Review of the Autonomic Nervous System's Function in Controlling Cerebral Blood Flow in Dementia

Andrew Spencer*

Editorial Office, Journal of Multiple Sclerosis, Belgium

Corresponding Author*

Andrew Spencer

Editorial Office, Journal of Multiple Sclerosis,

Belgium

Email: jmso@emedicinejournals.org

Received date: 05-June-2022, Manuscript No: jmso-22-70817; **Editor assigned:** 07-June-2022, PreQC No. jmso-22-70817(PQ); **Reviewed**: 20-June-2022, QC No. jmso-22-70817(Q); **Revised Date:** 23-June-2022, Manuscript No: jmso-22-70817(R); **Published date**: 30-June-2022, DOI: 10.35248/2376-0389.22.9.6.448

Abstract

In this review, we'll look at how the autonomic nervous system affects dementia patients' Cerebral Blood Flow (CBF). As the world's population ages, the 55 million people who already have dementia will grow in number. Understanding the alterations in vascular physiology associated with dementia may open the door to cutting-edge therapeutic strategies. Numerous dementia subtypes have been shown to have decreased CBF as well as increased cerebrovascular resistance and decreased vasoreactivity. Despite declines in global and regional CBF, Cerebral Autoregulation (CA), a crucial mechanism for maintaining cerebral perfusion, is mostly unaffected by cognitive impairments. Dementia results in a loss of Neurovascular Coupling (NVC), which may be a major cause of cognitive dysfunction. Despite a large number of research examining CBF regulation issues in dementia, less is known about the precise mechanisms causing the reported abnormalities. Disruption of the autonomic component is just one of several paths and processes that disturbances may be connected to. Using the clinical ramifications and potential for new biomarkers and therapeutic targets, we will examine clinical and animal research that explicitly examined the autonomic component of CBF regulation in dementia.

Keywords: Alzheimer's disease • Autonomic function • Cerebral autoregulation • Neurovascular coupling

Introduction

People with dementia frequently experience autonomic dysfunction. One example of a clinical symptom is Orthostatic Hypotension (OH), which may be linked to syncope and falls. Falls alone are a substantial cause of morbidity and mortality in dementia, and institutionalisation has increased five-fold [1]. The maintenance of Parasympathetic Nerve (PN) function through exercise training has a positive impact on cognition, for example, and there is a substantial correlation between autonomic function, lifestyle factors, and cognition. Additionally, elderly people with preserved autonomic function might live less sedentarily, which boosts mobility and lowers the chance of falling. Compared to Alzheimer's Disease, several dementia sub-types, including dementia with Lewy Bodies (DLB), Parkinson's Disease Dementia (PDD), and Vascular Dementia (VaD), are more likely to have Autonomic Dysfunction (AD).

The Acetylcholinesterase Inhibitors (AChEI), which improve the availability of acetylcholine at the synapse for neurotransmission, are one of the few treatments available for AD and PDD [2]. Although it is believed that AChEI exert their therapeutic effects by reducing the death of cholinergic neurons, another theory is that they enhance Cerebral Blood Flow (CBF) via altering the autonomic control of cerebrovascular tone. PN fibres heavily innervate the cerebral vasculature, and their activation may cause cerebral vasodilation. It has been demonstrated that AChEI raises CBF in AD.

In healthy people, central, but not peripheral, cholinergic activity during orthostatic stress (repeated upright tilt) mitigates the drop in CBF. Despite the fact that dementia patients frequently exhibit signs of autonomic dysfunction, research has generally concentrated on peripheral rather than central autonomic function. Studies have focused in particular on how Blood Pressure (BP) and Heart Rate (HR) alter in response to autonomic stimuli like the Valsalva manoeuvre, cold pressor test, and respiratory sinus arrhythmia at a regulated respiratory rate. Despite growing understanding of the part cerebrovascular dysfunction plays in the onset of both the AD and VaD subtypes of dementia, this remains the case. The co-existence of autonomic and vascular dysfunction in dementia reveals a potential connection between these two systems and the emergence of cognitive dysfunction, even if the Autonomic Nervous System's (ANS) function in the regulation of CBF is still debatable. This review's emphasis is therefore on the role of autonomic dysfunction in the regulation of CBF in dementia, the research gaps in this field, and autonomic factors that might reconcile the vascular and amyloid hypotheses of neurodegeneration. This review will focus on these specific dementia subtypes.

Control of the CBF and the autonomic nervous system in relation to cognition

The brain is a metabolically active organ that needs a steady supply of oxygen and nutrients to support neuronal activity, which is resource-intensive [3]. To accomplish effective matching of metabolic demand and supply, a number of control systems are in place that enables the brain to govern its own local and global blood flow. Metabolic variables, Cerebral Autoregulation (CA), and a mechanism reacting to ANS control all affect global cerebral circulation. Both static and dynamic CA rapid changes occurring over seconds can be widely categorised as occurring over minutes to hours or "stationary state" in CA [4]. However, static and dynamic changes can be seen as a continuum rather than as separate entities, representing variations in ultra-low (static), extremely low, low, and high (dCA) frequency oscillations [4]. Slow increases in BP are correlated with a comparatively stable CBF over a range of pressures known as the "gradient phase" of the autoregulatory curve. CBF can alter drastically outside of this phase, especially when BP varies quickly. Additionally, local blood flow is modified via the Neurovascular Coupling (NVC) mechanism in accordance with neuronal activity, directing blood flow to regions of the brain with higher neuronal activity [5]. There has been significant debate about how the ANS regulates cerebral blood flow. Despite these disputes, it is known that the cerebral vasculature is robustly innervated by both sympathetic and parasympathetic neurones, strongly indicating a role in maintaining perfusion or a protective role in reaction to abrupt increases in blood pressure. In a sizable multiethnic cohort, higher CBF was linked to better executive function, and numerous investigations have found links between lower CBF and worsened cognitive performance [6]. It is likely that NVC and CA, which are important processes for ensuring an ideal CBF in accordance with energy demands, contribute to the maintenance of cognition. CBF was a predictor of future risk of cognitive impairment in a significant, long-term study of ageing (The Rotterdam Study). Nevertheless, despite CBF reductions, exercising to lower CBF was linked to increased cognition [6]. Although the exact causes are yet unknown, it's possible that changes in brain metabolism rather than CBF can control this.

Autonomic function markers

There are direct and indirect indicators of autonomic function, such as neural control of vessel diameter and resistance (e.g., autonomic control of systemic arterial pressure). Because they are non-invasive and simple to use in clinical settings, indirect measurements like HR Variability (HRV) and Baroreceptor Sensitivity (BRS) are the main focus of investigations in humans. Since the sympathetic and parasympathetic tone is altered to maintain resting HR, variability reflects the level of autonomic control [7]. A lower HRV is linked to a higher risk of mortality and cardiovascular disease, which has prognostic value. Similar to this, the baroreceptor reflex is a crucial physiological mechanism that regulates the amount of sympathetic and

parasympathetic input to the cardiovascular system in order to maintain systemic blood pressure. BRS is therefore frequently used as a measure of autonomic integrity and function. Given the inherent ability of the brain to reduce the effects of systemic BP on CBF through CA, the function of this response in the regulation of CBF is yet unknown. Brain noradrenaline spillover has been measured using internal jugular venous sampling to represent cerebrovascular SN activity [8]. This method is somewhat intrusive, and its use in the evaluation of cognition and CBF control is restricted.

Dementia and autonomic nervous system dysfunction

The presenting characteristics (such as OH) [9], physiological tests, and the response to AChEI treatment all corroborate the existence of autonomic dysfunction in dementia. Dementia also affects parts of the central nervous system that are involved in autonomic processing, such as the hypothalamus, locus coeruleus, brain stem, and insular cortex. According to studies, there are several physiological differences between dementia patients and healthy older adults in their autonomic function, including relative increases in SN activity but decreased PN activity, decreased BRS, and links between neuropsychiatric symptoms and autonomic dysfunction [10].

Conclusion

In the context of CBF control, we have examined the evidence for the ANS's involvement in cognitive disorders, as well as how this may cause and sustain cognitive problems. All subtypes of dementia exhibit autonomic dysfunctional symptoms, and physiological research has shown that both peripheral and central autonomic function is aberrant in dementia. Studies connecting peripheral autonomic dysfunction with central CBF and cognitive performance in dementia are, however, notably lacking. Future research should look into these connections since they could provide more mechanistic understanding of how autonomic function affects dementia while also pointing to potential novel therapy options. Finding the link between CBF, cognition, and AChEI therapy may shed light on the ways in which AChEI works to assist patients and may lead to changes in pharmacological therapy that could be more effective. Higher resting vagal tone, attained by a balance in SN and PN activity, is suggested to be connected with greater cognitive function, albeit this association is not universal. As autonomic abnormalities go, dementia is characterised by increased sympathetic and decreased parasympathetic activity. This may imply that the observed reduction in cognitive performance in dementia may be related to the loss of the natural vagal tone. There are, however, few mechanistic investigations that link these peripheral alterations to CBF control and how this affects cognitive performance.

Future research should fill up this knowledge gap by examining the association between cognitive function in dementia patients and measures of peripheral autonomic function (HRV, baroreceptor function), in conjunction with beta-blockers. Though this can now only be done invasively in humans, future research should look into cerebral SN activity. Finally, to create a more thorough and cohesive understanding of the pathophysiological pathways underlying dementia, future research should focus on an integrated model of the vascular, cholinergic, and amyloid theories.

References

1. Fernando, E., et al. "Risk factors associated with falls in older adults with dementia: a systematic review." Physiother Can 69.2 (2017): 161-170.
2. Battle, C.E., et al. "Cholinesterase inhibitors for vascular dementia and other vascular cognitive impairments: a network meta‐analysis." Cochrane Database Syst Rev 2 (2021).
3. Iadecola, C. "The neurovascular unit coming of age: a journey through neurovascular coupling in health and disease." Neuron 96.1 (2017): 17-42.
4. Brassard, P., et al. "Losing the dogmatic view of cerebral autoregulation." Physiol Rep 9.15 (2021): e14982.
5. Phillips, A.A., et al. "Neurovascular coupling in humans: physiology, methodological advances and clinical implications." J Cereb Blood Flow Metab 36.4 (2016): 647-664.
6. Ogoh, S., and Tarumi, T. "Cerebral blood flow regulation and cognitive function: a role of arterial baroreflex function." J Physiol Sci 69.6 (2019): 813-823.
7. Thayer, J.F., et al. "A meta-analysis of heart rate variability and neuroimaging studies: implications for heart rate variability as a marker of stress and health." Neurosci Biobehav Rev 36.2 (2012): 747-756.
8. Mitchell, D.A., et al. "Jugular venous overflow of noradrenaline from the brain: a neurochemical indicator of cerebrovascular sympathetic nerve activity in humans." J Physiol 587.11 (2009): 2589-2597.
9. Allan, L.M. "Diagnosis and management of autonomic dysfunction in dementia syndromes." Curr Treat Options Neurol 21.8 (2019): 1-11.
10. Idiaquez, J., et al. "Association between neuropsychiatric and autonomic dysfunction in Alzheimer's disease." Clin Auton Res 12.1 (2002): 43-46.

Cite this article: Spencer A. Review of the Autonomic Nervous System's Function in Controlling Cerebral Blood Flow in Dementia. J Mult Scler. 2022, 09(6), 448.