ABSTRACTS

Heart Rate Variability:

Disclaimer: This article search was conducted using a systematic approach and keywords aimed at capturing the bulk of published research related to chiropractic care and heart rate variability. Given the limits related to key words and database searches, the search may not provide an exhaustive list of literature. The search was conducted between September 8 and September 17, 2020 using the databases Index to Chiropractic Literature, Alt-Health Watch, AMED, Scopus, Pubmed, CINAHL; keyword combinations were "heart rate variability or HRV" with the following terms: chiropractic, osteopathic manipulation, spinal manipulation, spinal mobilization, mobilization, and physical therapy manipulation.

Autonomic function and pressure pain threshold following thoracic mobilization in asymptomatic subjects: A randomized controlled trial

Francisco Xavier de Araujo, Maurício Scholl Schell, Giovanni Esteves Ferreira, Mariana Della Valentina Pessoa, Luiza Raulino de Oliveira, Brian Giacomini Borges, Fabrício Edler Macagnan, Rodrigo Della Méa Plentz, Marcelo Faria Silva

Journal of Bodywork and Movement Therapies

2018

Objective: To compare the effects of two different mobilization techniques and a placebo intervention applied to the thoracic spine on heart rate variability (HRV) and pressure pain threshold (PPT) in asymptomatic individuals.

Methods: Sixty healthy asymptomatic subjects aged between 18 and 40 years old were randomized to a single session of one of the three interventions: posterior-to-anterior (PA) rotatory thoracic passive accessory intervertebral mobilization (PAIVM) (PA group), unilateral thoracic PA in slump position (SLUMP group) or placebo intervention (Placebo group). HRV and PPT at C7 and T4 spinous process, first dorsal interossei muscles bilaterally, and muscle belly of tibialis anterior bilaterally were measured before and immediately after the intervention. A univariate analysis of covariance (ANCOVA) adjusted for baseline values assessed the effect of "Group". Pairwise comparisons with Bonferroni adjustment for multiple comparisons were performed.

Results: There were no significant between-group differences for HRV. A significant between-group difference for PPT in the ipsilateral tibia was found favoring the SLUMP group in comparison with the PA group. There were no significant between-group differences for PPT in the other landmarks.

Conclusion: A single treatment of thoracic PAIVM in prone lying and slump position did not alter PPT and HRV compared to placebo in asymptomatic subjects.

The effect of spinal manipulative therapy on heart rate variability and pain in patients with chronic neck pain: a randomized controlled trial

Anders Galaasen Bakken, Iben Axén, Andreas Eklund, Søren O'Neill

Trials

2019

Background: Recent experimental research has suggested that spinal manipulative therapy (SMT) may reduce pain through modulation of the ascending pain signals and/or the central pain-regulating

mechanisms. People with persistent neck pain (NP) have also been found to have disturbances in autonomic nervous system (ANS) regulation. A common way to study the ANS is to measure heart rate variability (HRV). It is not known whether deviations in HRV are related to changes in pain perception or to the treatment response to SMT. Commonly, an individual in pain will experience pain reduction when exposed to a second pain stimulus, a mechanism known as conditioned pain modulation (CPM). Patients with persistent pain have been found to have a reduced CPM reaction. It is not known whether this is predictive of treatment response to SMT. The aim of the study is to examine the effects of SMT on HRV and pain. Further, a secondary aim is to test whether a CPM test can be used to predict treatment response in a population of patients with recurrent and persistent NP.
Method/design: A multicentre randomized controlled clinical trial will be carried out in multidisciplinary primary care clinics. This setting is chosen to minimize bias resulting from patient preference for the treatment modality and provider. The subjects are either self-referred or referred from other health care practitioners locally. The treatment modalities are two well-known interventions for NP; SMT and stretching exercises compared to stretching exercises alone. HRV will be measured using a portable heart monitor. The subjective pain experience will be investigated by assessing pain intensity and the affective quality of pain. CPM will be measured with a standardized cold pressor test. Measurements will be performed three times during a 2-week treatment series.
Discussion: The study will utilize normal clinical procedures, which should aid the transferability and external validity of the results. The study will provide knowledge regarding the underlying mechanisms of the effects of SMT. Furthermore, the study will examine whether a CPM test is predictive of treatment outcome in a population of patients with recurrent and persistent NP.

Effects of manual cranial therapy on heart rate variability in children without associated disorders: Translation to clinical practice

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Complementary Therapies in Clinical Practice

2019

Background: and purpose: Heart rate variability (HRV) represents a marker of autonomic activity, self-regulation and psychiatric illness. Few studies of manual therapy have investigated the neurophysiological effects of manual cranial therapy (MC-t). This study assessed the neurophysiological short/medium-term effects of two manual therapy interventions: massage therapy (Mss-t) and MC-t.
Materials and methods: A double-blind clinical trial was conducted with 50 healthy children, randomized into two groups who received a Mss-t intervention or MC-t. The variables analysed included vital signs (temperature, respiratory rate, heart rate, blood pressure) and HRV components, including the root mean square of successive differences (RMSSD), high frequency (HF), low frequency (LF) and LF/HF ratio.
Results: Both interventions produced short-term parasympathetic effects, although the effects of MC-t were more persistent.
Conclusion: The persistence of the MC-t intervention suggested a prominent vagal control and better self-regulation. Autonomic imbalances in mental pathologies may benefit from the neurophysiological effects of MC-t.

Visceral responses to spinal manipulation

Philip S Bolton, Brian Budgell

Journal of Electromyography and Kinesiology

2012

While spinal manipulation is widely seen as a reasonable treatment option for biomechanical disorders of the spine, such as neck pain and low back pain, the use of spinal manipulation to treat non-musculoskeletal complaints remains controversial. This controversy is due in part to the perception that there is no robust neurobiological rationale to justify using a biomechanical treatment of the spine to address a disorder of visceral function. This paper therefore looks at the physiological evidence that spinal manipulation can impact visceral function. A structured search was conducted, using PubMed and the Index to Chiropractic Literature, to construct of corpus of primary data studies in healthy human subjects of the effects of spinal manipulation on visceral function. The corpus of literature is not large, and the greatest number of papers concerns cardiovascular function. Authors often attribute visceral effects of spinal manipulation to somato-autonomic reflexes. While this is not unreasonable, little attention is paid to alternative mechanisms such as somato-humoural pathways. Thus, while the literature confirms that mechanical stimulation of the spine modulates some organ functions in some cohorts, a comprehensive neurobiological rationale for this general phenomenon has yet to appear.

Effects of spinal manipulation and myofascial techniques on heart rate variability: A systematic review

Bruno Luis Amoroso Borges, Gustavo Luiz Bortolazzo, Hugo Pasin Neto

Journal of Bodywork and Movement Therapies

2018

Background: The analysis of heart rate variability is important to the investigation of stimuli from the autonomic nervous system. Osteopathy is a form of treatment that can influence this system in healthy individuals as well as those with a disorder or disease.

Objectives: The aim of the present study was to perform a systematic review of the literature regarding the effect of spinal manipulation and myofascial techniques on heart rate variability.

Methods: Searches were performed of the Pubmed, Scielo, Lilacs, PEDro, Ibesco, Cochrane and Scopus databases for relevant studies. The PEDro scale was used to assess the methodological quality of each study selected.

Results: A total of 505 articles were retrieved during the initial search. After an analysis of the abstracts, nine studies were selected for the present review.

Conclusion: Based on the findings, osteopathy exerts an influence on the autonomic nervous system depending on the stimulation site and type. A greater parasympathetic response was found when stimulation was performed in the cervical and lumbar regions, whereas a greater sympathetic response was found when stimulation was performed in the thoracic region.

The effects of thoracic manipulation on heart rate variability: a controlled crossover trial

Brian Budgell, Barbara Polus

Journal of Manipulative and Physiological Therapeutics

2006

Objective: The objective of this study was to measure the effects of thoracic spinal manipulation on heart rate variability (HRV) in a cohort of healthy young adults.
Methods: A controlled crossover trial that was conducted on 28 healthy young adults (23 men and 5 women; age range, 18-45 years; mean age, 29 +/- 7 years) measured HRV before and after a sham procedure and a thoracic spinal manipulation.
Results: In healthy young adults, thoracic spinal manipulation was associated with changes in HRV that were not duplicated by the sham procedure. The ratio of the powers of the low-frequency and high-frequency components increased from 0.9562 +/- 0.9192 to 1.304 +/- 1.118 (P = .0030, Wilcoxon signed rank test). In subjects undergoing sham spinal manipulation, there was no statistically significant change in the low-frequency or the high-frequency component of the power spectrum; neither was there any in the ratio of the two regardless of whether the comparison was made using the paired t test or the Wilcoxon signed rank test.
Conclusion: High-velocity and low-amplitude manipulation of the thoracic spine appears to be able to influence autonomic output to the heart in ways that are not duplicated by a sham procedure or by other forms of somatic/physical therapies.

Cardiac autonomic response after cranial technique of the fourth ventricle (cv4) compression in systemic hypertensive subjects

Ana Christina Certain Curi, Alex Souto Maior Alves, Julio Guilherme Silva

Journal of Bodywork and Movement Therapies

2018

Objective: The aim of this study was to compare blood pressure (BP) behavior and heart rate variability (HRV) among hypertensive stage I and normotensive individuals who were submitted to the cranial technique of the 4th ventricle compression (CV4), an osteopathic technique.
Methods: In this experimental controlled study, thirty men between 40 and 60 years old were evaluated and divided into two groups: normotensive (NT) and hypertensive (HT). The CV4 maneuver was applied in both groups and BP was measured at 5 (five) different stages: pre and post-intervention, 5, 10 and 15min after technique. Time-frequency parameters were obtained from measurements of RR intervals. Data were analyzed using an ANOVA two-way for analysis of the condition factor (NT and HT) and times with p-value ≤ .05.
Results: There was a reduction in the BP of the HT group. A significant intergroup difference (p = .01) was noticed, with respect to the standard deviation of successive normal R-R intervals (SDNN) values, mainly between pre-intervention and 15min stages. Concerning root mean square of the mean squared differences (RNSSD) values, the highlights were differences between pre-intervention and 10min (p = .01) only in the NT group. There was an increase in high frequencies (HF) values and a low frequencies (LF) attenuation in both groups at all different stages.
Conclusion: The data showed a BP reduction in the HT group in pre-intervention/15min and an increase in parasympathetic activity and decreased sympathetic activity in both groups. This suggests a change in the sympathetic-vagal balance. However, further studies are needed to elucidate the data on BP reduction mechanisms with CV4.

Effects of spinal manipulation therapy on autonomic activity and the cardiovascular system: a case study using the electrocardiogram and arterial tonometry

M D Driscoll, M J Hall

Journal of Manipulative and Physiological Therapeutics

2000

Objective: To determine if there is alteration in the autonomic nervous and cardiovascular systems after chiropractic manipulative therapy (CMT). A novel approach was used to quantitatively probe for changes in the activity of the autonomic nervous system, in blood pressure, and in pressure pulse transmission time. This approach uses the electrocardiogram and arterial tonometry equipment.

Design: This case study involves 1 subject treated over a 6-week period (2 visits/week). Respiration, electrocardiogram, and left and right radial artery blood pressures were measured during the baseline (2 visits) and treatment (10 visits) phases. Measurements were obtained before (n = 3) and after (n = 3) a break period (baseline) or before and after CMT. High-velocity, low-amplitude CMT that produced joint cavitation was used.

Setting: The study was performed at the Parker College Research Institute in a temperature-controlled laboratory.

Main outcome measures: Fourier analysis was performed on the electrocardiogram-determined rest-redistribution intervals. The low frequency power between 0.04 to 0.15 Hz and the high frequency power between 0.15 to 0.40 Hz represent the activity of the sympathetic and parasympathetic nervous systems, respectively. The main outcome measure was the sympathovagal index, which is determined from the ratio of low frequency to high frequency. The arterial pressure and the time for pressure pulses to travel from the heart to the radial artery recording sites (pressure pulse transmission time) were studied. Differences (average of 3 measurements after treatment minus measurements before treatment) for each variable were calculated.

Results: After the 1st CMT treatment, the difference between treatment and baseline decreased for both the low frequency/high frequency (-2.804 +/- 1.273) and low frequency power (-0.135 +/- 0.056). These findings indicated that the parasympathetic nervous system predominated the sympathetic nervous system. After the 3rd, 4th, 6th, and 9th treatment, the difference between treatment and baseline increased for low frequency/high frequency (0.908 +/- 0.338, 2.313 +/- 0.300, 2.776 +/- 1.102, and 0. 988 +/- 0.269, respectively) and indicated that the sympathetic nervous system predominated the parasympathetic nervous system. In addition, the difference between treatment and baseline for the pressure pulse transmission time decreased bilaterally after the 4th treatment (left, -13.52 +/- 3.70 ms; right, -9.75 +/- 3.76 ms) and 6th treatment (left, -9.53 +/- 3.60 ms; right, -9.24 +/- 3.50 ms), which indicated that arterial compliance had decreased. Furthermore, after the 6th treatment, the difference between treatment and baseline for the rest-redistribution interval time decreased (-0.084 +/- 0.014 s). The difference between treatment and baseline for the systolic, diastolic, and mean arterial pressure for the above-mentioned treatments was not considered significant.

Conclusion: This case study is the first to attempt to use electrocardiogram and arterial tonometry data to study the effects of CMT on the autonomic nervous and cardiovascular systems over an extended period of time. These devices allowed a more in-depth study of the cardiovascular and autonomic changes associated with CMT. Although changes in the autonomic nervous and cardiovascular systems

can be detected, further development of a reliable and reproducible experimental protocol is required before validating the effects of CMT on these systems.

Rationale for assessing the effects of manipulative therapy on autonomic tone by analysis of heart rate variability

A M Eingorn, G J Muhs

Journal of Manipulative and Physiological Therapeutics

1999

Background: For more than 100 years, chiropractors have asserted that overall health can be improved through the use of spinal manipulative therapy. The autonomic nervous system is known to control and regulate all involuntary physiologic activities by controlling the activities of the internal organs, glands, and circulation. Recent studies document a potential relationship between the vertebral subluxation complex, autonomic tone, and cardiac function.

Objective: This discussion reviews how it is possible to use heart rate variability analysis to calculate a quantitative index of autonomic function, which accurately reflects the sympathetic and parasympathetic tone and the sympathovagal balance.

Discussion: The technique of heart rate analysis known as heart rate variability could be extremely useful in assessment of treatment outcomes in clinical chiropractic practice. At present, heart rate variability is in widespread use in the fields of neurology, cardiology, psychology, psychophysiology, obstetrics, anesthesiology, and psychiatry.

Conclusion: Further studies in this area may lead to a better understanding of the effects of spinal manipulation on (1) the general health of an individual, (2) an individual's susceptibility to lowered immunity and recuperative capacity, and (3) conditions that lie outside the scope of musculoskeletal therapeutics and are more in line with classical chiropractic concepts. This can also contribute to a better-informed interprofessional cooperation between allopathic and chiropractic health care providers.

Suboccipital decompression enhances heart rate variability indices of cardiac control in healthy subjects

Paul D. Giles, Kendi L. Hensel, Christina F. Pacchia, Michael L. Smith

The Journal of Alternative and Complementary Medicine

2013

Objectives: Osteopathic manipulative treatment (OMT) focused on the upper cervical spine is theorized to affect the function of the vagus nerve and thereby influence the parasympathetic branch of the autonomic nervous system. This study was designed to determine the acute effect of upper cervical spine manipulation on cardiac autonomic control as measured by heart rate variability.

Design: Nineteen healthy, young adult subjects underwent three different experimental interventions administered in random order: cervical OMT, sham manipulation, and time control. Six minutes of electrocardiographic data were collected before and after each intervention, and heart rate variability was assessed by both time-domain and frequency-domain measures.

Results: No differences in resting heart rate or any measure of heart rate variability were observed between the baseline periods prior to each intervention. The OMT protocol resulted in an increase in

the standard deviation of the normal-to-normal intervals (0.12±0.082 seconds, $p<0.01$), an increase in the high frequency spectral power ($p=0.03$), and a decrease in the low/high frequency spectral ratio ($p=0.01$) relative to the sham and time control conditions. No significant differences between sham and time control were observed ($p>0.11$ for all variables).
Conclusions: These data support the hypothesis that upper cervical spine manipulation can acutely affect measures of heart rate variability in healthy individuals.

Sustained improvement of heart rate variability in patients undergoing a program of chiropractic care: a retrospective case series
Amy Haas, David Russell
Chiropractic Journal of Australia
2017
Objective: The purpose of this study was to report the sustained changes in heart rate variability (HRV) observed in 6 patients undergoing continuous chiropractic care for the correction of vertebral subluxations.
Clinical Features: Six patients between 25 to 55 years of age all presented with primarily musculoskeletal complaints for chiropractic care in a private practice setting. All patients were nonsmokers with no reported cardiac pathology. All patients were initially assessed for indicators of vertebral subluxation before being accepted for chiropractic care, and were monitored for changes in HRV scores over time.
Intervention and Outcomes: Chiropractic care, using Diversified and Thompson techniques to correct vertebral subluxations, was provided for an initial period of 10 to 52 weeks at a frequency of 2 to 3 visits per week. HRV, measured by SSDN, increased over the early part of their course of chiropractic care, and these increases were sustained whilst the patient remained under long term continuous care in all 6 patients. Improvements in SDNN ranged from 50% to greater than 300% as compared to pre-care values.
Conclusion: Patients receiving continuous chiropractic care to correct vertebral subluxation demonstrated a sustained improvement in HRV. This novel finding objectively demonstrates long-term change consistent with improved neurophysiological regulation, adaptability and resilience in patients undergoing chiropractic care, and suggests the utility of chiropractic care for outcomes greater than only musculoskeletal improvements.

Association between heart rate variability and manual pulse rate
John Hart
The Journal of the Canadian Chiropractic Association
2013
Introduction: One model for neurological assessment in chiropractic pertains to autonomic variability, tested commonly with heart rate variability (HRV). Since HRV may not be convenient to use on all patient visits, more user-friendly methods may help fill-in the gaps. Accordingly, this study tests the association between manual pulse rate and heart rate variability. The manual rates were also compared to the heart rate derived from HRV.
Methods: Forty-eight chiropractic students were examined with heart rate variability (SDNN and mean heart rate) and two manual radial pulse rate measurements. Inclusion criteria consisted of participants

being chiropractic students. Exclusion criteria for 46 of the participants consisted of a body mass index being greater than 30, age greater than 35, and history of: a) dizziness upon standing, b) treatment of psychiatric disorders, and c) diabetes. No exclusion criteria were applied to the remaining two participants who were also convenience sample volunteers. Linear associations between the manual pulse rate methods and the two heart rate variability measures (SDNN and mean heart) were tested with Pearson's correlation and simple linear regression.
Results: Moderate strength inverse (expected) correlations were observed between both manual pulse rate methods and SDNN (r = -0.640, 95% CI -0.781, -0.435; r = -0.632, 95% CI -0.776, -0.425). Strong direct (expected) relationships were observed between the manual pulse rate methods and heart rate derived from HRV technology (r = 0.934, 95% CI 0.885, 0.962; r = 0.941, 95% CI 0.897, 0.966).
Conclusion: Manual pulse rates may be a useful option for assessing autonomic variability. Furthermore, this study showed a strong relationship between manual pulse rates and heart rate derived from HRV technology.

The effects of a single spinal manipulation on cardiovascular autonomic activity and the relationship to pressure pain threshold: a randomized, cross-over, sham-controlled trial
Mathieu Picchiottino, Margaux Honoré, Charlotte Leboeuf-Yde, Olivier Gagey, François Cottin, David M Hallman
Chiropractic & Manual Therapies
2020
Background: The autonomic nervous system interacts with the pain system. Knowledge on the effects of high velocity low amplitude spinal manipulations (SM) on autonomic activity and experimentally induced pain is limited. In particular, the effects of SM on autonomic activity and pain beyond the immediate post intervention period as well as the relationship between these two outcomes are understudied. Thus, new research is needed to provide further insight on this issue.
Objectives: The aim was to assess the effect of a single SM (i.e. SM vs. sham) on cardiovascular autonomic activity. Also, we assessed the relationship between cardiovascular autonomic activity and level of pain threshold after the interventions.
Method: We conducted a randomized, cross-over, sham-controlled trial on healthy first-year chiropractic students comprising two experimental sessions separated by 48 h. During each session, subjects received, in a random order, either a thoracic SM or a sham manipulation. Cardiovascular autonomic activity was assessed using heart rate and systolic blood pressure variabilities. Pain sensitivity was assessed using pressure pain threshold. Measurements were performed at baseline and repeated three times (every 12 min) during the post intervention period. Participants and outcome assessors were blinded. The effect of the SM was tested with linear mixed models. The relationship between autonomic outcomes and pressure pain threshold was tested with bivariate correlations.
Results: Fifty-one participants were included, forty-one were finally analyzed. We found no statistically significant difference between SM and sham in cardiovascular autonomic activity post intervention. Similarly, we found no post-intervention relationship between cardiovascular autonomic activity and pressure pain threshold.
Conclusion: Our results suggest that a single SM of the thoracic spine has no specific effect on cardiovascular autonomic activity. Also, we found no relationship between cardiovascular autonomic

activity and pressure pain threshold after the SM. Further experimental research should consider the use of several markers of autonomic activity and a more comprehensive pain assessment.

Feasibility and effectiveness of thoracic spine mobilization on sympathetic/parasympathetic balance in a healthy population – a randomized controlled double-blinded pilot study

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Archives of Physiotherapy

2019

Background: Physiotherapists often use thoracic spine mobilization (TSM) to reduce pain in patients with back disorders via a reduction of sympathetic activity. There is a “trade-off” in the activity of the sympathetic and parasympathetic nervous system activity. A sympathetic/parasympathetic balance (SPB) is needed to guarantee body homeostasis. However, body homeostasis is seldom considered as an aim of the treatment from the perspective of most physiotherapists. Strong empirical evidence for the effects of TSM on the SPB is still lacking.

Some studies showed that spinal manipulation may yield beneficial effects on SPB. Therefore, it could be hypothesized that TSM is feasible and could influence SPB reactions. The primary aim was to describe the participants’ adherence to the intervention and to the measurement protocol, to identify unexpected adverse events (UAE) after TSM, to evaluate the best method to measure SPB parameters (heart rate variability (HRV), blood pressure (BP), heart rate (HR), skin perfusion and erythema) and to estimate the investigation procedure. The secondary aim was to assess the effects of TSM on SPB parameters in a small sample of healthy participants.

Methods: This crossover pilot study investigated TSM using posterior-anterior mobilization (PAM) and anterior-posterior mobilization (APM) on segments T6 to T12 in twelve healthy participants during two consecutive days. To evaluate feasibility, the following outcomes were assessed: adherence, UAE, data collection and data analysis. To evaluate the effect of TSM on SPB, HRV, BP, HR, skin perfusion and erythema were measured.

Results: The adherence was 100%. No UAE were reported. PAM showed larger effect sizes compared to APM in many secondary variables.

Conclusions: Although 100% maximal adherence was reached and no UAE were observed, data recording in future studies should be done during a second time interval while the data transfer from device to the computer software should occur immediately after completion of each participant’s measurement. The results of this pilot study suggest that PAM can reduce HRV HF and HRV ratio LF/HF and increase HR.

Heart rate variability modulation after manipulation in pain-free patients vs patients in pain

Richard A. Roy, Jean P. Boucher, Alain S. Comtois

Journal of Manipulative and Physiological Therapeutics

2009

Background: The purpose of this study was to examine heart rate variability (HRV) in the presence or the absence of pain in the lower back, while receiving one chiropractic treatment at L5 from either a manually assisted mechanical force (Activator) or a traditional diversified technique spinal manipulation.

Methods: A total of 51 participants were randomly assigned to a control (n = 11), 2 treatment, or 2 sham groups (n = 10 per group). Participants underwent an 8-minute acclimatizing period. The HRV tachygram (RR interval) data were recorded directly into a Suunto watch (model T6; FitzWright Company Ltd, Langley, British Columbia, Canada). We analyzed the 5-minute pretreatment and posttreatment intervals. The spectral analysis of the tachygram was performed with Kubios software.
Results: All groups decreased in value except the control group that reacted in the opposite direction, when comparing the pretests and posttests for the high-frequency component. The very low frequency increased in all groups except the control group. The low frequency decreased in all groups except the sham pain-free group. The low frequency-high frequency ratio decreased in the treatment pain group by 0.46 and in the sham pain-free group by 0.26. The low frequency-high frequency ratio increase was 0.13 for the sham pain group, 0.04 for the control group, and 0.34 for the treatment pain-free group. The mean RR increased by 11.89 milliseconds in the sham pain-free group, 18.65 milliseconds in the treatment pain group, and 13.14 milliseconds in the control group. The mean RR decreased in the treatment pain-free group by 1.75 milliseconds and by 0.01 milliseconds in the sham pain group.
Conclusion: Adjusting the lumbar vertebrae affected the lumbar parasympathetic nervous system output for this group of participants. Adaptation in the parasympathetic output, reflected by changes in high frequency, low frequency, and very low frequency, may be independent of type of adjustment. Therefore, the group differences found in the modulation of the HRV would seem to be related to the presence or absence of pain. The autonomic nervous system response may be specific and sensitive to its effectors organ.

Neuroendocrine response following a thoracic spinal manipulation in healthy men
Kesava Kovanur Sampath, Erik Botnmark, Ramakrishnan Mani, James David Cotter, Rajesh Katare, Pujika Emani Munasinghe, Steve Tumilty
The Journal of Orthopedic and Sports Physical Therapy
2017
Abstract: Study Design Controlled laboratory study. Background Spinal manipulation (SM) can trigger a cascade of responses involving multiple systems, including the sympathetic nervous system and the endocrine system, specifically, the hypothalamic-pituitary axis. However, no manual therapy study has investigated the neuroendocrine response to SM (ie, sympathetic nervous system-hypothalamic-pituitary axis) in the same trial. Objective To determine short-term changes in sympathetic nervous system activity, heart rate variability, and endocrine activity (cortisol, testosterone, and testosterone-cortisol [T/C] ratio) following a thoracic SM. Methods Twenty-four healthy men aged between 18 and 45 years were randomized into 2 groups: thoracic SM (n = 12) and sham (n = 12). Outcome measures were salivary cortisol (micrograms per deciliter), salivary testosterone (picograms per milliliter), T/C ratio, heart rate variability, and changes in oxyhemoglobin concentration of the right calf muscle (micromoles per liter). Measurements were done before and at 5 minutes, 30 minutes, and approximately 6 hours after intervention. Results A statistically significant group-by-time interaction was noted for T/C ratio ($P<.05$) and salivary cortisol ($P<.01$) concentrations. Significant between-group differences were noted for salivary cortisol concentration at 5 minutes (mean difference, 0.35; 95% confidence interval: 0.12, 0.6; interaction: $P<.01$) and for T/C ratio at 6 hours postintervention (mean difference, -0.09; 95% confidence interval: -0.16, -0.04; $P = .02$). However, SM did not differentially alter oxyhemoglobin,

testosterone, or heart rate variability relative to responses in the sham group. Conclusion Thoracic SM resulted in an immediate decrease in salivary cortisol concentration and reduced T/C ratio 6 hours after intervention. A pattern of immediate sympathetic excitation was also observed in the SM group.

Influence of spinal manipulation on autonomic and heart rate in patients with rotator cuff tendinopathy

Alyssa Conte da Silva, Cláudia Mirian de Godoy Marques, Jefferson Luiz Brum Marques,

Journal of Chiropractic Medicine

2018

Objective: The purpose of this study was to analyze the influence of thoracic spinal manipulation (SM) on autonomic modulation and heart rate in patients with rotator cuff tendinopathy.

Methods: The design of the study was quasi-experimental. Participants were divided into 3 study groups: the asymptomatic group (n = 30), which received SM; the tendinitis group (TG, n = 30), which received SM; and the placebo group (PG, n = 30), which received placebo manipulation. Heart rate variability was analyzed with an electrocardiogram before and after intervention. For intragroup analysis, the paired Wilcoxon test was used to compare the means (pre vs post) of sex and age divided into 5 age groups. The Kruskal-Wallis test was employed for analysis between the groups, and a significance level of 5% was adopted.

Results: The TG demonstrated an increase in respiratory rate (mean of the selected intervals corresponding to parasympathetic activity) post intervention for both sexes (P = .04). Heart rate exhibited reduction post intervention in women in the TG (P = .05). The PG demonstrated an increase in respiratory rate post intervention for both sexes (female P = .01; male P = .02). In the age groups, only the PG presented any difference in the 40- to 50-year and 50- to 60-year age groups (P = .03) for the same variable. Heart rate exhibited a reduction post intervention in women in the PG (P = .01) and a reduction in the 50- to 60-year age group (P = .04). No difference in the studied variables was observed in the asymptomatic group, and there were no differences among the groups.

Conclusions: Upper thoracic SM does not directly influence autonomic modulation or heart rate.

Short-term effects of manual therapy on heart rate variability, mood state, and pressure pain sensitivity in patients with chronic tension-type headache: a pilot study

Cristina Toro-Velasco, Manuel Arroyo-Morales, César Fernández-de-Las-Peñas, Joshua A Cleland, Francisco J Barrero-Hernández

Journal of Manipulative and Physiological Therapeutics

2009

Objective: The purpose of this study was to investigate the immediate effects of head-neck massage on heart rate variability (HRV), mood states, and pressure pain thresholds (PPTs) in patients with chronic tension-type headache (CTTH).

Methods: Eleven patients (8 females), between 20 and 68 years old, with CTTH participated in this crossover study. Patients received either the experimental treatment (massage protocol) or a placebo intervention (detuned ultrasound). Holter electrocardiogram recordings (standard deviation of the normal-to-normal interval, square root of mean squared differences of successive NN intervals, index HRV, low-frequency component, and high-frequency component), PPT over both temporalis muscles,

and Profile of Mood States questionnaire (tension-anxiety, depression-dejection, anger-hostility, vigor, fatigue, confusion) were obtained preintervention, immediately after intervention, and 24 hours postintervention. Self-reported head pain was also collected preintervention and 24 hours postintervention. Separate analyses of covariance (ANCOVAs) were performed with each dependent variable. The hypothesis of interest was group x time interaction.
Results: The ANCOVA showed a significant group x time interaction for index HRV ($F = 4.5$, $P = .04$), but not for standard deviation of the normal-to-normal interval ($F = 1.1$, $P = .3$), square root of mean squared differences of successive NN intervals ($F = 0.9$, $P = .3$), low-frequency component ($F = 0.03$, $P = .8$), or high-frequency component ($F = 0.4$, $P = .5$) domains. Pairwise comparisons found that after the manual therapy intervention, patients showed an increase in the index HRV ($P = .01$) domain, whereas no changes were found after the placebo intervention ($P = .7$). The ANCOVA also found a significant group x time interaction for tension-anxiety ($F = 5.3$, $P = .03$) and anger-hostility ($F = 4.6$, $P = .04$) subscales. Pairwise comparisons found that after the manual therapy intervention, patients showed a decrease in tension-anxiety ($P = .002$) and anger-hostility ($P = .04$) subscales, whereas no changes were found after the placebo intervention ($P > .5$ both subscales). No significant changes were found in PPT levels (right $F = 0.3$, $P = .6$, left $F = 0.4$, $P = .5$). A significant group x time interaction for pain ($F = 4.8$, $P = .04$) was identified. No influence of sex was found ($F = 1.5$, $P = .3$). Pairwise comparisons showed that head pain (numerical pain rating scale) decreased 24 hours after manual therapy ($P < .05$) but not after the placebo intervention ($P = .9$).
Conclusions: The application of a single session of manual therapy program produces an immediate increase of index HRV and a decrease in tension, anger status, and perceived pain in patients with CTTH.

Spinal manipulative therapy effects in autonomic regulation and exercise performance in recreational healthy athletes

Pedro L Valenzuela, Sara Pancorbo, Alejandro Lucia, Francisco Germain

Spine

2019

Study design: A randomized, double blind, parallel groups, sham-controlled trial.
Objective: The aim of this study was to analyze the acute effects of spinal manipulative therapy (SMT) on performance and autonomic modulation.
Summary of background data: The use of SMT is progressively spreading from the clinical to the sporting context owing to its purported ergogenic effects. However, its effects remain unclear.
Methods: Thirty-seven male recreational athletes (aged 37 ± 9 years) who had never received SMT were assigned to a sham (n = 19) or actual SMT group (n = 18). Study endpoints included autonomic modulation (heart rate variability), handgrip strength, jumping ability, and cycling performance [8-minute time trial (TT)]. Differences in custom effects between interventions were determined using magnitude-based inferences.
Results: A significant and very likely lower value of a marker of sympathetic modulation, the stress score, was observed in response to actual compared with sham SMT [$P = 0.007$; effect size (ES) = -0.97]. A trend toward a significant and likely lower sympathetic:parasympathetic ratio ($P = 0.055$; ES = -0.96) and a likely higher natural logarithm of the root-mean-square differences of successive heartbeat intervals [(LnRMSSD), $P = 0.12$; ES = 0.36] was also found with actual SMT. Moreover, a significantly

lower mean power output was observed during the TT with actual compared with sham SMT (P = 0.035; ES = -0.28). Nonsignificant (P > 0.05) and unclear or likely trivial differences (ES < 0.2) were found for the rest of endpoints, including handgrip strength, heart rate during the TT, and jump loss thereafter. Conclusion: A single pre-exercise SMT session induced an acute shift toward parasympathetic dominance and slightly impaired performance in recreational healthy athletes.

Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine

Arlene Welch, Ralph Boone

Journal of Chiropractic Medicine

2008

Objective: The aims of this study were to investigate the response of the autonomic nervous system based upon the area of the spine adjusted and to determine if a cervical adjustment elicits a parasympathetic response and if a thoracic adjustment elicits a sympathetic response.
Methods: Forty patients (25-55 years old) met inclusion criteria that consisted of normal blood pressure, no history of heart disease, and being asymptomatic. Patients were evaluated pre- and post-chiropractic adjustment for the following autonomic responses: blood pressure and pulse rate. Seven patients were measured for heart rate variability. The subjects received either a diversified cervical segment adjustment or a diversified thoracic segment adjustment.
Results: Diastolic pressure (indicating a sympathetic response) dropped significantly postadjustment among those receiving cervical adjustments, accompanied by a moderate clinical effect (0.50). Pulse pressure increased significantly among those receiving cervical adjustments, accompanied by a large effect size (0.82). Although the decrease in pulse pressure for those receiving thoracic adjustments was not statistically significant, the decrease was accompanied by a moderate effect size (0.66).
Conclusion: It is preliminarily suggested that cervical adjustments may result in parasympathetic responses, whereas thoracic adjustments result in sympathetic responses. Furthermore, it appears that these responses may demonstrate the relationship of autonomic responses in association to the particular segment(s) adjusted.

Effects of upper and lower cervical spinal manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain: a randomized controlled, cross-over, preliminary study

Ni Ni Win, Anna Maria S Jorgensen, Yu Sui Chen, Michael T Haneline

Journal of Chiropractic Medicine

2015

Objective: The aims of this study were to examine autonomic nervous system responses by using heart rate variability analysis (HRV), hemodynamic parameters and numeric pain scale (NPS) when either upper (C1 and C2) or lower (C6 and C7) cervical segments were manipulated in volunteers, and whether such response would be altered in acute mechanical neck pain patients after spinal manipulative therapy (SMT).
Methods: A randomized controlled, cross-over, preliminary study was conducted on 10 asymptomatic normotensive volunteers and 10 normotensive patients complaining of acute neck pain. HRV, blood

pressure (BP) and heart rate (HR), and NPS were recorded after upper cervical and lower cervical segments SMT in volunteer and patient groups.
Results: The standard deviation of average normal to normal R-R intervals (SDNN) increased (83.54 ± 22 vs. 105.41 ± 20; P = .02) after upper cervical SMT. The normalized unit of high frequency (nuHF), which shows parasympathetic activity, was predominant (40.18 ± 9 vs. 46.08 ± 14) after upper cervical SMT (P = .03) with a significant decrease (109 ± 10 vs. 98 ± 5) in systolic BP (P = .002). Low frequency to high frequency (LF/HF) ratio, which shows predominance of sympathetic activity increased (1.05 ± 0.7 vs. 1.51 ± 0.5; P = .02) after lower cervical SMT in the healthy volunteers group. However, there was an increase in SDNN (70.48 ± 18 vs. 90.23 ± 20; P = .02 and 75.19 ± 16 vs 97.52 ± 22; P = .01), a decrease in LF/HF ratio (1.33 ± 0.3 vs. 0.81 ± 0.2; P = .001 and 1.22 ± 0.4 vs. 0.86 ± 0.3; P = .02), which was associated with decreased systolic BP (105 ± 10 vs. 95 ± 9; P = .01 and 102 ± 9 vs. 91 ± 10; P = .02) and NPS scores (3 ± 1 vs. 0; P = .01 and 3 ± 1 vs. 1 ± 1; P = .03) following both upper and lower cervical SMT in the patient's group. The baseline HR was 67 ± 9 vs 64 ± 5 (upper cervical) and 65 ± 7 vs 69 ± 11 (lower cervical) in both the healthy volunteer' and patient' groups.
Conclusion: Upper cervical SMT enhances dominance of parasympathetic and lower cervical SMT enhances dominance of sympathetic activity in this young volunteer group. However, dominance of parasympathetic activity was found in patients with neck pain that received both upper and lower cervical SMT.

Effect of spinal manipulative treatment on cardiovascular autonomic control in patients with acute low back pain

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2017

Background: This study aimed to quantify the effect of spinal manipulative treatment (SMT) from an analysis of baroreflex, systolic blood pressure and heart rate variability (HRV) on patients with acute back pain. It was hypothesized that SMT would increase the parasympathetic cardiovascular autonomic control.
Methods: Twenty-two patients with acute back pain were randomly divided into two groups: one receiving sham treatment (Sham) and the other receiving SMT. Recordings were completed during the first day and the seventh day, immediately before and after treatment on both days. ECG and systolic blood pressure were continuously recorded to compute cardiovascular variability and baroreflex sensitivity components. The perceived level of pain was measured with the numeric pain scale (NPS) 48 h before, just before and just after each treatment. The NPS ranged from 0 to 100% (peak of pain before treatment). ECG and systolic blood pressure recordings were analyzed in time frequency domain using the Smoothed pseudo Wigner-Ville distribution.
Results: Root mean square of the successive differences, high frequency power of the heart rate variability, and high frequency baroreflex sensitivity differences between post and pre tests were higher in the SMT group than in the Sham group ($p < 0.01$), whereas no differences were observed with the other heart rate variability components. Also, no differences were observed with the systolic blood pressure components. Although the estimated pain scale values decreased over time, no difference was observed between the SMT and Sham groups.

Conclusions: This seems to be the first study to assess the effect of SMT on both heart rate variability and baroreflex sensitivity in patients with acute back pain. SMT can be seen to provoke an increase in parasympathetic control known to relate to a person's healthy state. Thus, cardiovascular variability analysis may be a useful tool for clinicians to quantify and objectify the beneficial effects of spinal manipulation treatment.

The effect of low force chiropractic adjustments for 4 weeks on body surface electromagnetic field
John Zhang, Brian J Snyder
Journal of Manipulative and Physiological Therapeutics
2005
Objective: To study the effects of 4 weeks of low-force chiropractic adjustments on body surface electromagnetic fields (EMFs).
Method: Thirty-five chiropractic students randomly assigned into control (17 subjects) and experimental groups (28 subjects). A triaxial fluxgate magnetometer was used for EMF detection. The subjects' body surface EMF was determined in the prone position before and after the chiropractic adjustment. A Toftness low-force chiropractic adjustment was applied to the cervical, thoracic, lumbar, and sacral areas as determined by the practitioner. Heart rate variability analysis was recorded once a week to determine autonomic nervous system activity in both the control and experimental groups.
Results: The EMF on the subjects' body surface decreased after chiropractic adjustment at the cervical, thoracic, lumbar, and sacral regions in all 6 visits during the 4-week treatment period. The EMF showed a downtrend over the 4-week period after the low-force adjustment. The same changes were not observed in the control group. The chiropractic adjustment group had a slight decrease in heart rate over the 4-week treatment period, and no significant change was observed in the control group. Heart rate variability analysis did not show consistent changes before and after the low-force adjustments during the treatment period.
Conclusion: Low-force chiropractic adjustment in the cervical and thoracic areas resulted in a consistent reduction of the body surface EMF after 4 weeks of active treatment. No statistically significant differences were found in the heart rate and heart rate variability in the 4-week study.

Effect of chiropractic care on heart rate variability and pain in a multisite clinical study
John Zhang, Douglas Dean, Dennis Nosco, Dennis Strathopulos, Minas Floros
Journal of Manipulative and Physiological Therapeutics
2006
Objective: The purpose of this study is to investigate the effect of chiropractic care in a multiclinic setting on sympathetic and parasympathetic nervous system activities using heart rate variability (HRV) analysis.
Methods: Physicians of chiropractic in private practice were provided with an HRV device to perform analysis before and after chiropractic adjustments on 10 subjects. At each site, 8 subjects were monitored before and after a single chiropractic adjustment, and 2 additional patients were followed for a 4-week period with 2 HRV recordings per week. Patient information forms and a visual analog scale (VAS) questionnaire were completed both before and after each chiropractic adjustment.

Results: Data from 96 physicians were divided into single-visit and 4-week groups. After 1 chiropractic adjustment, pain as analyzed by VAS was reduced significantly from 3.7 +/- 2.2 to 2.1 +/- 2.0 ($P < .001$). The mean heart rate reduced from 76.7 +/- 12.7 to 74.3 +/- 12.4 ($P < .01$), the SD of normal-to-normal QRS increased from a range of 55.8 to 44.6 to a range of 60.6 to 47.2 ($P < .001$), the high-frequency component increased from 359 +/- 968 to 444 +/- 1069 ($P < .01$), the low-frequency component increased from 403 +/- 753 to 465 +/- 755 ($P < .05$), and the total power increased from 1063 +/- 1886 to 1265 +/- 2048 ($P < .01$). After 4 weeks of chiropractic adjustments, pain measured by the VAS was reduced significantly before and after each visit as analyzed by t tests, but the significant changes were not found using analysis of variance analysis. The reduction of pain from each treatment was not maintained over the 4 weeks of study period. The analysis of variance on the HRV 4-week data found that changes in the SD of normal-to-normal QRS, total power, and low-frequency components reached statistically significant levels ($P < .05$). The heart rate and the high-frequency component did not change significantly ($P > .05$).

Conclusion: In this study, HRV and VAS changed in patients as a result of chiropractic care.