Influence of Osteopathic Palpatory Examination on Sympathetic Nervous System Function: A Pilot Study

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ABSTRACT

Objective: To investigate the influence of osteopathic palpatory examination on sympathetic nervous system function.

Design: A randomized, double-blind, placebo-controlled, within-subjects study of the effect of osteopathic palpatory examination.

Setting: Osteopathic medicine clinic consulting room.

Participants: Fourteen participants (6 male and 8 female volunteers, age of 21.4 ± 0.9 years (range: 20 - 23 years)) completed this study.

Intervention: An osteopathic screening examination of the thoracic spine, involving the assessment of the active, passive, active resisted and accessory ranges of motion and palpation of adjacent soft tissues. The placebo condition involved the examiner standing behind the seated participant. The examiner placed their hands on the participant's thoracic spine for a period of 5 minutes. The control condition involved the examiner standing behind the seated participant with no physical contact between them. This was maintained for a period of 5 minutes.

Outcome Measures: Systolic blood pressure, diastolic blood pressure, heart rate and skin conductance.

Results: Examination condition produced a statistically significant 6.8% decrease in skin conductance ($F = 6.705$, $p = 0.004$). Control and placebo conditions did not produce a significant change in skin conductance. Systolic and diastolic blood pressure and heart rate did not change significantly following the examination, control or placebo conditions.

Conclusion: Osteopathic palpatory examination of the thoracic spine influences sympathetic nervous system function, significantly reducing electrical skin conductance.

Key Indexing Terms: Osteopathic Palpatory Examination; Sympathetic Nervous System.

INTRODUCTION

In the last 10 years many studies have been conducted in an effort to uncover the analgesic and physiological effects of spinal manipulative therapy (SMT) (1-13). One of the common observations following SMT in the clinical setting is hypoalgesia, however the mechanism by which it is produced remains to be fully explained (1). This hypoalgesia maybe in part associated with the descending pain inhibitory systems (DPIS), and its close connection to the sympathetic nervous system (SNS) (1-13), producing associated physiological changes.

Early research into the DPIS highlighted the importance of the periaqueductal grey (PAG) area in the control of nociception (2). Further work identified two key regions within the caudal PAG; the ventral system (vPAG) and dorsal system (dPAG) (3-5). Animal research examining the functions of these regions found that stimulation of the vPAG elicited analgesia in association with immobility or freezing, recuperative behaviour and sympathoinhibition (3-5). Stimulation of the dPAG elicited analgesia in association with fight/flight behaviour, aversive reactions and sympathoexcitation. (3-5). Excitatory effects to the SNS were reported by Lovick (5), who found stimulation of the dPAG in rats resulted in analgesia, increased blood pressure, increased heart rate, vasodilation in hind limb muscles and increased rate and depth of respiration, indicative of sympathoexcitation.

Recent research has been focused on determining whether the same pathways are responsible for the analgesic and SNS changes associated with SMT (6-10). Oscillatory postero-anterior (PA) glide techniques applied to the lower cervical spine of asymptomatic subjects produced an initial hypoalgesic effect as measured by an increase in pressure pain threshold at the C5/6 articular pillar (6) and over the deltoid insertion in asymptomatic subjects (7). This finding was supported by Sterling et al (8), who concluded a unilateral grade III PA mobilization technique applied to the symptomatic side of the C5/6 motion segment produced a hypoalgesic effect to mechanical nociception.

The hypoalgesic effect of a lateral glide mobilization of the C5/6 motion segment has also been investigated in subjects with lateral epicondylalgia (9). Vicenzino et al (9) concluded that a manipulative therapy treatment technique applied to the lower cervical spine produced hypoalgesia at the elbow. Similar hypoalgesic effects were found when investigating the effect of a lateral glide mobilization to the elbow itself (10). Further research (11) investigated the interrelationship between manipulative therapy-induced hypoalgesia and sympathoexcitation in subjects with lateral epicondylalgia. Vicenzino et al (11) found that mobilization of the C5/6 motion segment not only produced hypoalgesic effects but also sympathoexcitation, as measured by increases in cutaneous blood flux at the elbow and skin conductance.

The influence of mobilization techniques on SNS function has been widely investigated, using outcome measures of heart rate (12, 13), blood pressure (12, 13), skin conductance (8, 11), skin temperature (8) and respiratory rate (13). Sympathoexcitatory responses as measured by heart rate, diastolic and systolic blood pressure increases during mobilization were significantly greater than changes observed in control and placebo groups. Skin conductance was found to significantly increase during cervical mobilization (8, 11), and although skin temperature also increased, this was not significantly different from control and placebo groups (8). Skin conductance is dependent upon sweat gland activity, which is controlled by the SNS. Therefore, excitation of the SNS, which increases sweat gland activity, results in increased skin conductance measures. Cervical mobilization also produces a significant increase in respiratory rate when compared to both control and placebo groups (13). All these findings represent the excitation of the SNS in response to grade III mobilization. In those studies that examined both SNS function and pain perception (8, 11), it was found that hypoalgesia always occurred in conjunction with sympathoexcitation. The studies suggest the control center responsible for this relationship is the dPAG.

To date the influence of palpatory examination on cardiovascular and SNS measures has not been investigated. Osteopathic palpatory examination includes the assessment of both joint movements and the quality of the surrounding soft tissues. Movements comprise active, passive, active resisted and accessory movements, assessing the overall quality and quantity of movement. Palpation of soft tissues aims to determine the presence of abnormal tension in underlying muscles, ligaments, fascial bands and tendons (14). This current observational study aims to examine the influence of osteopathic palpatory examination of the thoracic spine on sympathetic nervous system function and to investigate whether the examination process produces similar results as with treatment protocols of previous studies.

METHOD

Participants

Fourteen participants (6 male and 8 female volunteers: age 21.4 ± 0.9 years (range: 20 - 23 years)) completed this study. Volunteers underwent a screening process that ensured participants selected for the study were healthy, pain-free and with no history of cardiac disorders, back pain or pathology. As this was a convenience sample and because pain measures were not being investigated pain-free participants were used. All participants were drawn from the population of osteopathic medicine students studying at Victoria University. The Victoria University Human Ethics Committee provided ethical clearance for the study. Consent forms that contained information about the nature of the study were signed by all participants prior to participating in the study.

Outcome measures

Arterial blood pressure

Blood pressure was measured with a Digital Electronic Blood Pressure Monitor (M4 model, OMRON Medical, Japan). This device automatically determines the systolic and diastolic blood pressure once the brachial pressure cuff is inflated. The blood pressure cuff was applied to the left arm of all participants. The same investigator was responsible for taking all measures of blood pressure. These were recorded after the 10 minute rest period and straight after the treatment protocol.

Heart rate

Heart rate was measured with the Digital Electronic Blood Pressure Monitor (M4 model, OMRON Medical, Japan). While inflated this device automatically detects the pulse of the brachial artery. The same investigator was responsible for taking all measures of heart rate. These were recorded after the 10 minute rest period and straight after the treatment protocol.

Skin conductance

Skin conductance (SC) was measured using a PowerLab (ADInstruments), with GSR Amp attached. Metal plates were attached to the palmar middle phalanx of the second and third digits to detect electrical skin conductance. The plates were attached to the right hand of all participants. The same investigator was responsible for taking all measures of skin conductance. These were recorded after the 10 minute rest period and straight after the treatment protocol.

Treatment protocols

Treatment

The treatment protocol was an osteopathic palpatory screening examination of the thoracic spine. This involved the examiner assessing the active, passive, active resisted and accessory ranges of motion of each participant's thoracic spine and palpation of adjacent soft tissues (thoracic erector spinae muscle group). Active, passive and active resisted movements consisted of flexion, extension, side bending and rotation. Accessory movements consisted of anterior-posterior springing of spinous processes and rib angles (15). Duration of treatment was 5 minutes.

Placebo

The placebo protocol involved the examiner standing behind the seated participant. The examiner placed their hands on the participant's thoracic spine for a period of 5 minutes. This followed the procedure documented by Vicenzino et al (11).

Control

The control protocol involved the examiner standing behind the seated participant with no physical contact between them. This was maintained for a period of 5 minutes. This followed the procedure documented by Vicenzino et al (11).

Laboratory conditions

The study was conducted in a noise attenuated, temperature controlled examination room (temperature 21.3°C ± 0.4). Control of these environmental conditions served to minimize any potentially confounding influences in measures of SNS function. (7, 13)

Procedure

This study used a within-subjects design in which each participant experienced all three treatment protocols (treatment, placebo and control) in a randomised order. All experimental procedures were carried out on the same day. Prior to each treatment protocol participants were positioned supine and connected to monitoring equipment. Baseline measures of blood pressure, heart rate and skin conductance were taken after 10 minutes supine rest. Following this the participant underwent the nominated treatment protocol for 5 minutes before they returned to the supine position when post intervention measures of blood pressure, heart rate and skin conductance were recorded. During the procedure both the data recorder and participants were blind to the treatment protocol, while the examiner and participants were blind to the measures.

Data analysis

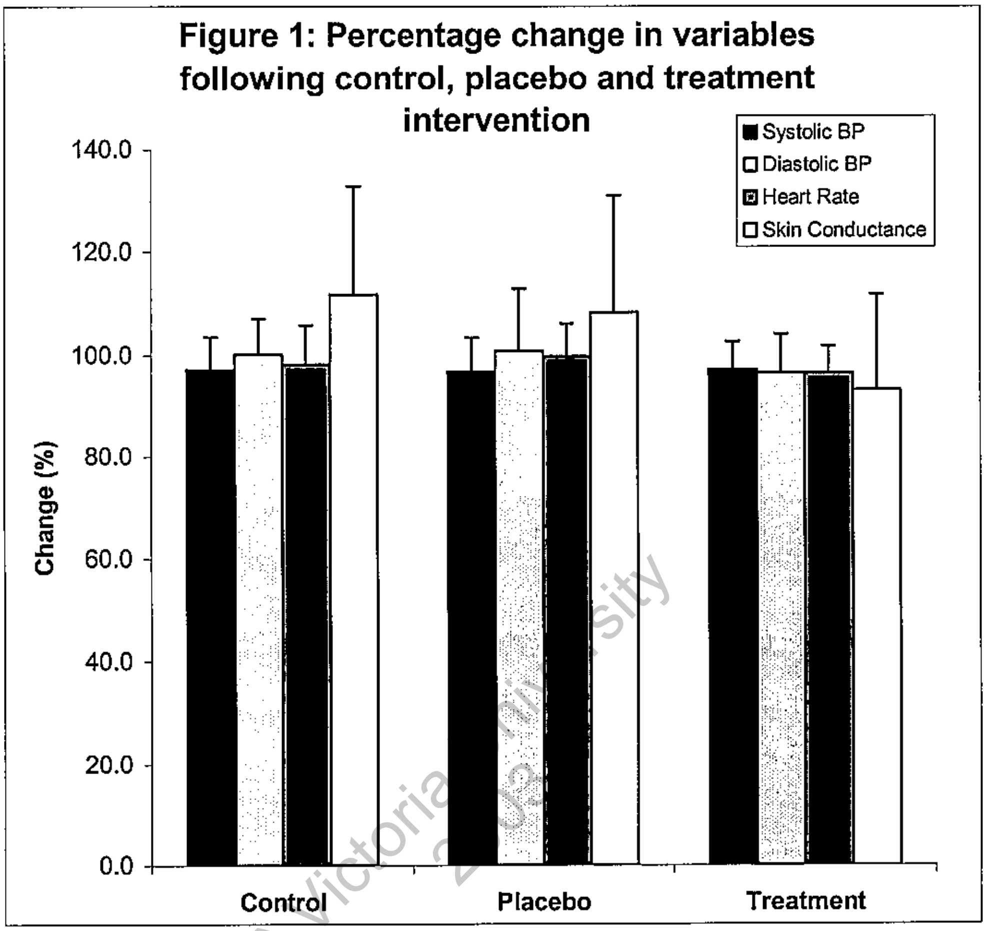
The raw data for the dependent variables (heart rate, skin conductance, systolic and diastolic blood pressure) were expressed as a mean percentage change from baseline values, which were designated as 100%. Statistical analysis of the data was undertaken using a one-way repeated measures of variance (ANOVA) using SPSS software (version 11.0).

RESULTS

The mean percentage change for heart rate, skin conductance, systolic and diastolic blood pressure during the thoracic examination, placebo and control protocols are presented in Figure 1. The results of repeated measures test for within-subjects effects is shown in Table 1. This shows that skin conductance was the only measure to demonstrate a statistically significant change.

There was a significant main effect of treatment protocol for skin conductance ($F = 6.705$, $p = 0.004$). The treatment protocol produced a 6.8% decrease in skin conductance, compared to an 11.8% increase for the control and 8.3% increase for the placebo protocols. By examining the skin conductance means for the control, placebo and treatment protocols, it can be seen that the significant difference is most likely to be between the treatment and control, and treatment and placebo protocols (Table 2).

Systolic blood pressure decreased slightly following all protocols. Both the treatment and control protocols produced a 2.8% decrease, compared to a 3.2% decrease for the placebo protocol. Diastolic blood pressure was decreased by 3.4% following the treatment protocol, whilst the control and placebo protocols increased diastolic blood pressure by 0.2% and 0.8% respectively.
Heart rate followed a similar pattern to systolic blood pressure, decreasing following all protocols. The treatment protocol produced a 3.4% decrease, compared to a 1.7% decrease for the control and 0.2% decrease for the placebo protocols.



	Systolic BP	Diastolic BP	Heart Rate	Skin Conductance
Level of Significance	0.335	0.162	0.158	0.004

Table 1: Repeated measures test for within-subjects effects

	Control	Placebo	Treatment
SC mean	111.8 (±21.0)	108.3 (±22.7)	93.2 (±18.6)

Table 2: Mean percentage change in skin conductance following application of control, placebo and treatment protocols.

DISCUSSION

This study demonstrated that osteopathic palpatory examination of the thoracic spine produced decreases in skin conductance, as measured over the palmar middle phalanx of the second and third digits. Treatment effects observed were greater than changes produced by the placebo and control protocols.

The results of this current study are in contradiction to those of similar studies. Vicenzino et al (11) reported a significant 69% increase in skin conductance from baseline during application of cervical mobilisation compared with both placebo and control conditions. Lesser, but still significant, changes were reported by Sterling et al (8), who also measured skin conductance changes following cervical mobilisation. The authors measured an overall increase in the effect of 16%. Our study demonstrated a 6.8% decrease, while the other treatment conditions exhibited increases in skin conductance.

Other measures of SNS activity, namely systolic blood pressure, diastolic blood pressure and heart rate did not demonstrate any significant changes. Similar studies investigating the effects of mobilisation have, however, reported significant changes in these variables following mobilization at the C5/6 motion segment (12, 13). Vicenzino et al (13) found that diastolic and systolic blood pressure increased by 14%, while heart rate increased by 13%. Similar results were noted by McGuiness et al (12), observing a 12.5% increase in diastolic blood pressure, a 4.5% increase in systolic blood pressure and a 10.5% increase in heart rate.

Unlike the findings of the other research mentioned above, this current study found an overall trend towards sympathoinhibition rather than excitation. A significant decrease in skin conductance was found, while systolic and diastolic blood pressure and heart rate were also observed to decrease following the examination protocol. Previous studies have also found that sympathoexcitation is present in conjunction with hypoalgesia (8, 11) it may be possible that palpatory examination could produce or exacerbate hyperalgesia in conjunction with sympathoinhibition. That osteopathic palpatory examination may elicit a hyperalgesic response is important in the clinical setting, as it may assist in provoking a patient's familiar pain to identify the tissue/s causing pain. Future studies looking into this area of research should incorporate measures of algesia to see if any such relationships do in fact exist.

This observational study aimed to see whether the osteopathic examination process produced similar results to those of previous studies using a treatment protocol. The observation that the results of this current study differ from these studies may lie in the differing treatment intervention. Where similar studies utilize mobilisation techniques applied to the cervical spine, this study used osteopathic examination of the thoracic spine in the way of motion and soft tissue palpation. It may be that osteopathic palpatory examination of the thoracic spine, at least, does not provide a great enough stimulus to activate the dPAG, as described in previous research.

Cervical mobilisation directly stimulates local sympathetic fibres and cervical ganglia (8, 12) which in turn are capable of directly, or indirectly, activating PAG mechanisms (13). In particular, these ganglia have connections with fibres innervating the heart, and may contribute to the observed increase in heart rate of similar studies (12). Other receptors located within the joints, capsules, ligaments, connective tissues and tendons of the cervical spine may also influence PAG activity (13). Due to its close anatomical relationship, cervical manipulation may also have a direct effect on the phrenic nerve (12) and/or baroreceptors within the vascular tree, thereby influencing and contributing changes in cardiovascular function (13). The examination protocol of this current study did not involve the cervical region, and therefore future research should incorporate osteopathic palpatory examination of the cervical spine as the treatment protocol, to gauge the influence of these structures.

The influence of psychological state must not be overlooked when interpreting SNS function. Many studies have investigated the effect of mental state, fear and anxiety on SNS activity, and more specifically, skin conductance (16-20). Skin conductance was found to decrease following osteopathic palpatory examination of the thoracic spine in this current study. This reduction may be due to participants being drawn from a population of osteopathic medicine students. The examination procedure used was familiar to all participants, thereby possibly producing a decreased anxiety response. Studies have demonstrated that increased anxiety levels correlate with increases in skin conductance. Caparara et al (16) found a statistically significant correlation between increased skin conductance and dental anxiety in subjects undergoing a routine dental examination. Similar results were found in subjects attending a routine eye examination (17). Studies involving mobilisation may have found differing results to this current study due to their use of participants unfamiliar with the treatment protocol, who may have been anxious during testing.

Research has demonstrated that relaxation techniques produce decreases in both heart rate and skin conductance (18). Although we did not find a significant decrease in heart rate, this may explain the reduction in skin conductance observed in this current study, with the treatment protocol being interpreted as a pleasant or relaxing experience. The palpation of soft tissue structures is after all, not that different from soft tissue massage techniques.

Findings of this study may also be indicative of possible involvement of the vPAG. Stimulation of the vPAG elicited analgesia in association with immobility or freezing, recuperative behaviour and sympathoinhibition in the rat subject (5). The results of this current study did indicate a trend of sympathoinhibition. However as skin conductance was the only outcome measure to show a significant decrease further research in this area is needed before any substantiated claims can be made.

Osteopathic palpatory examination may elicit a hyperalgesic response. This is important in the clinical setting as it may assist in provoking a patient's familiar pain to identify the tissue/s causing pain.

CONCLUSION

This study has found that osteopathic palpatory examination of the thoracic spine significantly reduces electrical skin conductance compared to placebo and control conditions. Although contradictory to previous studies investigating mobilization, this study has shown that osteopathic palpatory examination may influence sympathetic nervous system function.

REFERENCES

1. Wright A. Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological mechanism. Manual Therapy 1995;1:11-16.
2. Reynolds DV. Surgery in the rat during electrical analgesia by focal brain stimulation. Science 1969;164:444-445.
3. Morgan MM. Differences in antinociception evoked from dorsal and ventral regions of the caudal periaqueductal gray matter. In: Depaulis A, Bandlier R, editors. The Midbrain Periaqueductal Gray Matter. Plenum Press, New York 1991. p. 139-150.
4. Fanselow MS. The midbrain periaqueductal gray as a coordinator of action in response to fear and anxiety. In: Depaulis A, Bandlier R, editors. The Midbrain Periaqueductal Gray Matter. Plenum Press, New York 1991. p. 151-173.
5. Lovick TA. Interactions between descending pathways from the dorsal and ventrolateral periaqueductal gray matter in the rat. In: Depaulis A, Bandlier R, editors. The Midbrain Periaqueductal Gray Matter. Plenum Press, New York 1991. p. 101-120.
6. Vicenzino B, Gutschlag F, Collins D, Wright A. An investigation of the effects of spinal manual therapy on forequarter pressure and thermal pain thresholds and sympathetic nervous system activity in aymptomatic subjects: A preliminary report. In: Shacklock M, editor. Moving in on Pain. Butterworth-Heinemann, Adelaide 1995. p. 185-193.
7. Wright A, Vicenzino B. Cervical mobilization techniques, sympathetic nervous system effects and their relationship to analgesia. In: Shacklock M, editor. Moving in on Pain. Butterworth-Heinemann, Adelaide 1995. p. 164-173.
8. Sterling M, Jull G, Wright A. Cervical mobilization: concurrent effects on pain, sympathetic nervous system activity and motor activity. Manual Therapy 2001;6:72-81.
9. Vicenzino B, Collins D, Wright A. The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylagia. Pain 1996;68: 69-74.

10. Vicenzino B, Paungmali A, Buratowski S, Wright A. Specific manipulative therapy treatment for chronic lateral epicondylagia produces uniquely characteristic hypoalgesia. Manual Therapy 2001;6:205-212.
11. Vicenzino B, Collins D, Benson H, Wright A. An investigation of the interrelationship between manipulative therapy-induced hypoalgesia and sympathoexcitation. Journal of Manipulative and Physiological Therapeutics 1998;21:448-453.
12. McGuiness J, Vicenzino B, Wright A. Influence of a cervical mobilization technique on respiratory and cardiovascular function. Manual Therapy 1997;2:216-220.
13. Vicenzino B, Cartwright T, Collins D, Wright A. Cardiovascular and respiratory changes produced by lateral glide mobilization of the cervical spine. Manual Therapy 1998;3: 67-71.
14. Denslow J, Palpation of the musculoskeletal system. The Journal of the American Osteopathic Association 1964;63:135-144.
15. Greenman P. Principles of manual medicine. 2nd ed. Baltimore: Williams & Wilkins; 1996. p. 54-63.
16. Caparara H, Eleazer P, Barfield R, Chavers S. Objective measurement of patient's dental anxiety by galvanic skin reaction. Journal of Endodontics 2003;29:493-496.
17. Margrain T, Greenland K, Anderson J. Evaluating anxiety in patients attending optometric practice. Opthalmic and Physiological Optics 2003;23:287-293.
18. Lohaus A, Klein-Hessling J, Vogele C, Kuhn-Henninghausen C. Psychophysiological effects of relaxation training in children. British Journal of Health Psychology 2001;6:197-206.
19. Chapman C, Donaldson G, Nakamura Y, Jacobson R, Bradshaw D, Gavrin J. A psychophysiological causal model of pain report validity. Journal of Pain 2002;3:143-155.
20. Moller P, Dijksterhuis G. Differential human electrodermal responses to odours. Neuroscience Letters 2003;346:129-132.

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INFORMATION TO PARTICIPANTS SHEET

Influence of Osteopathic Palpatory Examination on Sympathetic Nervous System Function: A Pilot Study

Glossary:

Palpation: the application of the hand with light pressure to the surface of the body for the purpose of determining the consistency of underlying tissues.

Sympathetic nervous system: the part of the body's nervous system that regulates involuntary function, which acts to accelerate heart rate, constrict blood vessels, raise blood pressure and increase sweat gland activity.

One of the common observations following manual therapy treatment in the clinical setting is hypoalgesia (decreased sensitivity to pain), however the mechanism by which it is produced remains to be fully explained. Recent research has shown that the sympathetic nervous system (SNS) may be involved.

The influence of manual therapy techniques on SNS function has been widely investigated, using measures of heart rate, blood pressure, skin conductance, skin temperature and respiratory rate. Excitation of the SNS has been measured after treatment in the way of increased heart rate, and blood pressure.

To date the influence of palpatory examination on SNS measures has not been investigated. Osteopathic palpatory examination includes the assessment of both joint movements and the quality of the surrounding soft tissues. Movements comprise active, passive, active resisted and accessory movements, assessing the overall quality and quantity of movement. Palpation of soft tissues aims to determine the presence of abnormal tension in underlying muscles, ligaments, fascial bands and tendons. This current study aims to examine the influence of osteopathic palpatory examination of the thoracic spine on cardiovascular function.

14 healthy pain-free participants with no history of heart disorders, back pain or disease will be examined in this study. Participants will initially rest for 10 minutes before measurements of blood pressure, heart rate and skin conductance are recorded. Participants will then undergo three osteopathic examinations of their thoracic spines, with further measurements recorded after each.
Statistical analysis will be used to assess any changes in heart rate, blood pressure and skin conductance between the treatment, control and placebo conditions.

Measuring skin conductance:

Please be assured that the process of measuring skin conductance is completely pain and risk free. Two small plates are placed on the skin of two fingers, which automatically detects the skin conductance without the individual feeling anything.

If you would like any further information or would like to participate in this study, please contact Ross Boyd at the Osteopathic Medicine Clinic on 9248 1111.

Thank you for your time,

Ross Boyd
5th Year Osteopathy Student.

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Consent Form for Participants

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study examining the effect that osteopathic palpatory diagnosis of the thoracic spine has on the sympathetic nervous system. This will involve taking measurements of electrical skin resistance, blood pressure and heart rate.

CERTIFICATION BY PARTICIPANT

I,
of

certify that I am at least 18 years old and that I am voluntarily giving my consent to participate in the study entitled: Influence of osteopathic palpatory diagnosis on cardiovascular function: a pilot study, being conducted at Victoria University of Technology by:

Patrick McLaughlin, Cameron Gosling and Ross Boyd

I certify that the objectives of the study, together with any risks to me associated with the procedures listed hereunder to be carried out in the study, have been fully explained to me by Ross Boyd and that I freely consent to participation involving the use on me of these procedures.

Procedures:

1. Participants initially enter examination room 1, where they disrobe from the pelvis up and if so desire, place on a provided gown.
2. Assistant A then enters the room and attaches the blood pressure monitor and ADInstrument's PowerLab, which will measure your ESR and heart rate.
3. You will then be asked to enter examination room 2, where you will lie on a treatment table for a period of five minutes, in the presence of the examiner.
4. You will then return to room 1 and a second round of measurements will be recorded.
5. You will then return to room 2 and the examiner will assess the participant's thoracic spine by means of commonly accepted osteopathic diagnosis techniques.
6. Finally you will return to room 1 again and a third round of measurements will be recorded.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this experiment at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed: .... }

Witness other than the experimenter: } **Date:** ....

....}

Any queries about your participation in this project may be directed to the principal researcher, Patrick McLaughlin, telephone no: 9248 1131. If you have any queries or complaints about the way you have been treated, you may contact the Secretary, University Human Research Ethics Committee, Victoria University of Technology, PO Box 14428 MC, Melbourne, 8001 (telephone no: 03-9688 4710).