressure, heart-rate, premature ventricular contractions, ventricular rate in atrial fibrillation, vasomotor activity and migraine. The difficulty was discussed of introducing parallel controls to take into account all the possibilities for placebo responses and non-specific effects. Work with animals no longer provide a sound base for human experiments, since Professor Neal Miller and his co-workers have not been able to repeat some of his original findings on rats. Also there is some evidence, summarised by Dr. A. BLACK in the New Scientist of 31 January 1974, that observed changes may be due to effects other than learning, such as voluntary changes in general motor activity or in respiration, both of which can alter autonomic activity indirectly. Fully or partly curarising animals can eliminate purely muscular effects, but does not eliminate any central link between neural circuits controlling movements and those circuits controlling autonomic functions. This state of affairs has restored to focus the old Yogic teachings that by muscular and respiratory practices (Asanas and Pranayamas) or by mental exercises (relaxation/concentration) a person can achieve a degree of voluntary control over the autonomic functions of the body.

Most workers agree that blood pressure, peripheral skin-temperature and some cardiac arrhythmias can be controlled by operant conditioning or by biofeedback. Professor Neal Miller recently reviewed the work on premature ventricular contractions (New England Journal of Medicine 290 684 1974) and the editor of the British Medical Journal advised clinicians to keep a keen but critical watch on biofeedback research which may soon have something new and useful to offer to their patients. In a more recent issue of the BMJ (12 June 1976) the Editor stated in respect of blood pressure control, that the scope of these techniques remained to be defined. The feasibility of their widespread application was uncertain; and there was no immediate suggestion that physicians' efforts to lower blood pressure with drugs would be replaced wholesale by relaxation techniques. "But in a few years", he said "who knows".

The effect of static exercise on blood pressure and heart rate was reviewed in an editorial article in the Lancet of 18 October 1975. It has been shown by A. R. LIND (Circulation Research 20 supp.1 1967) that at tensions greater than 15% of maximum effort (produced by electrical stimulation) the blood pressure and pulse rate become raised and remain so until fatigue forces the muscle to relax, at which point a rapid

return to normal occurs. As the tension increases over 15% the rise in pulse and blood pressure increases and fatigue occurs earlier. However, the size of these changes are independent of the size of the muscle-group involved. A small muscle-group (e.g. in hand grip) would produce the same changes as a large muscle-group if the % of maximum effort is the same. Thus, carrying a weight by hand (using a small muscle-group) produces larger cardio-vascular changes and becomes fatigued earlier than carrying the same weight on the back (large muscle-group), because for the same weight the tension in the large back muscles is a smaller percentage of their maximum effort. One can regard Yoga postures (Asanas) as being mainly static exercise; but excessive increases in heart rate and blood pressure do not occur, probably because most of the Asanas involve large muscle masses, especially of the back, and the tensions developed are only small percentages of the maximum possible in these powerful muscle-groups.

K. N. UDUPA in a series of articles during 1975 in the Indian Journal of Medical Research explored the effects of Yoga on various biochemical indices. In one experiment he had 10 young University students doing Yogic exercises for 6 months:- 4 doing Shirshasana, Bhujangasana, Shalabhasana and Mayurasana; 4 others doing Sarvangasana, Matsyasana, Halasana and Paschimottanasana; and 2 doing Surya Namaskar. He found that at the end of the 6 months, the pulse rate had remained the same, the blood pressure tended to decrease slightly, the fasting blood-sugar had decreased by about 30% (without any change in diet).

In another study he assigned 2 healthy young men to group 1 (doing Sarvangasana and Matsyasana) and another 2 to group 2 (doing Shirshasana and Mayurasana), and a final 2 young men to group 3 (doing Halasana and Paschimottanasana). After 6 months of daily performance of these Asanas, the subjects' fasting blood-sugar had decreased by 8 to 20% and the total serum lipids had fallen to almost half the previous value, whilst the plasma catecholamines had decreased by 30 to 40%.

In a further study, 6 young, healthy men performed breathing exercises daily (Ujjayi for 7 minutes followed by Bhastrika for 10 minutes with 5 minutes rest intervening). After 6 months, he found that fasting blood sugar had fallen by 8%, and total lipids had decreased in the serum by more than 50%.

So far as the cardiovascular system is concerned, the reduction in blood-sugar and blood-lipids may be useful in mild diabetes and in hyperlipidaemia both of which conditions tend to be associated with arterial disease, including coronary insufficiency. The fall in plasma catecholamines may be partly responsible for the above changes in blood chemistry. It seems, therefore, that the long-term effects of Yogic physical and breathing exercises may be beneficial to the cardio-vascular system, partly by decreasing sympathetic activity (as shown by the decrease in plasma

catecholamine activity) and perhaps partly by direct effects on endocrine glands and blood chemistry. However, there were no parallel controls in these experiments and the results have to be interpreted with caution. Similar studies without controls were done by S. K. CANGULY et al (Yoga Minamsa 17 89 1974) on 11 male students. They did one hour daily of Asanas, Pranayama, Bandhas, Mudras and Shuddhi Kriyas. The Harvard Step Test was used to assess cardiovascular fitness at the start of the experiment and then after 9 months of exercises. The results showed significantly improved cardio-vascular efficiency.

Pranayama and the Cardio-vascular System

Pranayama stresses breathing against increased resistance, prolonged expiration and retention of breath in inspiration. The stress is on diaphragmatic rather than thoracic breathing. The increased resistiance is imposed at the nose (by closing one nostril with the fingers) or at the larynx (by partly closing the glottis). V. A. NEGUS (Thorax 25 1970) showed that increased resistance in the nose affected both intra-tracheal and intra-thoracic pressures and produced dilatation of pulmonary capillaries and increased blood-flow into the lungs with related changes in cardiac function.

Dr. BHOLE and the Lonavla team of workers postulote that the slower (5 seconds) inspiration against resistance and the resulting increased negative intra-thoracic pressure cause an increase in cardiac and pulmonary filling with blood, thereby reducing the ventilation/perfusion ratio, which then normalises towards the end of inspiration where, in the breath-holding phase (lasting 20 seconds) the positive intra-thoracic pressure probably reduces lung perfusion. The subsequent expiration against pressure is prolonged (for usually 10 seconds) and the increased positive intra-thoracic pressure then boosts cardiac emptying. Thus the breathing ratio inspiration: retention: expiration = 5: 20: 10 seconds, against resistance applied at nasal and/or glottis level probably produces a slow pumping effect to boost the actions of the heart every 35 seconds.

A more powerful effect was shown by Swami KUVALYANANDA (Yoga Mimamsa 4 306 1933). After about 6 to 7 cycles (out of the prescribed 10 cycles) of breathing as described above, the alveolar carbon-dioxide level rises to about 6 to 7% and this results in vasodilatation in the brain, skin and muscles; vaso-constriction in the splanchnic and fingertip blood-vessels; stimulation of the sweat and serous glands; sedation of the cerebral cortex, but stimulation of the lower brain including the reticular activating system. In retention in inspiration the Chin Lock is recommended and this is considered further to stimulate the carotid sinus causing a slowing of the heart-rate.

These are the main effects of Yogic practices on the cardio-vascular system. A few warnings may be given at this stage. With Vajrasana and other postures which squeeze blood out of the legs into the general circulation, there is an increase in

central blood-pressure which stimulates the baro-receptors and leads to a compensatory vasodilatation in the skin and muscles. If the subject then suddenly comes out of the posture and stands up immediately, blood may pool into the widely-open blood-vessels of the legs under the influence of gravity and lead to fainting. Again, badly performed Bhastrika breathing may result in overbreathing or hyperventilation which, by blowing off carbon-dioxide from the blood, leads to hypocapnia which causes vasoconstriction of the blood vessels of the brain. At this stage, any slight Valsalva effect (such as from coughing or straining) can drop the supply-pressure to the brain blood-vessels and precipitate a faint. Teachers of Yoga normally advise against sudden changes of postures and against hyperventilation; but where students of Yoga try to teach themselves or else acquire inefficient teachers, they run the risk of experiencing several adverse effects; and this unjustifiably tends to create false and unfavourable impressions about this ancient and highly beneficial method of self-discipline.