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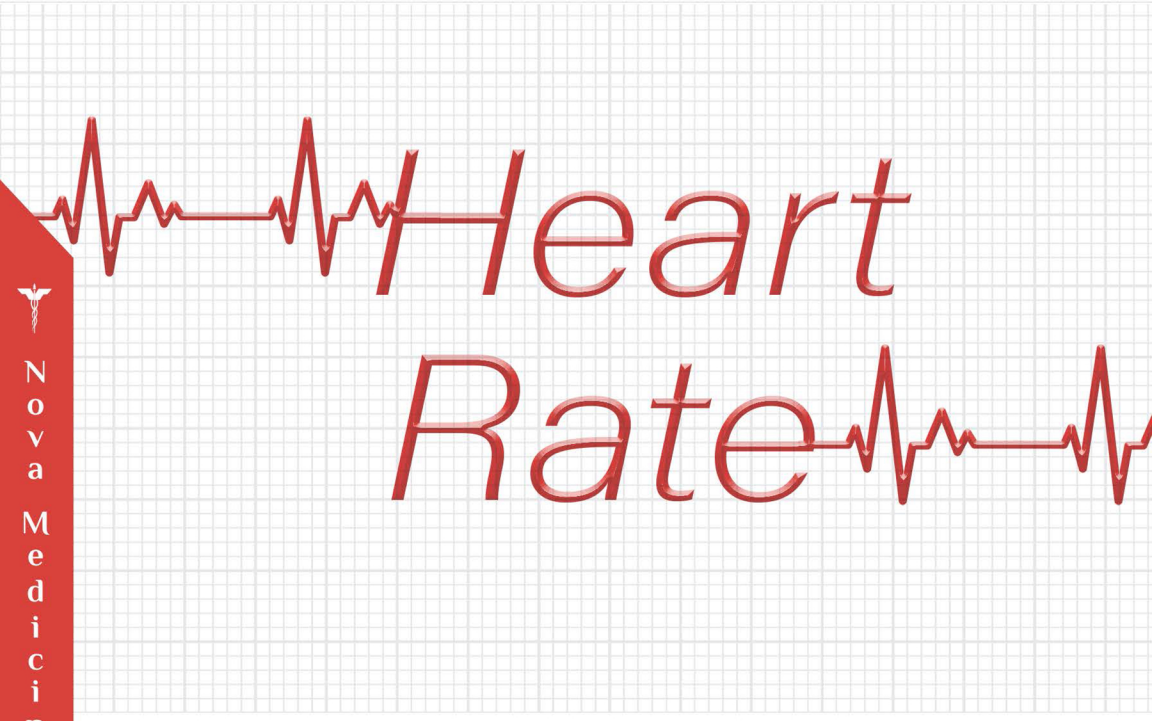
A Closer Look at Heart Rate



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A CLOSER LOOK AT HEART RATE

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A CLOSER LOOK AT HEART RATE

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EDITOR

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Medicine & Health
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Library of Congress Cataloging-in-Publication Data

Names: Alves Pereira, André, editor.
Title: A closer look at heart rate / [edited by] André Alves Pereira.
Description: Hauppauge : Nova Science Publishers, [2020] | Series: Cardiology research and clinical developments | Includes bibliographical references and index. |
Identifiers: LCCN 2019058245 (print) | LCCN 2019058246 (ebook) | ISBN 9781536169799 (paperback) | ISBN 9781536170344 (adobe pdf)
Subjects: LCSH: Heart beat. | Heart beat--Measurement. | Heart beat--Physiological aspects. | Electrocardiography.
Classification: LCC QP113 .C57 2020 (print) | LCC QP113 (ebook) | DDC 612.1/7--dc23
LC record available at https://lccn.loc.gov/2019058245
LC ebook record available at https://lccn.loc.gov/2019058246

Published by Nova Science Publishers, Inc. † New York

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In: A Closer Look at Heart Rate
Editor: André Alves Pereira
ISBN: 978-1-53616-979-9
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Chapter 4

MEDITATION: A SIMPLE INEXPENSIVE TECHNIQUE FOR VOLUNTARY CONTROL OF HEART RATE

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ABSTRACT

High resting heart rate (HR) is an independent cardiovascular risk factor and predictor of all-cause mortality in individuals with or without cardiovascular disease. Studies have demonstrated that drugs that increase the heart rate worsen the prognosis, while those that reduce the heart rate such as beta-blockers have a beneficial effect after acute

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myocardial infarction and in chronic cardiac failure. Available data suggest that a strategy which reduces the heart rate and improves heart-rate variability prevents cardiovascular morbidity, increase longevity and also has a favorable effect on the prognosis of cardiovascular disease. Meditation is a practice where an individual focuses their mind on a particular object, thought or activity for self-realization and inner awareness. Meditative practices are aimed at training the mind for an achievement of a state of increased consciousness. It allows the mind to calm down and relax mentally, increases attention and concentration, reduces stress and anxiety, and enhances inner peace and happiness. In this chapter, the role of meditation in cardiovascular risk reduction through beneficial modulation in heart rate and heart-rate variability will be reviewed and discussed.

Keywords: meditation, heart rate, heart-rate variability, cardiovascular risk

1. INTRODUCTION

High resting heart rate (HR) is an independent cardiovascular risk factor and predictor of all-cause mortality in individuals with or without cardiovascular disease [1-3]. Heart rate is closely related to body temperature, oxygen consumption and metabolic demand, thus it is associated with metabolic disturbances that lead to cardiovascular morbidity and mortality [4]. Increase in heart rate increases myocardial oxygen demand and its workload. Studies have demonstrated that an increase in heart rate of 10 beats per minute increases the risk of cardiac death by about 20% [5]. The lower the oxygen consumption and energy utilized, the longer the lifespan. This shows that there is an inverse relationship between the heart rate and longevity [6, 7]. High heart rate has a detrimental effect on the artery by increasing the arterial wall stress leading to atherosclerosis [8, 9]. Reduction in heart-rate variability (HRV) due to loss of control of heart rate and rhythm by the central autonomic nervous system is a strong predictor of cardiovascular morbidity and mortality [10-12].

Clinical studies have demonstrated that drugs that increase the heart rate worsen the prognosis, while those that reduce the heart rate such as

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beta-blockers have beneficial effect after acute myocardial infarction and in chronic cardiac failure. Studies have demonstrated that drugs that increase the heart rate worsen the prognosis, while those that reduce the heart rate such as beta-blockers have a beneficial effect after acute myocardial infarction and in chronic cardiac failure [13]. Available data suggest that a strategy which reduces the heart rate and improves heart-rate variability prevents cardiovascular morbidity, increase longevity and also has a favorable effect on the prognosis of cardiovascular disease [6, 14, 15]. Growing evidences suggest that heart rate and rhythm can be controlled voluntarily by the simple, inexpensive holistic traditional method of "meditation" [16]. Meditation relaxes mind, reduces stress, improves concentration and achieve a state of increased consciousness. It reduces the metabolic demand and heart rate. Studies have reported the beneficial effect of several forms of meditation on cardiovascular health [16-19]. In this chapter, the role of meditation in cardiovascular risk reduction through beneficial modulation in heart rate and heart rate variability will be reviewed and discussed.

2. MEDITATION

Meditation is a practice where an individual focuses their mind on a particular object, thought or activity for self-realization and inner awareness. It is practiced to (a) increase attention and concentration, (b) calm-down mind and relax mentally (c) reduce stress and anxiety (d) increase consciousness and (e) find inner peace and happiness [16]. Since antiquity, meditation has been practiced in many religious traditions as a path for enlightenment. Its origin is thought to be from Hinduism and Buddhism and the history of the practice of meditation dates as far back as 5000 BC. The references of meditative process can also be found in Christianity, Judaism, and Islam. The meaning of meditation is "to think, to contemplate, to ponder." The word 'Dhyana' derived from a Sanskrit root 'dhyai' in Hinduism means contemplation and meditation. An uninterrupted flow of the mind towards the chosen particular object of

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concentration is Dhyana or meditation. Dhyana is the penultimate step of eight limb yoga (Ashtanga yoga) prescribed to reach an ultimate stage of emancipation [20].

2.1. Types of Meditation

Several styles of meditation are in practice such as, to name a few are yoga meditation, OM meditation, Transcendental meditation, Cyclic-meditation, Vipassana meditation, Zen meditation, Mindfulness meditation, Loving kindness meditation (Metta meditation), Taoists meditation. Even within the same tradition, there are variations in the method of practice of meditation. It has been observed that schools and individual teachers belonging to the same faith, teach distinct types of meditation with permutation and combination of traditional methods (which are modified based on their observations and experience) [21]. The focus of object in meditation includes awareness on breath, awareness of internal sensations, attention on chanting powerful words and sounds, and fixing the gaze (with open eyes) on the object of meditation or dhyana. In this chapter, we enumerate those meditations which are widely practiced and researched to understand its health benefits, particularly on heart.

2.2. Classification of Meditation

I. Based on the origin of meditative practices, they can be broadly classified in to two groups.
   i) Hindu meditation: origin is from ancient Vedic tradition of India.
      a) Yoga meditations
      b) OM meditation
      c) Cyclic meditation
      d) Transcendental meditation.

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ii) Buddhist meditation: origin is from Buddhist teachings
   a) Vipassana meditation
   b) Samatha meditation
   c) Zen meditation (Zazen)
   d) Mindful meditation
   e) Metta meditation or loving kindness meditation

II. Based on traditional texts and modern neuroscientific conceptions, some meditative practices are broadly classified into two groups [22]:
   (1) Focused attention: include meditative practices that entail voluntary focusing of attention on a chosen object, breathing, image, words (mantra) or phrases. Yoga meditation, OM meditation, Cyclic meditation, chanting (mantra) meditation, transcendental meditation, loving kindness meditation etc.
   (2) Open monitoring meditation: include meditative practices that involve non-reactive monitoring of the content of experience from moment to moment. Instead of focusing on one object like in focused attention, here an individual strives to be in the present moment with open monitoring on all aspects of our experience, this may be an internal (thoughts, feelings, memory) or external (smell, sound etc) without becoming engrossed in or distracted by them. Vipassana meditation, mindful meditations are the examples of open monitoring meditation.

3. Influence of Meditation on Heart Rate

3.1. Yoga Meditation

Yoga is an ancient Indian science comprising psycho-somatic-spiritual discipline that helps to achieve a harmony between mind, body and soul [23]. Yoga is derived from a Sanskrit word ‘Yuj’ that means joining. It is

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joining of the individual self with the universal self. Yoga is a conscious process of gaining mastery over mind. Yogasanas or asanas (physical stretching exercise with controlled breathing), pranayama (breathing techniques), and concentration and dhyana (meditation) are the major parts of yoga practices. Yogasanas mainly aim at the achievement of positive, flexible bodily health, while meditation aims at influencing the mind and consciousness. In fact, yogasanas and pranayama also indirectly aim at influencing the mind. It is essential to first purify, vitalize and relax the joints and muscles of the body before undertaking meditation [24]. If the body is completely relaxed, and breathing becomes slow and stable then only one can focus on one point and meditate. Control of diet is a primary concern in yoga practices, so yoga meditators should adopt Sattvik (a pure vegetarian food, seasonal fruits) diet. Therefore, in yoga, asanas, kriyas (cleansing techniques), and pranayama are practiced in sequence before starting meditative practice. So, meditation is the penultimate step (eight steps of Ashtanga yoga) of yoga prescribed to reach an ultimate stage of emancipation. There are several forms of yoga based meditative practices: focusing on the breath or glabella (middle of the eyebrow) or on a particular object, chanting syllable 'OM' or mantra, silently chanting mantra in mind, guided cyclic combination of 'awakening' and 'calming practices' (Cyclic meditation). Few forms of yoga based meditative practices such as OM meditation and cyclic meditation are widely practiced individually and researched. These practices are discussed separately below.

It is believed that involuntary functions of the body (visceral and glandular functions) can be brought under voluntary control by yoga practice or meditation. So, yoga is a conscious process of gaining a voluntary control over involuntary functions through influencing the mind. Yogi, a master in yoga practice can control or reduce heart rate voluntarily. They even claim to stop the heart at will. Few classical experiments were conducted by scientists from India and other countries to investigate the yogic control on visceral functions, in particular on heart activities [25-29].

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Among these, two studies have observed that yoga masters can reduce the heart rate at will [25, 26]. Anand BK et al., studied the ability of the yogi (subject who is master in yoga) to control the heart rate at will in an air-tight sealed box for 8-10 hours, where they found that the subject can reduce the heart rate voluntarily from 85 beats per minute (bpm) at baseline to about 60 bpm. They also observed a reduction in the average utilization of oxygen from 19.5 liters/hour at baseline to 13.3 liters/hour during the period of study, without any increase in respiratory rate [26]. Another study published in the American Heart Journal, investigated a Yoga Master (Yogi) who claim to control the heart voluntarily. In this study, the subject (Yogi) was examined continuously, when he remained confined in a small underground pit for eight days in a state of deep meditation (called as 'Samadhi' in yoga) in sitting posture with little garments and a bottle of 5 liters of water (may not be for drinking but to keep the air fully humid inside the pit). An ECG was continuously monitored during the entire 8 days.

Heart rate was normal at baseline (before entering into the underground pit) which suddenly started rising progressively soon after closing the pit which reached to 250 bpm on the second day. This was followed by sudden straight line in the ECG tracing indicating that the subject has completely stopped his heart or decreased the electrical activity below a recordable level, which persisted till eighth day morning. Then to a surprise of researchers electrical activity returned (heart started beating) half an hour before the scheduled opening of the pit on eight day (as per instructions of the subject), exactly in the same way as claimed by the subject/Yogi that he will begin to come out from the deep trance or suspended animation meditation (Samadhi) after about seven days. The subject was on total starvation, sensory deprivation and present in a dark and closed humid atmosphere for 8 days, during which he lost about 4.5 Kg of weight.

Although the researchers could not explain the precise mechanism, but they speculated that the subject may be was in a hypometabolic wakeful state of meditation [30]. Other studies have also shown that yoga meditation can reduce heart rate by about 10 beats per minute in healthy

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and patients with asthma [31-33]. Yoga training for three months reduced the heart rate significantly in elderly individuals with hypertension [34]. A significant beneficial modulation in autonomic function through a reduction in sympathetic activity and shift in sympathovagal balance towards normal parasympathetic dominance was reported in healthy athletes [35] and elderly individuals with hypertension [36].

3.2. Cyclic Meditation (CM)

This is a guided meditation technique. Cyclic meditation is designed for those who either would be restless and cannot concentrate or fall asleep during an attempt to practice meditation. This technique is derived from an ancient Indian text (Manudkya Upanishad), stating that 'awaken the mind during a state of mental inactivity, calm it when it is agitated and once the mind reaches the perfect equilibrium then do not disturb it again.' Hence, CM includes a cyclic combination of 'awakening' by yogasanasa (stretching exercises with awareness and controlled breathing) and 'calming practices' (awareness on breath, body and chanting words or sounds). The duration of each of session of cyclic meditation is 23 minutes [37].

Activities during the day are known to influence the sleep on the following night. A practice of cyclic meditation two times a day showed a decrease in heart rate, improvement in heart rate variability (HRV) with reduced sympathetic tone and enhanced parasympathetic activity during sleep on the following night in young healthy adults [38]. A decrease in heart rate, an improvement in HRV and shift of sympatho-vagal balance towards a normal parasympathetic dominance after a practice of CM has been reported in healthy individuals [39-41].

Few studies have shown a decreased consumption of oxygen during CM when compared to supine rest for the same duration [42-44]. In comparison to supine rest, energy expenditure was lesser during the practice of CM [39].

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3.3. Transcendental Meditation (TM)

It is a form of silent mantra meditation developed by Maharishi Mahesh Yogi, an Indian scholar of Vedic tradition. This practice involves the use a specific mantra for different individuals. It is practiced with closed eyes for 20 minutes twice in a day. It is an effortless procedure without involving concentration, contemplation and mind control. This practice allows the mind to settle down to a state of calmness during which the person is aware of his or her consciousness. This state of consciousness is called transcendental consciousness, which is different from usual waking, dreaming and sleep state [45, 46].

Transcendental meditation is the most extensively studied style of meditation. Several studies have demonstrated that TM practice can reduce heart rate in healthy [47-49] and in adolescents with high normal blood pressure (at risk for hypertension development) [51]. However, there are few studies that did not find any influence of TM on heart rate [52, 53]. Many studies have also shown a beneficial influence of TM on cardiovascular haemodynamics. A reduction of systolic blood pressure by about 4 mmHg and diastolic blood pressure by about 3 mmHg has been reported by the practice of TM [54, 55]. There are slight discrepancies among the studies, regarding the effect of TM on heart rate and blood pressure. Few studies have reported a beneficial influence on HR but not on the BP [47] while others found a reduction in BP with no change in the heart rate [53]. Transcendental meditation was shown to have a better beneficial impact upon cardiovascular functioning than other relaxation techniques [51, 53]. It can also reduce the total peripheral resistance, which is responsible for the development of hypertension [51].

3.4. OM Meditation

‘OM’ or ‘AUM’ is the sacred syllable in Indian culture. OM is one of the most spiritual syllable or sound in Hinduism. This syllable is either chanted independently or before a mantra during meditative practices. It

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may be chanted loudly or silently in mind. It is usually practiced in a comfortable sitting posture with closed eyes and there is no fixed duration of practice. Vibrations created by 'OM' or 'AUM' chanting have a smoothening effect on the whole body and mind. Mental repetition of 'OM' results in mental alertness with physiological rest and increased sensitivity to sensory transmission [56, 57]. Studies have shown a significant reduction in HR by the practice of OM meditation in healthy individuals. These studies have also reported a beneficial modulation in autonomic regulation by OM meditation [58-60]. One study has demonstrated a decreased consumption of oxygen during OM meditation [58].

3.5. Buddhist Meditation

Samatha meditation, Vipassana meditation, Mindfulness meditation, Metta (loving kindness) meditation, Zen meditation are the meditative practices originated from Buddhist teachings. Samatha means "calm" and samatha meditation is often referred to as 'calm meditation.' It is a method of calming the mind by focusing on a single object, breath or image [16]. Vipassana is also known as 'insight meditation' which means 'to see into the true nature of reality' or 'to see things as they really are.' It is a method of training the mind through focused attention on emotions, internal bodily sensations and thoughts without mental reactivity to the experience. It is a technique for self transformation through self observation. The ultimate aim of this technique is an achievement of emotional stability and happiness [61]. Mindfulness meditation is mainly based on Vipassana meditation. It is a method of training the mind by observing and accepting all that arises without judgment. 'Metta' means kindness and benevolence. In Metta meditation or Loving kindness meditation, the meditator sits in a comfortable position with closed eyes and generates a feeling of kindness and benevolence in his mind. First generate loving kindness to oneself and then progressively to a good friend, to a neutral person, to a difficult person, to all the four equally (oneself, friend, neutral person, difficult

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person) and then gradually to the entire Universe. Zazen is the Buddhist meditation from Japan. Zazen means a 'seated meditation.' It is a means of insight into the nature of existence. It is practiced in two ways: (a) focusing attention on one's breath and (b) observing present moment, thoughts and experiences that pass through their minds and around them [16].

Studies have shown an increased cardiac autonomic regulation during meditation [61-65]. A significant difference in the HRV in Zen-meditation practitioners and non-meditators was reported. They found a significant decrease in sympathetic activity and increase in parasympathetic tone in Zen-meditation practitioners (with a mean meditation experience of 6.0 ± 3.2 years) when compared with non-meditators [64]. Another study investigated the difference in HRV between experienced and novice Zen-meditation practitioners. This study did not find any significant difference in heart rate between experienced and novice Zen-meditators. Further, they found an increased cardiac autonomic nervous system activity in the experienced meditators than novice Zen-meditators [65].

CONCLUSION

A strategy which reduces the heart rate and improves heart-rate variability prevents cardiovascular morbidity, increase longevity and also has a favorable effect on the prognosis of cardiovascular disease. Although, several types of meditative practices are in existence, they are all aimed at training the mind and calming down the mind for an achievement of a state of increased consciousness. The heart is regulated and controlled by mainly the autonomic nervous system and local hormones through the inputs from central and peripheral regions. All meditative practices, irrespective of its origin and teaching methods, appear to induce beneficial modulation in the cardiac autonomic nervous system and improve its regulatory control of heart rate, increase heart-rate-variability, reduce metabolic demand and heart rate. Meditation helps in maintaining sympathovagal balance through a reduction in sympathetic activation and restoring the normal parasympathetic dominance.

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Meditation is an effective, safe and inexpensive life-style modality that can be recommended for cardiovascular risk reduction and management of cardiovascular disease.

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