Hormonal and biochemical responses to transcendental meditation

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Summary: This study was designed to assess whether transcendental meditation (TM) could influence various endocrine responses in 10 experienced male meditators. Nine matched subjects, uninformed of the TM procedure, acted as controls. Meditators successfully practised their technique for 40 min in the morning while controls relaxed for this period. No significant differences emerged between these 2 groups with respect to carbohydrate metabolism (plasma glucose, insulin and pancreatic glucagon concentrations), pituitary hormones (growth hormone and prolactin) or the 'stress' hormones, cortisol and total catecholamines – although meditators tended to have higher mean catecholamine levels. Plasma free fatty acids were significantly elevated in meditators 40 min after completing the period of TM. No clear evidence was thus obtained that any of the stress, or stress-related, hormones were suppressed during or after meditation in the particular setting examined.

Introduction

The technique of transcendental meditation (TM) is a simple form of relaxation. It involves sitting with the eyes closed and effortlessly repeating a meaningless sound or 'mantra'. Much of the research available has claimed beneficial effects of TM in a variety of physiological and biochemical measurements (Fenwick, 1983). Of particular interest are reports of reduced levels of urinary catecholamine metabolites and plasma cortisol while practising the technique (Bujatti & Riederer, 1976; Jevning *et al.*, 1977), although Michaels *et al.* (1976) found no significant fluctuations in plasma catecholamines during meditation.

In the present investigation we have explored the possible hormonal and biochemical changes during the performance of TM, with special emphasis on the 'stress-related' hormones: catecholamines, cortisol, growth hormone, prolactin, pancreatic glucagon and insulin. These findings were then related to subjective experiences obtained during the meditation period.

Subjects and methods

Ten non-obese men, aged between 20 and 35 y, who were proficient and experienced in the TM technique participated in the study. Nine matched healthy subjects who had never practised TM and who were uninformed of the technique served as controls. None of the meditators nor controls were smokers and the TM group were non-drinkers.

Each individual arrived at the hospital laboratory at 0800 after a 10 h overnight fast. He was placed in the supine position in a quiet room. A venous cannula was inserted near the antecubital fossa and kept patent with slow-running saline. After 30 min, the subject sat up with his eyes open and remained quiet for 20 min during which time 2 blood samples were collected – at the beginning and end of this pre-TM period, or pre-relaxation period in the controls. Subjects then closed their eyes and the meditators began practising the TM technique, while the controls relaxed. Blood samples were withdrawn after 20 and 40 min during this 40 min TM or relaxation phase. Meditators and non-meditators then opened their eyes and remained quiet for a further 40 min, during which time additional blood samples were taken at 20 and 40 min. Great care was taken to ensure that blood samples were collected in as unobtrusive a manner as possible. The pulse and respiratory rates were recorded at the end of each phase of the study.

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Table I Pulse and respiratory rates in 10 meditators and 9 non-meditators before, during and after transcendental meditation or relaxation

	Meditators			Non-Meditators		
	Pre	During	Post	Pre	During	Post
Pulse rate	58 ± 2	59 ± 2	56 ± 3*	67 ± 4	65 ± 5	67 ± 4
Respiratory rate	12 ± 1	12 ± 1	11 ± 1**	14 ± 1	15 ± 2	16 ± 2

* $P < 0.05$ compared with non-meditators** $P < 0.025$ compared with non-meditators

Blood samples were collected into iced tubes, immediately centrifuged and the supernatant plasma deep-frozen until analysis some weeks later. Plasma glucose was estimated using a hexokinase method and free fatty acids by microtitration (Dole, 1956). Plasma total catecholamines (adrenaline and noradrenaline) were determined by a radioenzymatic technique (Pason & Peuler, 1973). The remaining hormones were measured by radioimmunoassay procedures. These included insulin (Welborn & Fraser, 1965), pancreatic glucagon, human growth hormone and prolactin (all with commercial kits supplied by Serona Diagnostics, Switzerland); and cortisol, assayed using reagents provided by Amersham International, UK. All hormonal measurements were performed in duplicate in single assay runs.

Subjective experiences were individually recorded after completion of the procedure, according to a standard questionnaire.

Paired and unpaired t-tests, as applicable, were used for the statistical analysis of data. Results are expressed as means ± s.e.m. in the Table and all the Figures.

Results

Pulse and respiratory rate (Table I)

The mean pre-meditation/relaxation pulse rate was slightly less in the meditators compared with the controls and it remained slower during the subsequent periods of observation, achieving statistical significance.

Figure 1 Plasma levels of pancreatic hormones and substrates in 10 meditators (○) and 9 non-meditators (●) before, during and after transcendental meditation or relaxation; (■) normal basal range. Vertical bars indicate standard errors of the mean.

* $P < 0.01$

nificance by the end of the post-meditation period. A similar trend emerged when the mean respiratory rates were analysed.

Effect on carbohydrate and lipid metabolism (Figure 1)

Mean plasma glucose concentrations remained fairly constant in both meditators and non-meditators, with no significant difference between the 2 groups at any sampling time. Mean plasma free fatty acids, on the other hand, tended to be higher in the meditating group at all times and this difference reached statistical significance at the end of the post-meditation period ($P < 0.01$ compared to the mean control value at that time).

The concentrations of plasma insulin and pancreatic glucagon were similar in both groups throughout the period of observation, mean glucagon levels

Figure 2 Plasma levels of growth hormone and prolactin in 10 meditators (○) and 9 non-meditators (●) before, during and after transcendental meditation or relaxation; (■) normal basal range. Vertical bars indicate standard errors of the mean.

Figure 3 Plasma levels of total catecholamines and cortisol in 10 meditators (○) and 9 non-meditators (●) before, during and after transcendental meditation or relaxation; (■) normal basal range. Vertical bars indicate standard errors of the mean.

lying slightly above the upper limit of the normal basal range.

Effect on pituitary hormones (Figure 2)

Growth hormone concentrations fell slightly in both groups during the post-meditation/relaxation period, the trend being more apparent in meditators. However, no significant differences were found at any sampling time either within or between groups. Mean prolactin levels remained unchanged in both groups of subjects.

Effect on 'stress' hormones (Figure 3)

Plasma catecholamines were measured at only one time during each phase of the study. Their mean concentration was consistently higher in the meditators, but individual results varied widely and statistical significance was not achieved. Mean plasma

cortisol levels showed no consistent pattern in either group and were not significantly different.

Subjective responses

All the meditators claimed to have 'transcended' during their period of meditation, and attained the desired sense of mental and physical well-being. They were unaware of their surroundings or any disturbances, such as blood sampling, during meditation. Conversely the non-meditators did not experience any subjective changes during the three stages of the experiment. Some were bored and impatient and kept opening their eyes during the 40 min relaxation period.

Discussion

Our study was designed to test whether TM could acutely modify a variety of hormonal and related biochemical responses, as some previous reports have suggested might occur (Bujatti & Riederer, 1976; Jevning *et al.*, 1977). We found no convincing evidence that any of the stress-related hormones were suppressed in subjects performing the technique at rest. If anything, catecholamine levels were higher in meditators during the study. Furthermore, plasma free fatty acid concentrations, reflecting in part the lipolytic action of catecholamines and other stress hormones (Goodman, 1970), showed a substantial elevation after the period of meditation was completed. This suggests that the state of apparent external relaxation achieved during TM may be accompanied by considerable 'internal' metabolic stimulation or activity.

Could other factors, apart from the TM itself, have influenced the biochemical responses that were

observed? It is conceivable that the unfamiliar laboratory environment and experimental procedures induced a degree of apprehension in the meditators, with resultant stimulation of the hypothalamo-pituitary-adrenal axis. Against this criticism are the subjective reports of the meditators claiming successful transcendental meditation and the objective evidence provided by their slower pulse and respiratory rates. Recording the electroencephalogram (EEG) tracing during meditation might have yielded additional support for this contention, since specific EEG patterns have been described (Wallace, 1970).

Our findings may have clinical relevance. TM has been reported to have therapeutic value in a variety of situations such as relieving psychogenic stress (Throll, 1981), treating insomnia (Woolfolk *et al.*, 1976) and managing patients with systemic hypertension (Blackwell *et al.*, 1976). Whatever benefit may occur in these situations does not appear to be associated with favourable biochemical or hormonal modifications. However, it may be that a reduction in the levels of stress-related hormones might only become apparent when they are already substantially elevated due to environmental stimuli. Moreover, we were unable to measure any of the recently isolated neuro-peptides (such as endorphins) where changes might be anticipated. Nor are we aware of any studies concerning the effect of TM on these peptides.

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