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Osteopathic Cranial Manipulation and its Possible Application in Managing Hypertension for the Optimization of Care

Stephanie Jackson, Tsz Chun Chung, Alyssa Arellano, James Keane, Leonard B. Goldstein*

University Mesa, Arizona and A.T. Still University, Mesa, Arizona, USA.

*Corresponding author: Leonard B. Goldstein.

Abstract

Context: Approximately 50% of US adults suffer from hypertension, with over 75% inadequately controlled. The baroreceptor reflex elicits vagal stimulation, reducing heart rate and blood pressure. Non-invasive osteopathic cranial manipulation (OCM), including occipito-atlantal (OA) release, may enhance vagal tone. This literature review examines the potential efficacy of OCM in optimizing hypertension management by augmenting vagal tone and subsequently reducing blood pressure.

Objective: To determine whether osteopathic cranial manipulation (OCM) may be utilized for blood pressure reduction and hypertension management via vagal nerve stimulation affecting the baroreceptor reflex. Specifically, we aim to investigate the effects occipito-atlantal (OA) release has on vagal tone and determine whether it has reasonable applications within hypertensive conditions.

Methods: Our group searched for credible literature sources on Still OneSearch, DynaMed, Google Scholar, PubMed, MEDLINE, and National Institutes of Health (NIH) online databases as well as the following journals: Frontiers in Neuroscience, Journal of Alternative and Complementary Medicine, and Medicines. The search strategy included keywords or a combination of keywords such as “hypertension or high blood pressure”, “baroreceptor reflex”, “vagal nerve stimulation”, and “osteopathy or osteopathic manual therapy or OMT or manual therapy or osteopathic medicine or osteopathic treatment” to discover related articles. Filters for peer reviewed sources with access to full text and publication dates between 2010 - 2023 were applied to our search, narrowing the results to only the most up-to-date information. Once studies of interest were selected, the articles were read and analyzed with pertinent components referenced throughout our literature review in accordance with AMA citation format. Altogether, this project demonstrates osteopathic significance because it emphasizes the value of osteopathic cranial manipulation (OCM), spreads awareness of Sutherland’s philosophies, and underscores the possibility of OCM applications in the treatment of hypertension. Furthermore, it describes how OCM can be used in combination with or as a safer alternative to managing hypertensive conditions, thus creating more options for providing quality healthcare.

Results: This literature review sought to examine the potential efficacy of HTN management through the utilization of osteopathic cranial manipulation. In the clinical and preclinical studies of vagus nerve stimulation (VNS) therapy, it was found that a 4-week-long VNS therapy significantly decreased mean arterial pressure and the number of arrhythmic episodes in rats with salt-induced hypertension, with a potential side effect being bradycardia due to asystole. In theory, by initiating manual biomechanical alignment in the OA joint would improve vagus nerve function and thus increase parasympathetic function to the heart to reduce atrial contraction, comparable to VNS. A study examining 19 healthy, young adults who underwent cervical OMT and had their heart rates measured pre- and post-electrocardiography, revealed moderate enhancement of parasympathetic HR control. In another study of 63 subjects with hypertension who were treated with OMT for 1 year, it was found that their systolic blood pressure improved significantly. In a randomized controlled study, a combination of kneading and stretching of soft tissues and suboccipital decompression, there is an increase of 15% of parasympathetic modulation of heart rate with $p=0.02$.

Conclusion: Research agrees that the instigation of parasympathetic activity through vagal nerve stimulation adjusts heart rate in the response to baroreceptors that detect arterial pressure changes within the heart. Giles et al demonstrated a positive relationship between the effects of OMT and acute heart rate variability. However, the relationship between heart rate and vagal activity is not linear, and has been previously difficult to clearly denote. Overall, this literature review demonstrates the significant impact hypertension has on society and the need for alternative treatments. In research conducted by Giles et al, OMT was proven to have an effect on heart rate variability in health individuals and although the research was not conducted on patients with somatic dysfunction, the data suggests that the effect on heart rate via OMT is measurable and definitive. This lends to a promising advancement in the relationship between OMT and heart rate in a diseased population. Assessment of this change in the frequency domain of autonomic control suggests necessary evaluation of the shift in sympathetic to

parasympathetic states within chronic HTN patients. In evaluation of current research, it is not possible to draw a definitive conclusion about the effectiveness of OCM on the management of HTN. Future research should be conducted in the evaluation of OCM and the specific types of techniques that offer the greatest effect on both heart rate and blood pressure. Ideally these projects would determine the effectiveness of OCM through a dedicated, well-designed, controlled and blinded outcome study for the evaluation of statistically significant results. The data that would be extracted from these future studies could have profound impacts on the integration of OMT into the scheme of hypertension management and inform policy changes to enable it as a viable tool for treatment.

Keywords: high blood pressure; hypertensive conditions; cardiovascular health; baroreceptor reflex; vagal nerve stimulation; vagus nerve; autonomic nervous system; parasympathetic; osteopathy; osteopathic cranial manipulation; OCM

Introduction

Hypertension

In 2020, the Centers for Disease Control and Prevention (CDC) found that 48.1% of adults in the United States had hypertension [1]. Of those individuals, 77.5% had uncontrolled hypertension (HTN), defined as a blood pressure (BP) equal to or higher than 130/80 mmHg [1]. In 2017, American Cardiology College and American Heart Association collaborated with National Heart, Lung, and Blood Institute to update the definition of hypertension, from the previous threshold of 140/90 mmHg to 130/80 mmHg [2]. Two types of hypertension include primary and secondary hypertension [1, 2]. Primary hypertension, also known as essential hypertension, is the most common form of hypertension with a gradual increase in blood pressure complicated by lifestyle habits such as high sodium diet, weight gain, sedentary lifestyles, and genetic factor, but without an identifiable underlying cause [2]. Secondary hypertension has an identifiable cause, commonly renal stenosis or primary hyperaldosteronism [3]. It is essential to explore new avenues of HTN intervention and management because HTN contributes to 25% of heart failure and 64% of cerebrovascular events in the US [4, 5]. Current recommendations for initiating HTN drug therapies are either a BP equal to or greater than 130/80 mmHg with high-risk characteristics (chronic kidney disease, diabetes, or cardiovascular disease), or a BP equal to or greater than 140/90 mmHg without high-risk characteristics [6]. In other words, hypertensive patients lacking high risk characteristics could benefit from non-pharmaceutical interventions, such as osteopathic manipulation medicine (OMM) to prevent chronic progression. Theoretically, patients who have already begun pharmaceutical interventions may also demonstrate better BP management with OMM added to their care. This review investigates osteopathic cranial manipulation

(OCM), a form of OMM, and its potential for blood pressure reduction and hypertension management via vagal nerve stimulation affecting the baroreceptor reflex. Specifically, we aim to investigate the effect of occipito-atlantal (OA) release on vagal tone and determine whether it has reasonable applications within hypertensive conditions.

Osteopathic Cranial Manipulation (OCM)

Osteopathy was founded by Andrew Taylor Still in the late 19th century, with his students expanding on his teachings and contributing to what is known today as Osteopathic Medicine [7]. One specific student, William G. Sutherland, D.O., D.Sc., took interest in the skull's articulations and explored how its anatomic structures were interrelated with the physiology of its somatic dysfunctions [7, 8]. Sutherland appreciated the inherent mobility of cranial bones and recognized that the cranium's articular surfaces not only accommodated but facilitated the harmonious functions of the central nervous system (CNS), cerebrospinal fluid (CSF), and dural membranes [7, 9, 10]. He labeled this synergistic interplay as primary respiratory mechanisms (PMR) [9]. Sutherland cultivated these concepts and developed a branch of osteopathy called osteopathic cranial manipulation (OCM) which was based on the integration of balanced membranous tension (BMT) and PMR [7, 10]. Taking theory into practice, Sutherland and his students were then able to apply physical forces to the cranium for the manual manipulation of the bones, membranes, and fluids (ex. cerebrospinal fluid; CSF) within the head [8, 9]. The occipitoatlantal (OA) joint, also known as the atlanto-occipital joint, is a specialized area where the base of the skull (occiput) and the first vertebra of the cervical spine (atlas) meet to facilitate flexion and extension movements of the head [7, 11]. Interestingly, C1 is associated with the tenth cranial nerve (vagus nerve) and its effects on the parasympathetic nervous system can be elicited

through OA release or decompression [7, 12, 13]. The process of OA release begins with motion assessment of the OA joint with the patient supine and physician at the head of the table [7]. Preference for translatory motion, and thus side bending is assessed in neutral, flexed, and extended positions to achieve a diagnosis of somatic dysfunction [7]. The direction of OA rotation occurs opposite to that of side bending [7]. Once a diagnosis is made, the physician will proceed with OA release by contacting the patient's inferior occiput with their index and middle fingers; mild traction and respiratory assist are employed throughout treatment [7, 13]. OA release offers the benefit of restoring balance to the autonomic system via increasing vagal tone [12]. Although exact mechanisms remain unknown, OA release is presumed to operate on the vagus nerve through direct manual manipulation of its overlying cervical fascia or reflexive reactions triggered by activate cutaneous C1- C2 afferent nerve fibers [13].

Vagus Nerve & the Baroreceptor Reflex

The vagus nerve, a significant component of our autonomic nervous system, plays a multifaceted role in regulating various bodily functions, including the cardiovascular system [7]. Studies have pointed out that the vagus nerve is intricately linked to maintaining our body's physiological balance, particularly in its connection to heart rate variability (HRV) [14]. The high-frequency component of HRV closely associates with vagal tone, highlighting how the vagus nerve influences our heart's function [7, 13, 14]. Notably, the medial region of the brain's vasomotor center communicates with the nearby dorsal motor nuclei of the vagus nerves to subsequently relay parasympathetic signals to the heart for the modulation of heart rate and cardiac contractility [15, 17]. This parasympathetic influence allows the vagal nerve to fine-tune the heart's rhythm control and cardiac function, contributing to the overall balance in our cardiovascular system [15].

On a parallel note, the tenth cranial nerve employs its parasympathetic effects through the baroreceptor reflex for maintenance of blood pressure within a narrow and optimal range [7, 13-15, 17]. Baroreceptors are spray-type nerve endings strategically placed within our blood vessel walls, especially abundant in each internal carotid artery and the aortic arch [17]. These receptors respond to vascular stretching to tirelessly monitor and respond to changes in blood pressure [14, 17]. When an

elevation in blood pressure is detected, these baroreceptors swiftly transmit signals to our brain, mainly targeting the nucleus tractus solitarius of the medulla oblongata [14, 17]. Here, the vagus nerve assumes a pivotal role in relaying these signals for blood pressure regulation [17]. Thus, leveraging the body's natural vagal stimulatory effects and optimizing its control, namely through OCM and OA release, would theoretically present a non-invasive and non-pharmaceutical approach to HTN management.

Methods

Our group searched for credible literature sources on Still OneSearch, DynaMed, Google Scholar, PubMed, MEDLINE, and National Institutes of Health (NIH) online databases as well as the following journals: Frontiers in Neuroscience, Journal of Alternative and Complementary Medicine, and Medicines. The search strategy included keywords or a combination of keywords such as "hypertension or high blood pressure", "baroreceptor reflex", "vagal nerve stimulation", and "osteopathy or osteopathic manual therapy or OMT or manual therapy or osteopathic medicine or osteopathic treatment" to discover related articles. Filters for peer reviewed sources with access to full text and publication dates between 2010 - 2023 were applied to our search, narrowing the results to only the most up-to-date information. Once studies of interest were selected, the articles were read and analyzed with pertinent components referenced throughout our literature review in accordance with AMA citation format. Altogether, this project demonstrates osteopathic significance because it emphasizes the value of osteopathic cranial manipulation (OCM), spreads awareness of Sutherland's philosophies, and underscores the possibility of OCM applications in the treatment of hypertension. Furthermore, it describes how OCM can be used in combination with or as a safer alternative to managing hypertensive conditions, thus creating more options for providing quality healthcare.

Results & Discussion

This literature review sought to examine the potential efficacy of HTN management through the utilization of osteopathic cranial manipulation. In theory, initiating manual biomechanical alignment in the OA joint would improve vagus nerve function and thus increase parasympathetic function to the heart to

reduce atrial contraction, comparable to vagus nerve stimulation (VNS) [17]. VNS has emerged as a promising therapeutic approach with potential implications for cardiovascular health, especially since vagal stimulation activates the parasympathetic nervous system, resulting in a reduction in heart rate and cardiac contractility [14]. This orchestrated parasympathetic response effectively counters the effects of the sympathetic nervous system, which typically elevates heart rate and blood pressure during moments of stress or excitement.¹⁷ In the clinical and preclinical studies, it was found that a 4-week-long VNS therapy significantly decreased mean arterial pressure and the number of arrhythmic episodes in rats with salt-induced hypertension [14, 18]. Upon electrophysiological studies of salt-sensitive rats who underwent stimulation of the tenth cranial nerve, it was found that VNS induced significant action potential duration (APD) changes [18]. Specifically, a lower ADP and maximum slope of APD restitution in the right ventricle with an increased conduction velocity in the left ventricle [18]. Differences in ventricle response provided insight on vagal intervention in pacemaker activity and suggested possible electrical remodeling [18]. Additionally, stimulating the vagus nerve presented a potential side effect of bradycardia due to transient asystole [14]. It is known that baroreceptors are extremely sensitive, where incorrect pressure to the neck will trigger vagal-acetylcholine effects on the heart, leading to a slower than normal heart rate [17]. Sometimes the reflex may be so strong that the heart will stop for 5 – 10 seconds and cause syncope [17]. Therefore, stimulation of the vagus nerve requires conscientious application in both VNS and OCM approaches.

In a study examining 19 healthy young adults who underwent cervical OMT and had their heart rates measured pre- and post-electrocardiography, results revealed moderate enhancement of parasympathetic HR control [19]. The study involved three experimental interventions (OMT via suboccipital decompression, sham treatment, and time control) which were foundational to the low frequency (LF) and high-frequency (HF) results of their spectral analysis [19]. HF represented parasympathetic control of heart rate and was significantly increased in the OMT group ($p=0.02$) while no effect was observed in sham and time control groups ($p>0.32$) [19]. LF represented both parasympathetic and sympathetic influence on heart rate, and the LF/HF ratio was notably decreased during OMT (from baseline

$p<0.01$; compared to sham and time control $p=0.033$) [19]. This demonstrated the shift towards vagal control of heart rhythm secondary to the effect of suboccipital decompression and most importantly, reinforced the proposed relationship between OA manipulation and cardiovascular system.

In another study of 63 subjects with hypertension who were treated with OMT for 1 year, it was found that their systolic blood pressure improved significantly post-intervention [20]. Patients involved in this study continued their usual antihypertensive regimen and met with a single provider who evaluated and treated somatic dysfunction in different parts of the body with various techniques [20]. After a year, statistical analysis evoked an overall improvement in SBP (-4.317 ; -6.421 , -2.214), but no difference in DBP [20]. Although their approach was not limited to OA release, this study effectively demonstrated how OMT can be added in combination to traditional cardiovascular treatment methods to better manage high risk patients.

Conclusion

Research agrees that the instigation of parasympathetic activity through vagal nerve stimulation adjusts heart rate in the response to baroreceptors that detect arterial pressure changes within the heart [14, 17, 21]. Experimentation has demonstrated a positive relationship between the effects of OMT and acute heart rate variability [19]. However, the relationship between heart rate and vagal activity is not linear, and has been previously difficult to clearly denote [22]. Furthermore, there are side effects of vagal nerve stimulation such as bradycardia-induced syncope that require more research pertaining to its risk-benefit profile [17, 14]. In research conducted by Giles et al, OMT was proven to have an effect on heart rate variability in health individuals and although the research was not conducted on patients with somatic dysfunction, the data suggests that the effect on heart rate via OMT is measurable and definitive [19]. This lends to a promising advancement in the relationship between OMT and heart rate in a diseased population. Assessment of this change in the frequency domain of autonomic control suggests necessary evaluation of the shift in sympathetic to parasympathetic states within chronic HTN patients.

However, in evaluation of current research, it is not possible to draw an absolute conclusion about the

effectiveness of OCM on the management of HTN. Future research should be conducted in the evaluation of OCM and the specific types of techniques that offer the greatest effect on both heart rate and blood pressure. Ideally these projects would determine the effectiveness of OCM through a dedicated, well-designed, controlled and blinded outcome study for the evaluation of statistically significant results. The data that would be extracted from these future studies could have profound impacts on the integration of OMT into the scheme of hypertension management and inform policy changes to enable it as a viable tool for treatment. Overall, this literature review demonstrates the significant impact hypertension has on society and the need for alternative treatments. Osteopathic philosophy as well as its manual manipulations can be taught to individuals from various backgrounds, making it easily accessible. Moreover, the non-invasive and holistic qualities of osteopathic therapies present attractive treatment options for a wide range of individuals. Especially patients who have failed pharmacological intervention due to adverse reactions, refuse to take oral medications, or have resistant hypertension, may benefit from the incorporation of OMT to optimize their care. This review encourages further investigation into osteopathic applications and approaches to hypertension management.

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