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Clinical application of visceral thoracic osteopathic manipulations in heart rate variability measurement with photoplethysmography for stress-related symptoms: a case report

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Abstract:
Heart rate variability (HRV) is the change in frequency from one heartbeat to the next, due to the adaptation of the heart's rhythm in response to an internal or external stimulus. Increased HRV has been reported as a potential indicator of general health. The relationship between structure and function is one of the guiding principles of osteopathy; it considers anatomy essential for explaining physiological dysfunction. There is a paucity of research on the effects of Osteopathic manipulative medicine (OMM) on the effects of HRV. We hypothesize that OMM can be used safely and to help promote healthier HRV. We herein report on a case of improved HRV after serial OMM sessions.

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Introduction:

Heart rate variability (HRV) is the change in frequency from one heartbeat to the next, due to the adaptation of the heart's rhythm in response to an internal (physiological) or external (environmental) stimulus. Visceral osteopathy has yet to receive the same attention as structural osteopathy within the scientific community. There are several definitions of what a visceral dysfunction is composed of. Lossing defined it as an "impaired or altered mobility or motility of the visceral system or related fascial, neurological, vascular, skeletal, and lymphatic elements."[1] While Jean-Pierre Barral, a French osteopath, adapted Still's definition and defined visceral fixation as the presence of a partial or total loss of organ mobility.[2] There have been several studies on the viscoelastics properties of a visceral ligament.[3,4]

To date, to the best of our knowledge, there has not been a study on HRV response to visceral OMM. We hypothesize that visceral OMM can be used safely and to help promote healthier HRV. For the first time herein, we describe an osteopathic approach that uses an objective physiological endpoint, useful important to obtain proper outcomes.[5] From an osteopathic point of view, anatomy is key. The pericardium is the heart's fascial fibrous envelope. One of its roles is to absorb movements and tension in the rib cage, so as to protect the heart's pumping mechanism.[6] This follows the osteopathic principle wherein structure and function are reciprocally interrelated,[7] tension in the fibrous pericardium (structure) could mechanically restrict the heart's pumping action (function)[8,9] and consequently affect its physiological functions.

Osteopathic Methods:

Heart rate variability (HRV) is described as the change in frequency between heartbeats. This is due to the adaptation of the heart's rhythm in response to an internal (physiological) or an external (environmental) stimulus.[10] HRV can be used as an indicator of the body's self-regulating capacity, through autonomic nervous system (ANS) tone.[11] Psychological stress can be an important contributor to altered HRV.[12] This may cause symptoms such as idiopathic temporary intermittent heart palpitations.[13] Several studies have shown significant improvement of HRV using OMT,[14] including cranial manipulations,[15,16] or high-velocity low-amplitude thoracic spinal adjustments.[17,18] These studies were conducted for research purposes but they also suggested the interesting potential of using HRV in a clinical practice. As yet, no study has investigated nor documented the effects of visceral OMT on HRV, specifically with an emphasis on the pericardium.

To the authors' knowledge, this is the first prospective study to present such clinical findings. As a proof of concept, this clinical report also aims to explain certain osteopathic visceral manipulations in order to promote larger studies focusing on the heart/pericardium. The subject had previously been medically assessed without clinical findings.

Case Report:

A 34-year-old man, presented complaining of what he called palpitations over the previous five to six months. His symptoms were present only in the evening after various house chores. He also complained of neck stiffness, especially in right rotation, for more than 10 years. He did have a distant history of several impacts while playing football. His medical history included a pericarditis in 2011, and he mentioned having suffered emotional stress when a neighbor around his age died in 2015 of a heart problem. He had been evaluated by a physician who assessed his heart rate for 24 hours using a portable device. Results of the heart rate monitoring were considered normal and no heart disease was diagnosed. The subject did not feel the symptoms described affected his daily activities, but were more bothersome at night making it hard for him to fall asleep and he felt increased levels of anxiety.

On initial examination, the patient was found to have as listed in Table 1 and he was subsequently treated with OMT. After the treatment, the subject's HR decreased from 100 +/- 3 bpm before treatment to 93 +/- 4 bpm, showing a slight improvement, though not clinically significant.

Table 1. Summary of subjective and objective information

Session	1	2	Final Follow up
Pre OMT HRV	100 +/- 3 bpm	91 +/- 3 bpm	85 +/- 10 bpm
Post OMT HRV	93 +/- 4 bpm	85 +/- 4 bpm	
Assessment	Greater expansion in the rib cage	Rib cage expansion perceived as normal	
	Decreased rotation at C5/C6	Decreased rotation at C5/C6	
	Trapezius muscle tight bilaterally	Tension still perceived but to a lesser degree in the pericardial ligaments (superiorly, inferiorly and laterally)	
	Anterior rotation of the right ilium		
	Decreased range of motion in the right sacroiliac joint		
	Tightness felt in both diaphragmatic cupolas		
	Perceived tension in the pericardial ligaments (superiorly, inferiorly and laterally)		
Implementation	Functional correction of pelvic restrictions	Functional correction of somatic dysfunction at T8/T9	
	Local functional technique of thoracic diaphragm	Functional correction of K8 costo-vertebral articulation right and left.	
	Muscle energy techniques for somatic dysfunctions at C3/C4, C5/C6 and C7/T1	Functional release of pericardial ligaments	
	Functional release of pericardial ligaments		

Data was collected at each session, presented under the S.O.A.P.I.E. documentation method.

One week later, the patient noted a general improvement in his condition: he felt greater expansion of his rib cage; his heart palpitations in the evening were still present but less frequent, and these were no longer felt daily as before. However, his neck range of motion was still limited and right rotation had no significant improvement. His stress level was subjectively at a 5/10. His heart rate remained almost the same after the first treatment: 91 +/3 bpm. At the end of the second treatment, the heart rate of the patient was 85 +/- 4 bpm, which fell within the normal range [50–90 bpm (27)] and the patient felt relief afterwards (Table 1).

Two weeks after the first evaluation, the subject returned for a final assessment. No OMT was used; only stress levels, neck mobility and HRV were measured. The sensation of rib cage restriction had disappeared and almost no heart palpitations were felt during the previous two weeks. The patient felt a continued decrease in stress (3/10). Neck rotation was still limited to the right (35 degrees) but the left side had improved significantly (almost 90 degrees compared to 60 during the first session).

His HRV was 85 +/- 10 bpm: a considerable improvement from the measurement taken during his initial evaluation.

Discussion:

The manipulations used (described in the supplementary material) considered the anatomy of the pericardial ligaments and were inspired by techniques described by Barral,[2] Curtil and Metra.[19] Cranial osteopathy[16,20,21] and General OMT (based on ligamentous tension and cranio-sacral techniques)[14] were observed to increase parasympathetic activity and decrease HR. This was deduced from an increase in the high frequency band power calculated from frequential HRV analysis. Even though such an analysis of HRV was impossible during this study, due to the insufficient duration of measurements (less than the five minutes recommended[22]), HR decreased to a value within the normal range. This would appear to follow such trends observed with cranial or soft tissue osteopathic techniques.

By the follow-up session, the patient's HRV had improved by 10 bpm, compared to 3 bpm during the first session. This followed an improvement in HR of 18 bpm (17.48% decrease from the first assessment). The patient's HR was initially 13 bpm over the normal limit.[23] After two osteopathic sessions, his HR fell to 85 bpm, well within the normal range (50 -90 bpm).

The pericardium's function is to absorb somatic tensions so as to preserve the heart's pumping mechanism.[6] Because of this, significant tensions in the pericardium could restrain heart movements, and create palpitations resulting from reduced heart mobility and neck stiffness (due to cervical insertions of the pericardium). This hypothesis is conceivable since a biomechanical approach (releasing tensions in specific targeted pericardial ligaments) lessened patient symptoms.

Simple HRV measurements were obtained through a smartphone application. This case study reports indirect supportive evidence of improvement in HRV using non-invasive visceral OMT. This study also illustrates the safety of the protocol and the need for larger, more in depth studies for optimization and validation. In future studies, the analyse HRV data from an ECG and obtain information about sympathetic or parasympathetic activities with more sophisticated equipment is warranted in order to obtain more direct HRV measurements.[24]

Conclusion:

To the authors' knowledge, this is the first case study using visceral OMT applied to the pericardium on a healthy patient. The resolution of the patient's specific complaints (decreased range of motion in the rib cage, cervical spine, and idiopathic heart palpitations) show indirect supportive evidence of correlation between the symptoms and associated tension in the pericardium. The protocol was implemented without injury to the subject. Using a smartphone application made it simple to monitor a patient's HRV, but more in depth measurements would aid future studies. Additional studies are warranted to confirm the findings of this study and provide further optimization.

Author Contributions:

All authors equally contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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SUPPLEMENTARY MATERIALS

Osteopathic approach applied to target the pericardial ligaments

The osteopathic approach used in this study focuses on the anatomy and physiology of the pericardium and its surrounding tissues.[6,25] The term "tension" refers to an osteopathic dysfunction detected by osteopathic palpation, as defined previously.[1] In this study, the myofascial osteopathic protocol was designed to a) avoid moving the patient and b) include three direct techniques, executed with the patient lying supine. The techniques presented here aim to affect the pericardial ligaments by using neighboring myofascial structures, without physically touching the pericardium. These techniques included: 1) releasing putative tension in the inferior and superior sternopericardial ligaments;
2) releasing tension in the vertebropericardial and anterior pericardiophrenic ligaments; and 3) releasing tension in the fascial visceropericardial band (attached to the oesophagus, the trachea and the thyroid). These techniques are gentle and non-invasive (low amplitude and very low speed), target the previously mentioned pericardial ligaments without any certainty these ligaments are actually affected. A pillow is placed under the patient's knees to minimize tensions that may occur in the limbs and lower back. (Figures 1–2)

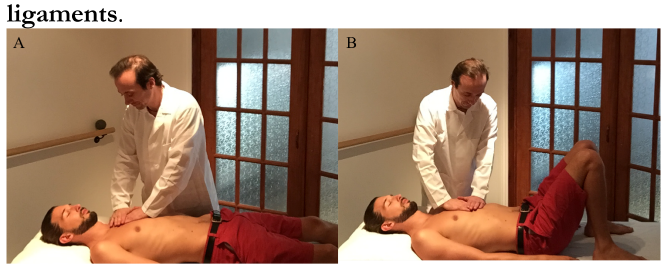
The patient subject of this case study does not appear in the photographs. The black square was used for the models appearing in the photographs.

1) Release of the inferior and superior sternopericardial ligaments (2 steps)

Due to the location and orientation of the inferior and superior sternopericardial ligaments, the head or the legs may influence the movement of the manubrium or the xiphoid respectively, where these ligaments are attached.

The therapist places one hand on the manubrium for the superior sternopericardial ligament or the xiphoid process for the inferior sternopericardial ligament. Then, the therapist uses a two- or three-finger contact with the other hand on top to move the structures. This places the ligament under tension in one direction or the other (right or left). The therapist then asks the patient—lying supine—to turn the head or tilt the bent legs, to one side or the other (according to the ligament targeted). The practitioner waits for the first tissue release. The therapist then asks the patient to turn the head or tilt the legs in the opposite side to increase tension and wait for the release. The technique is complete when the manubrium or the xiphoid process can be easily moved in both directions.

Figure 1: Release of superior and sternopericardial ligaments.



(A) superior ligament, B) sternopericardial ligament.

2) Release of vertebro—and anterior pericardiophrenic ligaments (in one step)

The vertebropericardial ligament attaches between C7 and T3, which are under tension when the neck is extended. The anterior pericardiophrenic ligament attaches between the inferior edge of the heart and the anterior edge of the left diaphragmatic cupola. To put it under tension, the thoracic diaphragm needs to be lowered by the patient inhaling and holding the breath.

The therapist is positioned at the patient's head, which protrudes beyond the table and rests on the therapist's thigh. The therapist has one hand placed upon the diaphragm and the other supporting the cervical spine. The therapist creates tension in these two ligaments at the same time by lowering the head (posterior direction) and maintaining the diaphragmatic hand caudally. If the patient cannot hold their breath before the tension in the ligaments releases, the process is repeated with the patient taking another breath.

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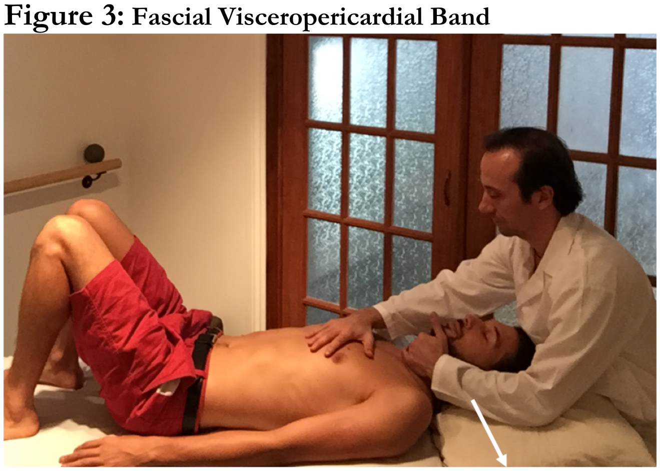
Figure 2: Release of vertebra and anterior pericardiophrenic ligaments and fascial visceropericardial band at the same time

The white arrow indicates the direction of tensioning.

3) Release of the visceropericardial band
This band attaches to the esophagus, the thyroid gland, the trachea and the heart's large blood vessels.[6,25]

To release the visceropericardial band, three points of contact are needed: the first for the pericardium (therapist's caudal hand upon the heart), the second for the thyroid, and the third with the head of the patient resting on the therapist's knees. This creates tension as the therapist's knees are slowly lowered and the therapist's hands maintain their contact and position, waiting for tension release.

Figure 3: Fascial Visceropericardial Band



The white arrow indicates the direction of tensioning with the therapist's knees while the hands in regards of the structures maintain them in place.