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Yoga for control of epilepsy

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Yoga is an age-old traditional Indian psycho–philosophical–cultural method of leading one's life, that alleviates stress, induces relaxation and provides multiple health benefits to the person following its system. It is a method of controlling the mind through the union of an individual's dormant energy with the universal energy. Commonly practiced yoga methods are 'Pranayama' (controlled deep breathing), 'Asanas' (physical postures) and 'Dhyana' (meditation) admixed in varying proportions with differing philosophic ideas. A review of yoga in relation to epilepsy encompasses not only seizure control but also many factors dealing with overall quality-of-life issues (QOL). This paper reviews articles related to yoga and epilepsy, seizures, EEG, autonomic changes, neuro-psychology, limbic system, arousal, sleep, brain plasticity, motor performance, brain imaging studies, and rehabilitation.

There is a dearth of randomized, blinded, controlled studies related to yoga and seizure control. A multi-centre, cross-cultural, preferably blinded (difficult for yoga), well-randomized controlled trial, especially using a single yogic technique in a homogeneous population such as Juvenile myoclonic epilepsy is justified to find out how yoga affects seizure control and QOL of the person with epilepsy.

Key words: yoga; relaxation; seizures; quality of life (QOL); randomized controlled trials (RCTs).

INTRODUCTION TO YOGA

Yoga is an age-old traditional Indian psycho–philosophical–cultural method of leading one's life that alleviates stress, induces relaxation and provides multiple health benefits to the person following its system. It is a method of controlling the mind ('yug') through union of the individual dormant energy ('prana' or 'kundalini') with the universal energy the 'Brahman'. In physiological terms, any kind of afferent or efferent neuronal discharge associated with consciousness represents a union, which has an effect on the body or mind. This experience can be modulated depending on one's level of conscious awareness, e.g. when a painful stimulus is received (external energy), the perception of pain (individual energy, dependent on neuronal chemistry and the resultant electrical phenomena in neurons) may vary, depending on one's pain threshold, state of neuronal gating and conscious awareness. Our conscious awareness may vary at different times in identical environments and with identical stimuli giving us varying degrees of experience.

This is so because innumerable numbers of unions ('yogas') are taking place in our body at a given time, so that the most prominent among them is responsible for the experience at that particular time. Conscious realization and modulation of these unions ('yogas') is called self-realization. Various psychological or physical irritants ('kleshas') in the form of inputs from outside or inside the body are responsible for upsetting the balanced state of being, causing disease or suffering. A systematic attempt to reduce their intensity may be made through yoga, so that the harmful effects of the body's response (hormones, endorphins, histamines etc.) to these irritants may be reduced. Various randomized controlled trials (RCTs) have shown beneficial effect of yoga for control of asthma, hypertension, stress and anxiety.

The commonly practiced yogic methods are 'Pranayama' (controlled deep breathing), 'Asanas' (physical postures) and 'Dhyana' (meditation) admixed in varying proportions with differing philosophic ideas. These give the many schools of yoga practice such as Hatha Yoga, Karma yoga, Bhakti yoga

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and Raja Yoga. In yoga, especially in Sahaj yoga, the dormant energy in our body located at certain points of concentration ('chakras') of various body segments is awakened and felt during the yogic act, which has positive effects on physical, mental, emotional and psychological state of the body. Different schools of yoga work towards the final common aim of self-realization and control of mental, physiological, and psychological parameters through yogic experiences related to integrated inputs from the environment. Bhavan Yoga involves modulation of thinking, feeling and reasoning for self-realization.

Patanjala Yoga involves behavioural commitments in life, to reinforce the psyche at emotional (niyama) and intellectual (yama) levels.

Kundalini Yoga deals with control of hidden life energy ('kundalini'), in relation to external stimuli, so as to finally achieve awareness of a particular pattern of its working and to be able to control conscious experience of external inputs.

YOGA AND PHYSIOLOGY

The subject of yoga is difficult to evaluate for physiologists because the evaluation of subjective states of awareness such as self, self-realization, self-awareness, consciousness and self–non-self discrimination do not lend themselves to measurement by physiological techniques that mainly are measures of objective variables.

The interest of the western medical profession in yoga and its therapeutic effects dates back to 1910, when Schultz[1] in Germany investigated Raja yoga and proposed the system of relaxation and meditation called 'Autogenic training', a psychotherapeutic tool for self-help. In the USA during the 1920s, Jacobson[2] studied the physiological effects of relaxation and proposed the term 'Progressive relaxation'. The French physician Brosse, carried out electrocardiographic studies on Yogis in India who claimed to control or stop their heart beats. Das and Gastaut[3] carried out EEG studies on meditation in 1953–54. Benson[4] introduced the term 'relaxation response' for relaxation documented after transcendental meditation. There has since then been a surge in medical studies related to effects of yoga and meditation on health.

Various controlled studies[5–7] have shown objective alterations due to yoga in:

- the musculo-skeletal system—changes in muscular activity, reflex activity, flexibility and pressure changes in body cavities,
- the respiratory system—changes in diaphragmatic breathing, nostril dominance, force of breathing, breath holding time, tidal volume minute ventilation and vital capacity,
- metabolic rates—basal metabolic rate and oxygen consumption,
- the cardiovascular system—regional blood flows, heart rate, blood pressure, sinus bradycardia, nodal rhythms and increased physical work capacity for heart rate,
- enzyme and hormone levels—biochemical changes, e.g. regarding catecholamines, histamine, 17-hydroxy steriods, vanilylmandelic acid, and plasma acetylcholine.

YOGA AND NEUROPHYSIOLOGY

The states of consciousness have traditionally been divided as wake state, sleep state and dream state. Meditation has been considered as the fourth state of consciousness. Etevenon[7] in Paris studied the effects of yoga on sleep, meditation, and degree of consciousness. He also studied the phylogenetic evolution of sleep wake cycles, focusing on phylogenetic and ontogenetic appearances of REM cycles (activated sleep). A correlation was seen on EEG studies during states of concentration, found to be specific brain activity different from deep sleep. The relaxation response is associated with a predominant alpha spectral band in the EEG, high galvanic skin resistance (GSR), reduced muscular tension, reduced pulse rate and rate of breathing[4,8].

Stancak *et al.*[9] studied 11 people (without a control group) and showed an initial increase in alpha, and then theta spectral bands in the occipital region with a relative increase in slower frequencies in the EEGs when they were practicing high-frequency yogic breathing called Kapalabhati. Orme-Johnson *et al.*[10] observed increased alpha in all cortical areas while yogic flying in 23 subjects, compared with random jumps using the same subjects as an intra-group control.

Satyanarayana *et al.*[11] demonstrated increased alpha activity in prefrontal and occipital areas of the brain in eight subjects performing Shantikriya yoga (a combined breathing and relaxation technique): however no randomization or controls were used.

Corby *et al.*[12] studied autonomic and EEG correlates of Tantric yoga meditation in three groups of subjects as they progressed from normal consciousness to meditation. Groups differed in their level of meditation proficiency. Unlike most previously reported meditation studies, the subjects proficient in meditation demonstrated increased autonomic activation and increased alpha and theta power, minimal evidence of EEG defined sleep and decreased autonomic orientation to external stimulation. Subjects inexperienced in

meditation showed autonomic relaxation. This state of sudden autonomic activation was characterized by the meditating subject as an approach to the yogic ecstatic state. Banquet[13] showed better synchronicity between right and left hemisphere during yoga meditation on EEG spectral analysis of middle-aged individuals.

Roldan and Dostalek[14] studied Agnisara which is a Hatha yoga exercise consisting essentially of alternate, forceful retractions and protrusions of the abdominal wall performed along with a 20–30 second period of apnea. In the course of this practice they demonstrated spindle bursts of 'wicket' EEG wave pattern developed over para-Rolandic areas of the cerebral cortex, at frequencies around 12–13 Hz, with waxing and waning amplitudes in the range of 50–100 μV. This 'Xi' rhythm could be considered as the expression of the central excitation, produced by the long-lasting and repeated stimulation of visceral and somatic receptors by the exercise, affecting the cortical areas with somato-visceral representation. They further studied other Hatha yoga[15] exercises such as Nauli, Bhastrika and Suryabhedana and demonstrated three characterstic EEG patterns: A wicket rhythm, 12–17 Hz, in para-Rolandic areas (Xi rhythm), a 26–33 Hz sinusoidal activity confined to the mid-saggital parieto-occipital region and paroxysmal activity localized to the lateral boundaries of parieto-temporo-occipital regions bilaterally. The expectation that the Hatha yogic exercises would affect the electrical activity of circumscribed, relatively well-defined areas of the brain was based on the fact that these exercises imply a strong stimulation of somatic and splanchnic receptors, the afferents of which are fed into specific cortical representation areas localized for the most part around central and anterior parietal areas.

YOGA AND AUTONOMIC SYSTEM CHANGES

There are a large number of studies on subjects performing yoga that demonstrate some alteration in autonomic function. These changes suggest both autonomic activation and inhibition (relaxation) of different subsets of the autonomic nervous system, with inter-individual differences in people practicing the same yoga meditation. Measurements of galvanic skin resistance, heart rate, blood pressure and respiratory rates have shown a great reduction of GSR during anxiety or stress and more than 200 times increase after yoga meditation[16]. A reduced sympathetic response after yoga meditation has been consistently demonstrated, while the parasympathetic response may be unaltered[17] or increased[18,19]. Corby *et al.*[12] demonstrated that there was a gradual autonomic activation in experienced yogis while inexperienced ones had autonomic relaxation. The sudden autonomic activation observed as the subjects neared the yogic ecstatic state had challenged the relaxation theory of meditation, and shows that autonomic function is subject to modulation depending on the training that the person has received.

YOGA AND THE LIMBIC SYSTEM

Woolfolk[20] reviewed scientific research that has investigated the physiological changes associated with meditation as adherents of Indian yoga, transcendental meditation and Zen Buddhism (that have not shown a thoroughly consistent, easily replicable pattern of response) practice it. The majority of studies show meditation to be a wakeful state accompanied by a lowering of cortical and autonomic arousal. Additional research into the mechanisms underlying the phenomena of meditation will require a shifting from old to new methodological perspectives that allow for additional experimental control and testing of theories.

YOGA, BRAIN PLASTICITY AND NEUROPSYCHOLOGY

Various tests[21–23] for plasticity such as visual and auditory reaction times, perceptual motor speed, tests for non-verbal intelligence, errors for static motor performance and balance board tests showed significantly improved results after yoga in controlled studies. Jella *et al.*[24] showed a significant increase in spatial task performance with left uni-nostril breathing and improvement in verbal tasks with right uni-nostril breathing in 51 right-handed undergraduate psychology students. Blumenthal *et al.*[25] showed that on random allocation to aerobic exercises, yoga and waiting-list control groups, elderly men and women showed significantly improved aerobic capacity and reduction in emotional impairment with yoga, with relatively few improvements in cognitive performance associated with aerobic exercise. The mood benefits of Hatha yoga and swimming, two activities that differ greatly in aerobic training benefits were examined and 87 college students were assigned to yoga, swimming or control groups randomly. Consistent mood benefits of significantly greater reduction of scores on anger, confusion, tension and depression were observed in the yoga group as compared with the control or swimming groups.

YOGA AND PSYCHIATRY

That Yoga has beneficial effects on psychiatric symptoms was shown by a within-subjects-pre–post-test

design study[26] of 40 hospitalized children with adjustment disorder and depression. During relaxation training by yoga, a significant reduction of anxiety and anxious behaviour was seen as well as reduction in cortisol levels as compared with the control group, which was shown the relaxation videotape. Shannahoff-Khalsa and Beckett[27] investigated the efficacy of Yogic techniques in the treatment of eight adults with obsessive–compulsive disorder (OCD). After one year of yoga therapy, a significant improvement in the Yale-Brown Obsessive–Compulsive scale comparing baseline with three, six, nine and 12 months results was seen for repeated measures, anxiety, global severity indices and perceived stress scale scores.

Nespor[28] has given a good account of his experience with the application of yoga in the prevention and treatment of alcohol- and drug-related problems, in psychosomatic medicine, sexology, neuroses, old-age psychiatry and prevention of stress with respect to specific indications and contraindications of different yoga exercises.

YOGA AND BRAIN IMAGING

There are few studies that have investigated the effects of yoga on brain imaging. Using positron emission tomography (PET), measurements of regional cerebral metabolic rate of glucose (rCMRGlc) are able to delineate cerebral metabolic responses to external or mental stimulation. In order to examine possible changes of brain metabolism due to Yoga meditation, PET scans were performed in eight members of a Yoga meditation group during a normal control state and yoga meditative state. The rCMRGlc values were slightly increased in frontal and grossly reduced in occipital (primary and secondary visual) areas. Intra-individual variations were significant but an intra-group comparison was not significant[29].

Lou *et al.*[30] designed a study to examine if the neural structures subserving meditation can be reproducibly measured, and if so, whether they are different from those supporting the resting state of normal consciousness. Cerebral blood flow distribution was investigated using PET in nine adults, who were highly experienced yoga teachers, during the relaxation meditation (Yoga Nidra or yogic sleep) and during the resting state of normal consciousness. Spectral EEG analysis was conducted throughout the investigations. In the resting state of normal consciousness, differential activity was found in dorso-lateral and orbital frontal cortex, anterior cingulate gyri, left temporal gyri, left inferior parietal lobule, striatal and thalamic regions, pons, cerebellar vermis and hemispheres, structures thought to support an executive attentional network. In meditation, differential activity was seen in the posterior sensory and associative cortices known to participate in imagery tasks. It was concluded that characteristic patterns of neural activity support the resting and meditative state.

YOGA AND SEIZURE CONTROL

Current anticonvulsant medication does not completely improve the seizure control in one-fifth of people with epilepsy[31].

Many non-pharmacological intervention procedures have been investigated for possible therapeutic benefit, in drug-resistant epilepsy with varying degrees of success. Many alternative procedures such as biofeedback[32], relaxation[33], and various psychological approaches[34] have been tried for this purpose with anxiety alleviating or relaxation inducing factors as the common denominator. Meditation has been shown to produce relaxation and in light of the effectiveness of relaxation in psychosomatic disorders, various workers have tried meditation as an interventionial strategy for drug-resistant epilepsies. Of the few studies on yoga for seizure control two randomized controlled studies were found. The effect of Sahaj yoga meditation on seizure control and EEG alteration was assessed in 32 patients with idiopathic epilepsy[35]. Subjects were randomly divided into three groups. Group I ($n = 10$) practiced Sahaj yoga for 6 months, Group II ($n = 10$) practiced exercises mimicking Sahaj yoga for 6 months and Group III ($n = 12$) served as the control group. Group I subjects reported a 62% decrease in seizure frequency at 3 months and a further decrease of 86% at 6 months of intervention. Power spectral analysis of their EEG showed a shift in frequency from 0–8 Hz towards 8–20 Hz. The ratio of EEG powers in delta (D), theta (T), alpha (A) and beta (B) bands i.e. A/D, $A/D+T$, A/T and $A+B/D+T$ were increased. Percentage D power decreased and percentage A power increased. No significant changes in any of the parameters were found in Groups II and III, indicating that Sahaj yoga practice brings about seizure reduction and EEG changes. The possible mechanism underlying the beneficial effect of Sahaj yoga is not clear.

Meditation may modulate limbic system activity, which via the hypothalamus may modulate sympathetic nervous system activity and regulate endocrine secretions. Conditioning of these regions by practice of meditation may help in maintaining the normal homeostatic conditions. The fundamental effect of stress reduction may be an important factor contributing to seizure reduction and EEG changes.

In the study by Deepak *et al.*[36] 11 adults suffering from drug-resistant epilepsy were given med-

itation practice while another nine adults acted as waiting-list controls. All patients were on antiepileptic drugs and their serum levels were monitored regularly. Patients in the intervention group were given training in meditation, and they practiced it for 20 minutes a day for one year. They showed a significant reduction in seizure frequency and duration, an increase in the background EEG frequency, a reduction in mean spectral intensity of the 0.7–7.7 Hz segment, and an increase in mean spectral intensity in the 8–12 Hz segment of the EEG. All changes were statistically significant. Control patients did not show significant changes in seizure frequency or duration during the period of observation of one year. The results indicate that continued meditation practice is of substantial help in improving the clinico-electrographic picture in drug-resistant epilepsies.

CONCLUSIONS

Behavioural methods are currently being tested for seizure reduction since some people with epilepsy do not achieve seizure control despite regular and adequate medication[37–40]. However, such studies are lacking and the results are conflicting. Often the number of subjects studied are small, the studies anecdotal, not randomized or controlled making their conclusions difficult to accept in the light of scientific practice. Some are single subject studies designed for individual patients which makes the application and interpretation of results to the general population unreliable. There are few studies related to yoga and seizure control and the two randomized, controlled studies discussed have methodological problems (randomization, heterogeneous seizure types) that do not allow the results to be accepted completely. Studies on yoga cannot be blinded (single or double) for obvious reasons and actually need to be double-sighted, so as to ensure the correctness of the yoga by the yoga teacher and for correct relation of the yoga experience by the subject to the evaluators.

A multi-centre, cross-cultural, ‘double-sighted’, well-randomized controlled trial, especially using a population of a homogeneous epilepsy syndrome such as juvenile myoclonic epilepsy, is justified to find out the beneficial effect of a single yoga method protocol on seizure control and quality-of-life issues.

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