Radiography 22 (2016) e54–e58

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Meditate don't medicate: How medical imaging evidence supports the role of meditation in the treatment of depression

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ARTICLE INFO

Article history:
Received 6 May 2015
Received in revised form
22 July 2015
Accepted 8 August 2015
Available online 22 August 2015

Keywords:
Depression
Diffusion tensor imaging
Magnetic resonance imaging
Meditation

ABSTRACT

Introduction: Depression is a debilitating psychiatric disorder that affects a large proportion of the population. The current treatment for depression involves anti-depressant medication which is associated with side effects and a heightened risk of relapse.
Methods: A systematic literature review was performed to determine the value of medical imaging studies in measuring the impact of meditation on depression.
Results: Medical imaging studies have successfully demonstrated that meditation may counteract or prevent the physiological cause of depression by decreasing amygdala activity and increasing grey matter volume and activity of the hippocampus, prefrontal cortex and other brain regions associated with attention and emotional self-regulation. Recent advances in functional imaging have enabled visualisation of neural plasticity within the brain. This has shown that for meditators, practice-induced alterations could be due to micro-anatomical processes that may represent an increased functional capacity within the brain regions activated. These changes within brain physiology in association with the skills gained during meditation such as self-regulation, mental processing of negative information and relaxation techniques could potentially lead to a permanent cure for depression and thus prevent relapse.
Conclusions: The results of this review suggest that medical imaging has a valuable role to play in evidencing the physiological changes within the brain caused by meditation that counteract those that cause depression. These studies indicate that meditation is a viable alternative to medication for clinical treatment of patients with depression. More rigorous longitudinal imaging studies are proposed to enhance understanding of the neural pathways and mechanisms of meditation.

Introduction

For thousands of years, many religions have encouraged believers to use the ancient spiritual practice of meditation to improve concentration, calm the mind and promote inner peace and well-being. Science on the other hand, values above all else the investigation of truths where results are based on discoveries and evidentiary proofs that can be replicated by peers experimentally. This literature review attempts to marry these 2 paradigms to determine the value of medical imaging in measuring the impact of meditation on depression.

Depression is a medical illness that affects how an individual feels, thinks and acts. It is a condition that causes a persistent feeling of sadness and loss of interest and is one of the most prevalent and debilitating psychiatric disorders.[1] In 2008, the Australian Bureau of Statistics reported that depression affected one million Australians and further stated that one in seven people will have depression at some point in their lives.[2] Beyond Blue, an Australian organisation documented that depression-associated disability cost the Australian economy $14.9 billion annually and over $600 million each year for the cost of treatment.[3]

Long-standing evidence links depression with changes in the levels or activity of certain chemicals or areas within the brain. In particular a reduction of available monoamine neurotransmitters including serotonin (5-HT), norepinephrine (NE) and dopamine (DA) induces depression.[4,5] From these findings, clinicians have

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http://dx.doi.org/10.1016/j.radi.2015.08.002
1078-8174/

resorted to treating depression with medication such as selective serotonin reuptake inhibitors (SSRIs).

The pharmacological treatments for depression are often accompanied by side effects including nausea, agitation, dizziness, drowsiness, weight fluctuations and headaches.[6,7] Medications for depression commonly suppress the reuptake of serotonin and/or noradrenaline in the synaptic cleft between nerves.[7] In particular this enhances neurotransmission in key structures such as the amygdala and the hippocampus; areas where reductions in serotonin and noradrenaline play a central role in the pathogenesis of depression. Medications that improve depressive symptoms also promote neurogenesis in the hippocampus and reverse depression related atrophy however they also replace the function of the prefrontal cortex (PFC) leading to atrophy. The fact that adult hippocampal neurogenesis is impaired by stress and facilitated by antidepressant medication suggests that neurogenesis may play a critical role in the pathogenesis of depression.[6] Chronic depression and other syndromes that are characterised by high levels of glucocorticoids (such as anxiety disorders) are associated with hippocampal volume loss that is proportionate to the duration of illness, independent of age.[8] Unfortunately antidepressant medication is symptom-suppressive rather than curative due to the loss of PFC function and thus used indefinitely to prevent relapse. There is no published evidence to suggest that antidepressants reduce further risk of depressive episodes once treatment is terminated which suggests that causal mechanisms of depression are unchanged. This leaves patients with an elevated risk for subsequent episodes of depression.[9] Thus alternative treatments such as meditation have recently been investigated to treat depression.

Meditation is an ancient spiritual practice used to gain insight and to transform consciousness. This has been done through introspectively observing one's own emotions as well as focusing attention on the here and now. It aims to still the fluctuations of the mind through cognitive function and improve concentration, mental clarity and help discriminate emotions.[10,11] Meditation is an increasingly popular treatment for individuals with depression.[12] Although there are many different types of meditation, each form aims for inner peace and to still the fluctuations of the mind. Most of the recent clinical therapeutic interventions utilise Mindfulness Meditation, which originated in India as part of Theravada and Mahayana Buddhist meditation practices.

Developments in neuroimaging technologies such as structural magnetic resonance imaging (MRI), diffusion tensor imaging (DTI), as well as functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and single photon emission computed tomography (SPECT) have enabled investigation of the biology and neuroscience of meditation. While functional studies have identified areas of the brain that become activated during the act of meditation, structural studies have been able to demonstrate areas of the brain which have responded with neurogenesis and neuroplasticity. Although there are many regions of the brain that are potentially affected by meditation practices, the scope of this literature review will only address those regions involved in the structural and functional changes seen in people with depression. The review aimed to determine the role of medical imaging in measuring the efficacy of meditation for the treatment of depression.

Methods

A literature search was undertaken in 2014 within Scopus, Web of Science, ScienceDirect and Pub Med for relevant English language publications from 2000 onwards when functional imaging started to become more widespread. Table 1 summarises the search strategy. Other journal articles were located from citation lists. A 2-stage screening approach was utilised to select and categorise appropriate evidence. Initially abstract review was performed to ensure the inclusion criteria were met and to exclude published "abstracts only", letters and comments, case reports and animal studies. Following this, a full-text article screening was performed to ensure relevance of content. For inclusion articles must have reported outcomes measured by medical imaging procedures related to treatment of depression with a meditation-based intervention. There were no limitations on study design, although publications that were clearly derived from an identical patient dataset were excluded. Critical review and scoring of the resulting selected articles was performed independently by 2 researchers to reduce observer bias. A structured approach to critical review was utilised based on the SIGN critical appraisal checklists.[13] Subsequent thematic analysis identified key themes arising within the selected evidence. Ethical approval was not required given that no primary research was conducted.

Results

A total of 51 studies were located via the search strategy; the screening and critical appraisal process resulted in 12 structural and functional studies being passed for analysis. Table 2 summarises the characteristics of the included studies. The evidence clearly identifies the structures within the brain that consistently exhibit increased grey matter volume and density in meditators. Although the types of meditation used varied across the studies the results from all studies were consistent irrespective of meditation style. The responding structures are found within the limbic system, and include PFC, amygdala and hippocampus. Since patients with depression are found to have neurotransmitter degradation or decreased reuptake of serotonin, noradrenaline and dopamine within these structures, the review findings drawn from appraisal of all the included studies have been structured around them.

Discussion

Pre-frontal cortex

One of the major functions of the PFC is executive cognitive function, and as part of this it moderates the activity of the amygdala. Thus, when the PFC is dysfunctional and the normal suppressive activity is absent or reduced, the amygdala becomes hyperactive, leading to depressive symptoms.[6] One of the ways antidepressants reduce depressive symptoms is by imitating the PFC function, and thus suppressing an overactive amygdala. A pioneering 2005 study used MRI to compare cortical thickness between meditators and a randomly selected and matched cohort of non-meditators.[14] When the images of the two groups were compared, it was found that particular areas of the brain, including the PFC, in long term meditators were thicker than in non-meditators. Functional imaging studies using PET, SPECT and fMRI confirm this increase of cortical thickness is consistent with repeat activations of these structures. Several functional studies further demonstrated functional activations of the PFC, right insula or left temporal gyrus.[15–19] This is consistent with suggestions that meditation could promote neural plasticity in regions that are routinely engaged during the meditative practice.[14] SPECT studies detected an increased regional cerebral blood flow during meditation of eight Tibetan Buddhists with greater than 15 years' experience compared to controls.[17,19] Other functional studies also consistently demonstrated activation of the PFC in meditators.[10,15,16,18]