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Research report

Physiological effects of a CV4 cranial osteopathic technique on autonomic nervous system function: A preliminary investigation

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Abstract

Background and objectives: Research conducted in the field of cranial manipulation has primarily focused on inter- and intra-reliability detecting both the Cranial Rhythmic Impulse and cranial dysfunction. Limited literature exists regarding the effects of cranial manipulation on health outcomes, and little has been done to investigate the physiological effects of the techniques in practice. The aim of this pilot study was to investigate the physiological effects resulting from the administration of a single cranial technique (CV4) compared with simple touch.
Methods: Heart rate variability, respiration rate, galvanic skin resistance and skin temperature were measured in ten subjects (six females, four males) in an experiment consisting of five generic phases. These phases consisted of baseline, touch only, intervention (CV4), touch only and baseline. During the intervention phase, a registered osteopathic practitioner applied the CV4 technique commonly used in cranial manipulation. Changes in outcomes between each of the five phases were analysed for each dependent variable.
Results: The results of this study demonstrated that the application of the CV4 technique when compared to simple touch in asymptomatic individuals had minimal physiological effect in any of the autonomic variables recorded. No significant differences were observed in any variable across the five phases. On examination of heart rate variability, it became apparent that three subjects may have responded in a manner that was consistent with an increase in parasympathetic activity during the treatment phase. This identification leads to the notion that there may be both 'responders' and 'non-responders' to cranial treatment.
Conclusions: This pilot study fails to support the theorised effects of the CV4 technique that are commonly described. In response to application of the technique there were minimal physiological changes observed in the autonomic measures investigated. Additional research is required if the hypothesised physiological effects of techniques used in the field of cranial manipulation are to be demonstrated in the laboratory setting.

Keywords: Osteopathy; Cranial manipulation; CV4; Physiological effect; Autonomic nervous system

1. Introduction

Cranial manipulation is practised by a wide variety of manual therapists including osteopaths, physiotherapists, chiropractors and massage therapists.[1] This therapy originated within the osteopathic profession in the 1930s from the observations of William Garner Sutherland. Sutherland suggested that the bevelled sutures of cranial bones reflected mobility, and spent many years investigating the effect of restrictive forces exerted on the skull.[2] He claimed that distortion of the cranial bones and membranes could be a source of pathology, and that such distortion could be detected through clinical palpation and identified as dysfunction. Sutherland maintained that such dysfunction could be treated by a 'facilitatory' touch and could diminish symptoms. It is claimed that distortions can be caused by trauma, birth, dental work, muscular tension, or dysfunctions of the locomotor system and

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internal organs.[3] Depending on where the restrictions lie, clinical symptoms can range from visual disturbances to endocrine disturbances.

To date, the research on cranial manipulation has predominantly focused in two main areas; examiner reliability for the detection of dysfunction and the Cranial Rhythmic Impulse (CRI)[4–12] and the effect of cranial manipulation on health outcomes.[13–19]

The majority of studies have investigated inter and intra examiner reliability. Hartman and Norton[20] published a review of current research and demonstrated no evidence for inter-examiner reliability in palpating cranial dysfunction or the CRI. They did however, report more acceptable results for intra-reliability of CRI rate detection.[20]

There has been minimal research investigating the physiological effects that health practitioners claim occur with cranial osteopathy. This study aims to document the physiological response to a technique commonly used in cranial manipulation, the CV4. The CV4 technique has previously been used in research[16,21–24] and was chosen for this study due to its widespread use in cranial osteopathy as a general health enhancing therapy. The technique is reported to have profoundly relaxing effects, lowering the tone of the sympathetic nervous system and enhancing fluid exchange.[25]

Heart rate variability (HRV) has become a widely used tool by researchers to examine the autonomic control of the heart. Each cardiac cycle can be marked by the peak of the R wave, easily detectable on an electrocardiogram. By analysing heart function reflected in the changing beat to beat alteration, it is possible to derive the modulation of the heart from the parasympathetic and sympathetic nervous systems. Parasympathetic control occurs through vagal activity, exhibiting rapid cardiac effects occurring due to the effect of acetylcholine on the potassium ion channels within the effector cells. Sympathetic modulation however, occurs relatively slowly due to the slow release of noradrenaline and the second messenger system involved in cardiac expression. By analysis that shows variance as a function of frequency, it is possible to determine the relative input from each system on cardiac function.[26]

The aim of this study was to investigate the physiological effects when a single cranial technique (CV4) is administered compared with simple touch.

2. Methods

2.1. Subjects

Ten individuals (six females and four males) of mean (SD) age = 29.8 (6.3) years (range 22–40 years) were recruited into the study. All subjects were non smokers and not receiving any current treatment or in any pain or discomfort. They had no history of skull surgery, neurological disease, cerebrovascular accident or head injury. Subjects were not taking any medications relating to their cardiovascular system, influencing the sympathetic or parasympathetic nervous system or controlling their appetite. Subjects were asked to avoid beverages containing caffeine for the six hours prior to their experiment. The Unitec Research Ethics Committee approved the study, and written informed consent was obtained from all subjects.

2.2. Practitioner

The practitioner who administered the technique in this study has over eight years experience as an osteopath using osteopathy in the cranial field as the primary treatment modality. The practitioner estimated that 90% of treatments on a daily basis would consist of cranial manipulation. The practitioner has undertaken multiple postgraduate courses in the cranial field, including those run by the Sutherland Cranial Teaching Foundation. The practitioner also reported they had recently attended professional development courses in the 'biodynamic' form of cranial osteopathy.

2.3. Variables and operational definitions

2.3.1. Independent variables

The CV4 was performed in a manner that is consistent with that described by Chaitow.[25] The practitioner sat at the head of the table with their arms resting on the plinth. The patient was supine. The practitioners fingers were interlocked to form a bowl which cradles the patients head so that the thenar eminences were lateral to the external occipital protruberances, but medial to the lateral angles of the occipital squama. The practitioner then waited until able to palpate the cranial rhythm. During the extension phase the practitioner applied very slight pressure medially, exaggerating the motion of that phase. The pressure was generated from the deep flexors of the forearm and maintained until the cranial rhythm stopped (and event also known as the 'still point'). When a strong motion was felt bilaterally the resistance was then discontinued. The motion was followed and the cranial rhythm was reassessed.

During the 'touch only' phase the same hand hold was used, but the practitioner was instructed not to consciously 'engage' with the patient or provide any therapeutic intent or treatment.

2.3.2. Dependent variables

Ambient temperature and humidity: The laboratory was monitored to ensure a constant temperature. Ambient temperature and humidity were recorded at both the commencement and the conclusion of each experiment.

Four outcome measures were assessed for each subject during the experiment. A Powerlab Data Acquisition system (Model 4/SP, AD Instruments Pty Ltd, Victoria, Australia) was used to receive data from the transducers and plot the data against time on an electronic chart display (Chart v 5.0.1, AD Instruments). All data were saved onto hard disk for future off line analysis.

Galvanic skin resistance (GSR): GSR is a measure of skin conductance recording the activity of the sweat glands in response to sympathetic stimulation. Bipolar finger electrodes (ML116F, AD Instruments) were secured onto the first and fourth finger between the distal and proximal metacarpophalangeal joints.

Skin temperature: A small temperature probe (MLT409, AD Instruments) was secured to the skin on the third finger between the distal and proximal metacarpophalangeal joints using medical tape. The initial skin temperature was measured for all subjects prior to the experiment starting to ensure it was close to or exceeded 32 °C.[27]

Heart-rate variability: A three-lead electrocardiogram monitored the activity of the heart from which the length of the R-R intervals could be established (ML132, AD Instruments).

Respiration rate: A Respiratory Belt Transducer (MLT1132, AD Instruments) was secured at the level of the xiphoid process monitoring expansion of the chest.

2.3.3. Experimental procedure

The experiment consisted of five phases. The subject was asked to lie supine on a standard treatment table and the practitioner sat at the head of the table but had no physical contact with the participant in this initial phase. The transducers were connected to the subject as previously described. The subject was also asked to keep their eyes closed as the beginning of each phase was signalled by subtle eye contact between researcher and practitioner.

Phase 1 was a settling period as baseline readings were taken for 10 min. Phase 2 consisted of 5 min of touch only; on a signal from the researcher the practitioner assumed the correct hand position but did not consciously engage with the patient. Phase 3 was the intervention; when signalled to begin the CV4 the practitioner initiated the technique. To accommodate the differences in individual response to the cranial technique, the practitioner dictated the length of this phase. The process then reversed to 5 min of touch only during phase 4, and in phase 5 the practitioner removed their hands and sat quietly. The participant was then disconnected from the equipment and physically separated from the practitioner as they were both asked to privately note in writing their impressions of the experience. These subjective responses will not be addressed in the current study.

2.4. Data extraction

For all variables, off line analysis was performed by selecting the last five minutes of Phase 1 (the initial baseline) and the entirety of each successive phase.

2.4.1. Heart rate variability

An algorithm available with the HRV extension package (Chart v. 5.0.1 with HRV extension v. 1.0) detected the R-R intervals of each cardiac cycle. R-R intervals were then displayed in a tachogram and visually inspected in order to set manual thresholds to identify ectopic beats or other artefact. Ectopic beats were excluded from analysis and a new beat was interpolated halfway between the previous and subsequent normal beats as described by Aubert et al.[28] Data were excluded from further analysis if the ectopic rate was greater than 1%.

Power spectral density analysis was calculated with Fast Fourier Transforms to determine how the variance, or power, was distributed as a function of frequency. By convention, spectral power is distributed into four bands; ultra low frequency (ULF, <0.003 Hz), very low frequency (VLF, 0.003–0.04 Hz), low frequency (LF, 0.04–0.15 Hz), and high frequency (HF, 0.15–0.5).[26] The data were then pooled for all subjects.

2.4.2. Skin conductance and skin temperature

The analysis of skin conductance and skin temperature was performed by extracting data every 0.2 ms from each phase (the last 5 min of Baseline 1) which was averaged for the individual in each phase. The data were then pooled for all ten subjects.

As galvanic skin response is extremely sensitive to physiological change,[29] the first minute of each phase was also examined to see if there was an initial effect that may have been masked by the rest of the phase. The response was calculated as a percentage change from the previous baseline. The previous baseline was defined as the average value from the last minute in the preceding phase.

2.4.3. Respiration rate

The respiratory data was converted into cyclic measurements using Chart 5.0.1 (AD Instruments) as breaths per minute. The average breathing rate per minute for each phase was calculated and the data for all ten subjects was pooled.

2.5. Data analysis

For all data, inspection of the histograms and Q-Q plots as well as the Shapiro–Wilk test of normality were used to ascertain whether the data was normally distributed. If parametric, one way ANOVAs were used to compare means between phases. The two assumptions for a one way ANOVA are that the variable is normally distributed and that the groups have

approximately equal variance. Levene's test of homogeneity of variance was used to test the variance and ensure that the two assumptions had been met. As there were equal numbers of subjects in each phase the Tukey post hoc comparison was used.[30] If the data were not normally distributed, then the Wilcoxon Signed Ranks test was applied. Cohen's *d* was manually calculated to assist interpretation of the magnitude of differences between the various phases of the experiment and was interpreted according to the criteria described by Cohen.[31] All other statistical analysis was performed using SPSS v.12.0.1 for Windows (SPSS Inc., Chicago, IL).

3. Results

3.1. Environment

The mean average room temperature was 24 °C (SD 0.33) with a mean humidity reading of 50.35% (SD 4.82). Across all experiments the maximum variation in room temperature was 0.8 °C and humidity was 15%. The maximum variation in temperature and humidity within any single session was 0.3 °C and 2% respectively.

3.2. Skin temperature

The results of analysis of skin temperature are illustrated in Fig. 1. Nine out the ten subjects had an initial skin temperature greater than 32 °C (min 31 °C, max 36 °C) There were no significant differences in skin temperature between Baseline 1 and Touch 1, Baseline 1 and CV4 or Touch 1 and CV4 analysed by the Wilcoxon Signed Ranks test.

3.3. Galvanic skin response (skin conductance)

The results of analysis of galvanic skin response are illustrated in Fig. 2. A one-way ANOVA determined that there were no statistical differences in the mean galvanic skin response between any of the five phases. The initial response over the first minute of each phase is illustrated in Fig. 3. The maximum changes from previous baseline occur in the phases Touch 1 and Baseline 2.

3.4. Heart rate variability

One subject's data was excluded from further analysis due to an ectopic rate higher than 1%. The results of analysis of heart rate variability (normalised units) are illustrated in Fig. 4. As reported in Tables 1 and 2, a one-way ANOVA determined that there was no statistical difference between high frequency or low frequency data in any of the five phases.

3.5. Respiration rate

The pooled data from all ten subjects showed a consistent respiration rate through all five phases. The mean breathing rate for the whole experiment was 14.12 (SD 3.2) breaths per minute.

3.6. Individual responses

Three subjects showed individual increases in parasympathetic modulation initiated in the technique phase that continued at a lower level through the rest of the experiment. The results for one of them, Subject D, are shown in Fig. 5.

4. Discussion

The aim of this study was to investigate the physiological effects when a single cranial technique (CV4) is administered compared with simple touch. The results of this study demonstrated that the application of the

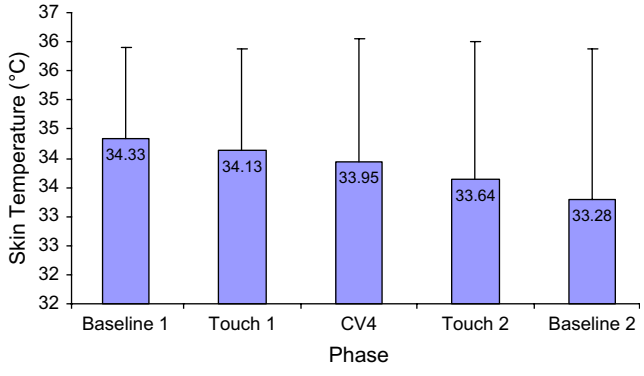

Fig. 1. Histogram illustrating the average skin temperature ($n = 10$) across each of the five phases. Error bars represent standard deviation. No significant differences were detected between Baseline 1, Touch 1 or CV4 using Wilcoxon Signed Ranks test.

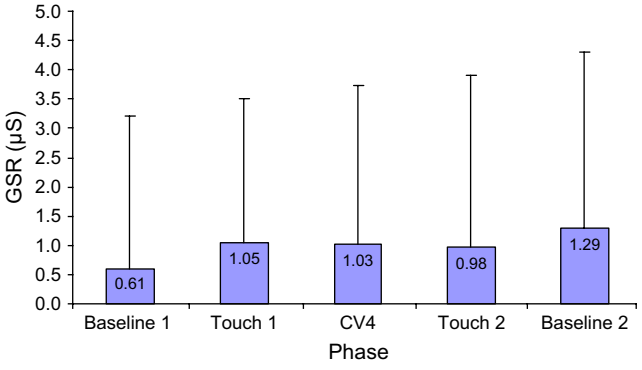

Fig. 2. Histogram illustrating the average galvanic skin response ($n = 10$) across each of the five phases. Error bars represent standard deviation. No significant differences were found between any of the five phases when a one way ANOVA was applied with the Tukey post hoc test.

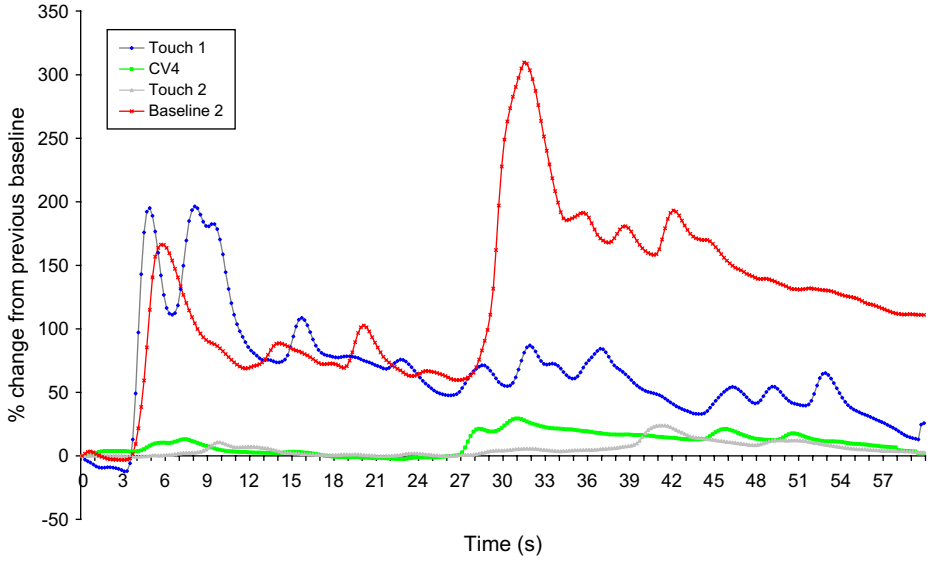

Fig. 3. Line graph illustrating the average galvanic skin response for all subjects ($n = 10$) during the initial minute of each phase.

CV4 technique when compared to simple touch in asymptomatic individuals had minimal physiological effect in any of the autonomic variables recorded.

Bogduk and Mercer[32] suggest that any form of treatment can be evaluated against the three separate axes of 'convention', 'biological basis' and 'empirical proof'. As there has been very little research investigating osteopathy in the cranial field, much of the evidence lies on the axis of 'convention', bound by assertions from teachers, experienced practitioners and experts in the field.[32] To highlight this point, this passage from Chaitow[25] describes the anecdotal evidence provided in textbooks pertaining to the CV4:

The 4th ventricular compression (CV4) is profoundly relaxing, enhancing cranial rhythmic function and improving lymphatic flow. It seems to enhance the movement of fluid, changes the rhythm of the diaphragms, and increases the temperature in the suboccipital region.[33] *Ettlinger and Gintis*[34] *state that it has been used successfully to relieve headaches, reduce fever, assist in difficult labour, relieve congested sinuses and lungs and reduce edema. It can also be used to reduce trauma such as whiplash. Upledger and Vredevoogd*[35] *believe that 'CV4 affects diaphragm activity and autonomic control of respiration and seems to relax the sympathetic nervous system tonus to a significant degree.*

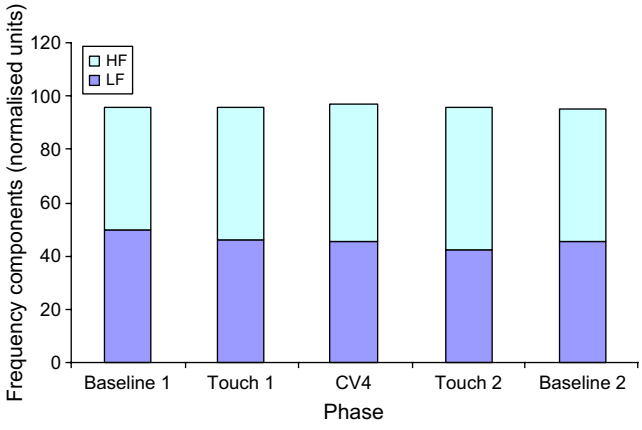

Fig. 4. Histogram illustrating the distribution of spectral power between high frequency and low frequency in normalised units ($n = 9$) across each of the five phases.

Anecdotal evidence typically describes isolated cases but is regarded as the lowest level of evidence as it documents solitary case reports rather than repeatable collective results obtained from scrutinised scientific studies.[36] One of the limitations of anecdotal evidence is that it is subject to various forms of cognitive bias, for example confirmation and self-serving bias. Confirmation bias describes the inherent tendency to interpret information in a way that confirms the preconceptions held by the individual.[37] Self serving bias prompts people to claim more success than failure, recognising personal responsibility for success but attributing external factors to failure.[38] Anecdotal evidence is also often distorted by an overestimation of prevalence.[39] Several authors[40–42] suggest that case reports should not be used as evidence, but for generating research questions to be investigated by methodologically sound studies.

The aim for the current experimental work was to provide objective data to support the anecdotal evidence that is described in Chaitow.[25] As the CV4 has been claimed to lower the tone of the sympathetic nervous system, it was theorised that the autonomic measures recorded would reflect a decrease in sympathetic activity and an increase in parasympathetic modulation during the application of the technique. Of all the measures of autonomic activity employed in the current study heart rate variability proved to be the most useful. It is widely accepted that

Table 1
Results from the one-way ANOVA performed to compare the mean values of the high frequency data (HF) in each phase (normalised units)

Phase	Pooled mean (SD)	Difference between means[a]	95% Confidence interval		*P* value	Effect size[b]
			Lower bound	Upper bound		
Baseline 1	**46.2 (24.2)**					
Touch 1	49.7 (25.4)	−3.52	−38.06	31.02	1	0.14 (Trivial)
CV4	51.5 (28.7)	−5.39	−39.93	29.15	0.99	0.20 (Small)
Touch 2	53.3 (26.2)	−7.1	−41.64	27.44	0.98	0.29 (Small)
Baseline 2	49.6 (23.5)	−3.46	−38	31.08	1	0.14 (Trivial)
Touch 1	**49.7 (25.4)**					
Baseline 1	46.2 (24.2)	3.52	−31.02	38.06	1	0.14 (Trivial)
CV4	51.5 (28.7)	−1.88	−36.41	32.66	1	0.07 (Trivial)
Touch 2	53.3 (26.2)	−3.58	−38.12	30.96	1	0.14 (Trivial)
Baseline 2	49.6 (23.5)	0.05	−34.49	34.59	1	0.00 (None)
CV4	**51.5 (28.7)**					
Baseline 1	46.2 (24.2)	5.39	−29.15	39.93	0.99	0.20 (Small)
Touch 1	49.7 (25.4)	1.88	−32.66	36.41	1	0.07 (Trivial)
Touch 2	53.3 (26.2)	−1.71	−36.25	32.83	1	0.07 (Trivial)
Baseline 2	49.6 (23.5)	1.93	−32.61	36.47	1	0.07 (Trivial)
Touch 2	**53.3 (26.2)**					
Baseline 1	46.2 (24.2)	7.1	−27.44	41.64	0.98	0.28 (Small)
Touch 1	49.7 (25.4)	3.58	−30.96	38.12	1	0.14 (Trivial)
CV4	51.5 (28.7)	1.71	−32.83	36.25	1	0.07 (Trivial)
Baseline 2	49.6 (23.5)	3.64	−30.9	38.18	1	0.15 (Trivial)
Baseline 2	**49.6 (23.5)**					
Baseline 1	46.2 (24.2)	3.46	−31.08	38	1	0.14 (Trivial)
Touch 1	49.7 (25.4)	−0.05	−34.59	34.49	1	0.00 (None)
CV4	51.5 (28.7)	−1.93	−36.47	32.61	1	0.07 (Trivial)
Touch 2	53.3 (26.2)	−3.64	−38.18	30.9	1	0.15 (Trivial)

Nine-subjects data were pooled and the post hoc test used was Tukey.
[a] Difference between means is the difference between the pooled mean for the relevant phase and the bolded mean immediately above.
[b] Effect size (Cohen's d) calculated for the difference between the pooled mean for the relevant phase and the bolded mean immediately above.

the high frequency band (HF) is a function of the parasympathetic nervous system, whereas the low frequency band (LF) comprises both parasympathetic and sympathetic input.[26] In the current study there were no differences between parasympathetic and sympathetic levels of modulation across each of the five phases. This pilot study does not support the theorised effects of the CV4 technique (described by Chaitow[25]) commonly promulgated by practitioners of cranial manipulation.

One recent study has investigated the effects of the CV4 technique on sleep latency and muscle sympathetic nerve activity (MSNA).[24] Results showed that sleep latency was significantly decreased during the CV4 trial when compared to both the CV4 sham or control trials, and MSNA was decreased during the CV4 induced still point of the cranial rhythmic impulse.[24] As the autonomic nervous system is known to play an important role in sleep/wake cycles these preliminary results possibly indicate a functional relationship with the CV4 and the autonomic nervous system. This relationship is also commonly reported within anecdotal evidence within the profession. The current study aimed to deconstruct this concept and document related physiological changes in variables of autonomic function.

While examining individual heart rate variability data it became apparent that three of the subjects may have responded in a manner that was consistent with an increase in parasympathetic activity during the treatment phase. This identification leads to the notion that there may be both 'responders' and 'non-responders' to cranial treatment. Effects shown in three individuals would have been diluted when the results for all subjects were pooled. Fig. 5 illustrates the data from one subject ('D') that was identified as a possible 'responder' showing a noticeable increase in parasympathetic modulation during the application of the CV4 technique that was maintained at a lower level for the remainder of the experiment.

It may be that 'responders' to cranial treatment propagate the anecdotal evidence that is reported. Where a cause can be easily linked to an effect, it is common to overestimate the likelihood of that causal link especially when the outcome is emotionally laden and attributed to success.[39] As successful outcomes are both prioritised and recalled, they are likely to reinforce the preconceptions held by the individual and circulate as further 'evidence'. For every piece of anecdotal evidence, the number of people not reporting the same experience is impossible to assess.

One of the obvious limitations of the current study is that the technique was performed on healthy asymptomatic individuals. No attempt was made to ascertain whether the subject would be likely to receive this

Table 2
Results from the one-way ANOVA performed to compare the mean values of the low frequency data (LF) in each phase (normalised units)

Phase	Pooled mean (SD)	Difference between means[a]	95% Confidence interval		*P* value	Effect Size[b]
			Lower bound	Upper bound		
Baseline 1	**49.6 (25.3)**					
Touch 1	45.9 (26)	3.79	−30.22	37.80	1	0.14 (Trivial)
CV4	45.2 (28.6)	4.43	−29.58	38.44	0.99	0.16 (Trivial)
Touch 2	42.3 (24.3)	7.26	−26.75	41.27	0.98	0.29 (Small)
Baseline 2	45.5 (21.6)	4.12	−29.89	38.13	1	0.17 (Trivial)
Touch 1	**45.9 (26)**					
Baseline 1	49.6 (25.3)	−3.79	−37.80	30.22	1	0.14 (Trivial)
CV4	45.2 (28.6)	0.64	−33.37	34.65	1	0.03 (Trivial)
Touch 2	42.3 (24.3)	3.47	−30.54	37.48	1	0.14 (Trivial)
Baseline 2	45.5 (21.6)	0.33	−33.68	34.34	1	0.02 (Trivial)
CV4	**45.2 (28.6)**					
Baseline 1	49.6 (25.3)	−4.43	−38.44	29.58	0.99	0.16 (Trivial)
Touch 1	45.9 (26)	−0.64	−34.65	33.37	1	0.03 (Trivial)
Touch 2	42.3 (24.3)	2.83	−31.18	36.84	1	0.11 (Trivial)
Baseline 2	45.5 (21.6)	−0.31	−34.32	33.70	1	0.01 (Trivial)
Touch 2	**42.3 (24.3)**					
Baseline 1	49.6 (25.3)	−7.26	−41.27	26.75	0.98	0.29 (Small)
Touch 1	45.9 (26)	−3.47	−37.48	30.54	1	0.14 (Trivial)
CV4	45.2 (28.6)	−2.83	−36.84	31.18	1	0.11 (Trivial)
Baseline 2	45.5 (21.6)	−3.14	−37.15	30.87	1	0.14 (Trivial)
Baseline 2	**45.5 (21.6)**					
Baseline 1	49.6 (25.3)	−4.12	−38.13	29.89	1	0.17 (Trivial)
Touch 1	45.9 (26)	−0.33	−34.34	33.68	1	0.02 (Trivial)
CV4	45.2 (28.6)	0.31	−33.70	34.32	1	0.01 (Trivial)
Touch 2	42.3 (24.3)	3.14	−30.87	37.15	1	0.14 (Trivial)

Nine-subjects data were pooled and the post hoc test used was Tukey.
[a] Difference between means is the difference between the pooled mean for the relevant phase and the bolded mean immediately above.
[b] Effect size (Cohen's *d*) calculated for the difference between the pooled mean for the relevant phase and the bolded mean immediately above.

technique in clinical practice. The technique was not contraindicated but may not have been clinically indicated. However the aim of the current study was to determine if the concept validity of the CV4 technique was supported with an observable physiological response. It was therefore appropriate for this initial line of enquiry to document whether there was a physiological response in asymptomatic subjects. Further research could supplement this enquiry by investigating a group of symptomatic subjects who met clinical indications as outlined by Liem.[3]

Skin temperature showed no significant changes between baseline, simple touch or the application of the CV4 technique. There was a slow decrease in temperature over time, which is consistent with heat dissipation with a decrease in skin blood flow at rest.[43] A number of studies have reported the effects of mobilisation techniques on sympathetic outflow.[44–46] This research, alongside the current study, have shown no significant changes in skin temperature indicating that it may be a less useful measure of sympathetic activity in experiments investigating physiological responses to manual and manipulative techniques.

The results from the galvanic skin response show no differences in average electrical skin resistance between any of the five phases. In Fig. 3 the first minute of each phase is illustrated to show the initial sympathetic skin response with pooled data from all subjects. The maximum changes from previous baseline occur in the phases Touch 1 and Baseline 2. Interestingly, there appears to be a latent sympathetic skin response occurring approximately 30 s into Baseline 2 (after the practitioner's hands are removed from the subjects head). This is mirrored in the CV4 phase, but with smaller magnitude. This apparent stimulatory effect is inconsistent with the relaxing effects traditionally attributed to the CV4. However, there is large

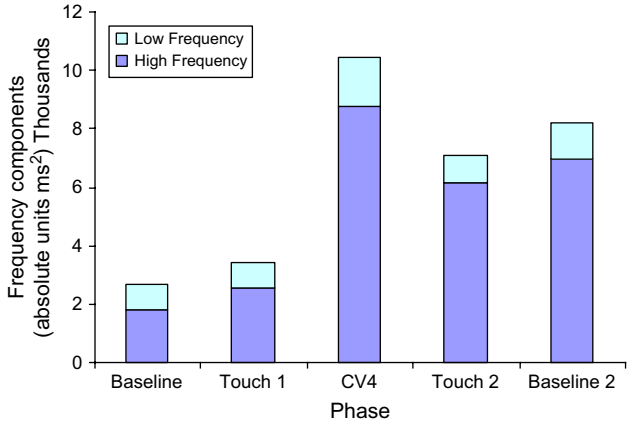

Fig. 5. Histogram illustrating the LF and HF components of autonomic control in absolute units (ms^2) for Subject 'D' throughout the five phases of the experiment.

variability within the results for galvanic skin resistance, similar to that reported in other studies.[29,47] Wide variability is problematic as an effect may have occurred but been masked by the large measure of spread.

In recent literature, it is becoming more apparent that galvanic skin response (GSR) is more complex than originally understood and may be affected by psychological and personality factors.[48] Electrodermal activity has been thought of as an easily obtainable and non-invasive measure of sympathetic activity as sweat glands are exclusively controlled by the sympathetic nervous system. However, Papaousek et al.[49] claim that this view of undifferentiated sympathetic outflow is incorrect, and that electrodermal activity must be regarded as an indicator of a specific sympathetic subsystem which cannot be generalised to other systems. This is supported by reports illustrating that galvanic skin response has little correlation with other parameters representing sympathetic activity such as heart rate or catecholamine concentration in plasma.[50,51]

The respiration rate was monitored for two reasons. Firstly, to see if there was any change evident in breathing rate during the cranial technique as opposed to simple touch. Secondly, respiration has a considerable influence on heart rate variability. Heart rate tends to increase with inspiration and decrease with expiration[52] and the term respiratory sinus arrhythmia (RSA) has been used to describe the fluctuation of R-R intervals relative to respiratory rate. Metronome regulated breathing has been used in previous studies to keep a consistent rate of 15 breaths per minute in order to allow the RSA to be contained in the high frequency band of the spectrum.[53,54] It was decided in the current study that the subject breathing would not be regulated as the CV4 has been reported by Chaitow[25] to have effects on the respiratory system which may be influenced. It was also postulated that subjects would be less likely to relax when receiving treatment as they would have to concentrate of maintaining the regulated breathing. Despite the omission of metronome regulated breathing in the current study, the average respiration rate was approximately 14 breaths per minute which is likely to have contained the respiratory sinus arrhythmia in the high frequency band as recommended. The respiration rate was not altered during the touch or intervention period.

The experiment had a small sample size of ten subjects who were recruited through convenience sampling. This has the advantage of making it easier to locate subjects, but it can lead to an increase in self selection bias as only people motivated to participate in the study will be involved.[55] The subjects were all from the same tertiary institution so the results are likely to be influenced by cluster bias. When subjects are too similar they are consequently unlikely to represent the diversity of the population.[56] Eight out of the ten subjects are enrolled in an undergraduate program in osteopathy. Although none of the subjects had, at the time of data collection, any formal practical training in cranial osteopathy, they had participated in theoretical classes which had discussed the concept of osteopathy in the cranial field (OCF) in the context of differing models of osteopathic treatment. There were only two subjects that were completely naïve to cranial osteopathy ('B', 'J') and both were identified as non-responders. The results of this study should be interpreted cautiously due to the small sample size, the possible preconceptions of the participants and the use of only one cranial practitioner. All of these factors limit the external validity of the study.

Future studies need to address this issue by using both a larger number of naïve subjects from a pool identified by random sampling methods as well as a wider stratified sample of practitioners that would more accurately represent the population who perform cranial manipulation. Heart rate variability is a useful and accurate measure of autonomic activity that may have a relationship with cranial manipulation. Further research could investigate the autonomic activity of both practitioner and patient in the clinical setting. This would increase the pragmatic value of future physiological investigation and more accurately represent the interaction that occurs in a therapeutic environment.

5. Conclusion

The results of this pilot study fail to support the theorised effects of the CV4 technique commonly described by cranial practitioners. In response to application of the technique there was minimal physiological changes observed in the autonomic measures investigated. Additional research is required if the hypothesised physiological effects of techniques used in the field of cranial manipulation are to be demonstrated in the laboratory setting.

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