Stress reduction and blood pressure control in hypertension: a role for transcendental meditation?

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It is generally believed that the achievement of a state of psychological relaxation may induce a blood pressure reduction in subjects with high blood pressure. Indeed, stress reduction has often been regarded as an important component of the lifestyle changes that might be beneficial in reducing an elevated blood pressure in hypertensive patients [1].

Lifestyle changes have been confirmed as an important step in the approach to antihypertensive treatment both by the 2003 ESH–ESC guidelines and the the American JNC-VII guidelines [2,3], with the former emphasizing that 'Lifestyle measures should be instituted whenever appropriate in all patients, including subjects with high normal blood pressure and patients who require drug treatment' [2]. However, neither of these guidelines mention stress reduction as a recommended intervention, but include among the lifestyle measures that are widely agreed to lower blood pressure or cardiovascular risk, smoking cessation, weight reduction, reduction of excessive alcohol intake, physical exercise and dietary interventions [2–4]. The limited evidence for any clinically significant results being obtained by stress management interventions, as well as the difficulty of identifying stress management approaches that might be easily implemented on a large scale in the daily life of hypertensive patients, outside of a psychophysiology laboratory or clinic, are probably among the reasons for excluding stress reduction as one of the recommended approaches in the non-pharmacological treatment of hypertension in these recent guidelines.

In this issue of the *Journal of Hypertension*, Canter and Ernst [5] address the possible role of one of the available approaches for stress reduction, namely transcendental meditation (TM), in lowering blood pressure [5]. To this aim, the authors carried out a systematic review of the randomized clinical trials that have investigated the blood pressure effects of TM. However, their conclusions do not appear to provide a final answer as to whether TM can be regarded as an effective non-pharmacological approach for blood pressure reduction in hypertension. In their review, Canter and Ernst [5] emphasize that all randomized clinical trials investigating the blood pressure-lowering effects of TM published to date have important methodological weaknesses, and are potentially biased by the affiliation of their authors to the TM organization. Thus, it appears that there is no sufficient good quality evidence to firmly establish whether or not TM has a cumulative positive effect on blood pressure [5].

Nothwithstanding the inability to reach a clear conclusion on such an issue, the review by Canter and Ernst [5] represents an interesting source of information for stimulating a deeper assessment of the role of stress reduction in lowering an elevated blood pressure, and of the possible mechanisms that might be involved in this effect. The authors also emphasize the importance of some methodological aspects that should never be overlooked by investigators aiming to explore this difficult field. The first is the need to have this issue assessed by truly independent investigators, who should not have any affiliation to the organizations or Societies proposing and teaching different forms of TM, or similar techniques. The second is the crucial need to select objective and reproducible methods for blood pressure measurement when addressing the blood pressure effects of TM, which is a field where a high degree of intra-individual and inter-individual variations in the blood pressure response are to be expected. In this context, there is no doubt that ambulatory blood pressure monitoring and/or repeated blood pressure measurements, obtained by automated blood pressure measuring devices linked to a printer or provided with a facility for data storage, should be considered, because of the demonstrated reproducibility, reliability and clinical value of the blood pressure information that these blood pressure monitoring approaches can provide [6–9].

In general, the review by Canter and Ernst [5] emphasizes important methodological limitations that have plagued the investigation of psychological methods for blood pressure control.

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Methods for psychological control of blood pressure

The notion that people can control their blood pressure voluntarily emerged in the 1960s, with great hope for techniques such as biofeedback, autogenic training, meditation and relaxation training. It was anticipated that self-control methods could reduce the need for hypertensive medication, or even help patients avoid medication altogether. However, despite early promising results [1], these expectations have not materialized. There is substantial evidence that modifications of lifestyle are certainly relevant to the prevention and management of hypertension. However, as previously mentioned, the more efficacious methods involve increasing physical activity, changing dietary intake, reducing body weight and alcohol consumption, and improving adherence to hypertensive medication [2–4]. In comparison, direct psychological control of blood pressure has not established itself in the clinical field.

Nonetheless, there is continued interest in the effects of psychological methods of reducing blood pressure and controlling hypertension. TM is one such method that has gained some popularity because of its promotion by a number of religious institutions, or by institutions of the TM organization [5,10]. There are many forms of meditation, some of which involve postural changes, bodily movements, changes in respiration patterns and muscle relaxation. TM is more cognitive in orientation, with passive mental focusing in conjunction with slow breathing. However, as noted by Canter and Ernst [5], previous reviews highlighting the specific benefits of TM in blood pressure control have been conducted by firm believers in the technique, typically researchers affiliated with TM organizations. Broader reviews and meta-analyses have not shown TM to produce greater effects on blood pressure compared to relaxation training, biofeedback, or stress management [11]. It is striking as to how few methodologically adequate studies have been published regarding TM compared to the many non-randomized or uncontrolled reports. Only one study involved patients with hypertension, as opposed to people with high–normal or normal blood pressure. A follow-up beyond the initial treatment period has been described only in a single investigation [12].

Other methodological limitations include small sample sizes, inadequate characterization of study participants and a lack of appropriate controls [13]. Intention-to-treat analyses have seldom been used in this literature, and because drop-out rates are marked, this presents a significant limitation to the inferences that can be drawn. There have also been problems in establishing accurate baseline levels of blood pressure against which the effects of treatment can be evaluated. Eisenberg *et al.* [11] noted that the blood pressure reductions with self-control treatments were higher in studies involving only a single baseline session of blood pressure measurement compared to those using more elaborate protocols. Johnston *et al.* [14] required that mildly hypertensive patients monitor their own blood pressure twice a day for 12 weeks before stress management. Substantial blood pressure reductions were recorded in both treatment and control groups over this period, with no further decreases in response to the stress management itself. Treatment effects have been largest in those studies of psychological interventions in which initial blood pressure was the highest, further supporting the likelihood of regression to the mean [11]. Limited information is also available on the ability of stress management interventions to modify average 24-h ambulatory blood pressure and blood pressure variability patterns, including the degree of nocturnal blood pressure fall and the rate of blood pressure rise in the morning, which are all parameters that have been demonstrated to carry prognostically relevant information [6–9]. Exploring this issue appears to be of particular interest in relation to the cardiovascular effects of stress in daily life. In fact, not only extremely stressful but rare natural disasters such as an earthquake [15], but also stress associated with usual daily life events [16] has important effects on blood pressure variability patterns over 24 h. The importance of exploring the blood pressure effects of stress and its reduction by specific interventions through ambulatory blood pressure monitoring is further supported by the evidence that different laboratory stressors and different stress management interventions have different blood pressure effects not only between, but also within subjects over time [17,18]. Furthermore, stress-induced changes in ambulatory blood pressure variability have only a limited relationship with the blood pressure effects of laboratory stressors [19].

Considering other more general aspects of studies on the blood pressure effects of stress reduction, it is not known how representative are those individuals who participate in studies using psychological techniques for blood pressure control. Patients who agree to take part in research on non-pharmacological therapy may not be representative of hypertensives in general, but may have a particular interest in 'alternative' approaches. Few studies provide information about how many individuals were initially approached about participating and agreed to be screened or referred to the study. Greater methodological rigour is essential if research into non-pharmacological methods such as TM is to bear fruit.

Mechanisms involved in blood pressure reduction by transcendental meditation

The observation that TM elicits blood pressure reduction of a similar magnitude to that produced by relaxa-

tion training or stress management suggests that common mechanisms may be operative. Amongst these, a reduction in sympathetic activity has been advocated to play a role, and the association of TM with slow and deep breathing appears to be of particular relevance in this context [20]. Slow breathing associated with a mantra (i.e. the rhythmic recitation characteristic of TM) is accompanied by low frequency oscillations in blood pressure and heart rate synchronized at the low respiratory frequency (approximately 0.1 Hz), and has been shown to induce a reduction in chemoreflex sensitivity and an increase in arterial baroreflex sensitivity, coupled with an increased parasympathetic and a decreased sympathetic cardiovascular modulation [21].

Indeed, slow breathing, whether induced by recitation of a mantra, recitation of the Catholic Rosary or paced breathing through a beep or device-generated *ad hoc* music [22,23], induces important changes in blood pressure levels, and affects the activity of cardiovascular control mechanisms [24]. Concerning the factors involved in determining the blood pressure effects of respiration, cyclic changes in ventilation due to phasic breathing have mechanical effects through changes in intrathoracic pressure, and thus in venous return and in the afterload to the left ventricle, leading to regular rises and falls in blood pressure through changes in stroke volume. Changes in the transmural pressure of intrathoracic blood vessels and cardiac chambers lead to a change in discharge frequency of intrathoracic vascular receptors, which in turn leads to reflex changes in sympathetic activity and total peripheral resistance. Blood gas changes have both a direct action on peripheral vascular resistance and a reflex effect on the heart and peripheral circulation through changes in peripheral arterial chemoreceptor activity. Finally, neural mechanisms affecting the heart and peripheral vessels include influences stemming from central respiratory centres and reflex influences originating from cardiopulmonary stretch receptors and arterial baroreceptors. It should be emphasized that respiratory-induced reflex modulation of sympathetic activity and peripheral resistance is importantly affected by breathing rate [25]. Reducing breathing rate from 15 to 10 or even 6 b.p.m implies an increase in tidal volume, leading to a greater cardiopulmonary stretch-receptor stimulation, which in turn determines a reduction in sympathetic efferent discharge and vasodilation. Moreover, arterial baroreflex sensitivity at breathing rates of 3–12 b.p.m. is enhanced during expiration compared to inspiration, which may contribute to explain why slow breathing with prolonged expiration may sensitize the arterial baroreflex [24,26]. Of special interest is slow-breathing at a rate around 6 b.p.m., which is in phase with spontaneous fluctuations in sympathetic neural traffic, peripheral vascular tone (occurring at a frequency of approximately 0.1 Hz) and the resulting arteriolar diameter changes (i.e. vasomotion). These fluctuations may play an important role in controlling peripheral vascular resistance. Breathing at 0.1 Hz (i.e. once every 10 s) might thus enhance and further synchronize the well-known spontaneous blood pressure oscillations at this frequency, known as 'Mayer waves'. Because of all these effects breathing at a lower frequency may prove useful as a non-pharmacological approach to blood pressure reduction in hypertension (i.e. in a condition characterized by an increase in peripheral resistance, by an impaired baroreceptor–heart rate reflex sensitivity and by an increased chemoreflex sensitivity), as suggested by recent studies [27].

How much these cardiovascular effects of slow breathing directly contribute to the suggested blood pressure effects of interventions aimed at stress reduction, such as TM, needs to be assessed further by longitudinal controlled trials, which should be carried out taking into account the methodological requirements emphasized by Canter and Ernst [5].

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