Reflex Effects of a Spinal Adjustment on Blood Pressure

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ABSTRACT: *Objective*: To investigate whether an adjustment to any segment in the spine resulted in a blood pressure change and to see whether the direction of any potential blood pressure changes were dependent on the region of the spine adjusted. *Methods:* Participants included 70 patients attending the New Zealand College of Chiropractic Student Health Centre. Blood pressure was recorded by a blinded examiner before and after either a single Diversified type chiropractic adjustment or an adjustment set-up with no thrust. Participants were randomly allocated to groups. Each trial was allocated to a subgroup based on the spinal region involved. Some participants were involved in more than one trial session with a total of 118 trials included in the study. *Results:* Multifactorial repeated measures ANOVA assessing for any effect from the adjustment revealed a significant overall interactive effect for the factors TIME (pre / post) and GROUP (adjustment / control) [$F(1,103)=4.23$, $p=0.042$] for systolic blood pressure. Further analysis of the adjustment group revealed a significant overall effect [$F(1,49)=10.89$, $p=0.002$] with systolic blood pressure decreasing significantly (-3.9 +/- 10.3mmHg) following an adjustment. No other significant differences were found in the adjustment or control groups. *Conclusion:* An adjustment to any segment in the spine resulted in a statistically significant average decrease in systolic blood pressure of 3.9 mmHg. The direction of blood pressure change that was observed was not dependent on the region of the spine adjusted. However, visual analysis suggests cervical and lumbopelvic adjustments had a greater influence on systolic blood pressure than thoracic adjustments. Diastolic blood pressure remained relatively constant. Average changes in blood pressure were unlikely to be clinically significant. However, in individual participants some blood pressure changes were considered to be clinically relevant following an adjustment.

INDEX TERMS: (MeSH): CHIROPRACTIC; MANIPULATION, SPINAL; BLOOD PRESSURE; AUTONOMIC NERVOUS SYSTEM; SYMPATHETIC NERVOUS SYSTEM; PARASYMPATHETIC NERVOUS SYSTEM

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INTRODUCTION

Over the past 30 years many studies have focused on the effects of spinal adjustments on various functions of the autonomic nervous system (ANS).[1-13] The results of these studies have been confusing and contradictory at times. A number of studies have investigated the effect of a chiropractic adjustment on blood pressure,[3 4 6-8 11-14] most of which suggested that a reduction in blood pressure occurs as a consequence of a chiropractic adjustment.[3 4 6 8 11 14] These studies have tended to focus on one region of the spine, in particular the cervical or upper thoracic region. Other studies have shown either no significant effect of a spinal adjustment on blood pressure[7] or no conclusive relationship between the level of the spinal adjustment and the type of autonomic change.[2]

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Harris and Wagnon suggested a link between the region of the spine adjusted and the resulting autonomic response.[5] Distal skin temperature was shown to decrease, which reflects a shift towards sympathetic outflow, when an adjustment was performed between spinal levels T1-L3. Adjustments to cervical or lower lumbar levels resulted in an increase in distal skin temperature which was thought to reflect sympathetic inhibition. These differences were thought to relate to the anatomical position of the sympathetic preganglionic neurons within the spinal cord. Recently, two studies have investigated the effect of adjustments to different levels of the spine on the autonomic nervous system.[12 13] Both of these studies provided evidence to support the findings of Harris and Wagnon, with a cervical adjustment resulting in an autonomic response described as parasympathetic in nature and a thoracic adjustment resulting in a sympathetic response.

A number of mechanisms have previously been discussed that may explain the results observed in these studies. They include: cervical and lumbar adjustments may stimulate primary afferents that result in activation of supraspinal pathways that cause descending inhibition of sympathetic outflow,[1 9-11 15-18] thoracic adjustments may result in direct or indirect excitation of preganglionic sympathetic cells in the thoracolumbar spine,[19] thoracic adjustments may cause direct mechanical pressure on the heart and great vessels which could cause a transient increase in blood pressure[9] and if noxious input occurs due to an adjustment this could cause an excitatory effect on sympathetic outflow.[9 10 20 21]

Although much research has been conducted that focuses on the somatoautonomic effects of chiropractic adjustments it is clear that further clinical investigation concerning the relationship between spinal adjustments and the ANS is required. In this paper we present the results of a study that investigated the effect of a single diversified spinal adjustment on blood pressure. The aims of the study were to investigate whether an adjustment to any segment in the spine resulted in a blood pressure change and to see whether the direction of any potential blood pressure changes were dependent on the region of the spine adjusted.

METHOD

Study Design and Setting

This study was a randomised controlled trial conducted at the New Zealand College of Chiropractic (NZCC) student health centre. The rooms used were temperature controlled and were familiar to the participants.

Participants

Participants were recruited from patients presenting to the New Zealand College of Chiropractic (NZCC) student health centre. To be eligible to participate in this study volunteers needed to be an active patient at the NZCC student health centre, have no known contraindication to receiving a chiropractic adjustment and have experienced no previous significant adverse reactions to spinal adjustments.

Volunteers were not eligible to participate if they were taking blood pressure medication or if they had stage II hypertension (systolic 160mmHg or greater or diastolic 100mmHg or greater) on the day they enrolled in the study. They were also ineligible to participate if their blood pressure was less than 90/60mmHg on the day they enrolled in the study.

Volunteers were excluded if they had consumed any substance that was likely to have a significant effect on blood pressure on the day they were involved in the study. This included caffeine, tobacco, tea, coffee, cola, drugs or alcohol. They were also excluded if they had participated in any significant physical exercise within two hours prior to their involvement in the study.

Study Protocol and Interventions

Inclusion/exclusion criteria were checked and informed consent to participate was obtained. Participants reported to the student health centre for routine, or already scheduled, chiropractic visits. They were asked to relax individually in an examination room for 5 minutes prior to a baseline blood pressure reading being recorded by a Research Assistant. Blood pressure was recorded using an oscillometric sphygmomanometer in accordance with standard published procedures.[22 23] Their regular chiropractic intern then performed the necessary examination to determine the required chiropractic care for that day based on standard NZCC Health Centre protocol which includes clinical indicators such as leg length inequality, palpable restricted intervertebral range of motion and tenderness over the spinal segment. These clinical indicators have been found to have acceptable interexaminer reliability.[24-27] Participants were then randomly assigned to a group for the intervention by a Research Assistant blinded to initial blood pressure readings. Possible groups to be assigned to were cervical adjustment group, cervical control group, thoracic adjustment group, thoracic control group, lumbopelvic adjustment group, lumbopelvic control group. After group assignment a qualified chiropractor with between 15-30 years of clinical experience entered the room and performed the appropriate adjustment or adjustment set-up based on the participants examination findings and group allocation. The adjustment group received a single Diversified type chiropractic adjustment to the allocated spinal segment. The procedure for the control group participants was the same as above except that following the adjustment set-up only gentle digital pressure was applied to the spinal segment but no adjustment was performed. This intervention was not designed to be a sham adjustment. It was designed to be an active control that accounted for body and head movements that may have had an impact on blood pressure recordings. The blinded Research Assistant then re-entered the room and recorded an immediate post adjustment or set-up blood pressure reading. The participant's attending intern then continued the normal visit procedure and performed any further chiropractic adjustments deemed necessary based on their chiropractic examination. Each participant was involved in up to four trials. Each trial coincided with a routine chiropractic adjustment that was scheduled based on the participant's own case needs.

Outcomes and Equipment

The outcome measure was systolic and diastolic blood pressure which was measured immediately pre and post intervention. Blood pressure was measured utilising an automatic A&D UA-779 blood pressure monitor. This monitor is a reliable and accurate device that has been approved for clinical use by the European Society of Hypertension.[23] All blood pressure measurements were recorded on hard copy before being entered onto a Microsoft Excel spreadsheet.

Sample Size

A power calculation estimated that to determine a regional specific effect of an adjustment on blood pressure with an anticipated effect size of 0.4, with α of 0.05 and power of 0.8 the adjustment group (i.e. combined cervical, thoracic and lumbosacral groups) would require 51 participants. We therefore aimed to conduct 60 trials in the combined adjustment group, which meant that in total 120 trials would be necessary in order to surpass the minimum power requirement.

Randomisation

A computer based random number generator produced a list that was used to assign the participants to a group following their baseline blood pressure recording. Group assignment was performed by a Research Assistant blinded to the initial blood pressure recording.

Table 1

BLOOD PRESSURE CHANGES FOR THE ADJUSTMENT GROUP

Segment	N	Average Systolic Change (mmHg)	SD (mmHg)	95%CONF (mmHg)	Average Diastolic Change (mmHg)	SD (mmHg)	95% CONF (mmHg)
C1-C7	18	-6.9	+/- 12.5	6.3	0.7	+/- 5.7	2.9
T1-L2	20	-0.3	+/- 10.8	5.5	-0.6	+/- 7.3	3.7
L3-SI	20	-4.9	+/- 6.9	3.3	2.1	+/- 11.3	5.4
All segments	58	-3.9*	+/- 10.4	3.0	0.7	+/- 8.4	2.4

*P<0.05

Table 2

BLOOD PRESSURE CHANGES FOR THE CONTROL GROUP

Segment	N	Average Systolic Change (mmHg)	SD (mmHg)	95%CONF (mmHg)	Average Diastolic Change (mmHg)	SD (mmHg)	95% CONF (mmHg)
C1-C7	20	-2.9	+/- 8.0	3.8	0.7	+/- 7.5	3.6
T1-L2	20	-1.0	+/- 10.9	5.7	0.4	+/- 13.4	7.0
L3-SI	20	-0.6	+/- 7.5	4.1	-0.4	+/- 10.7	5.8
All segments	60	-1.5	+/- 8.8	2.6	0.2	+/- 10.7	3.15

Blinding

The Research Assistant performing all blood pressure recordings was blinded to participant group allocation. Due to the nature of the study the chiropractor providing the intervention was unable to be blinded to group allocation. Participants were all regular chiropractic patients so blinding of participants was not possible either.

Statistical analysis

To assess for potential blood pressure effects from adjusting the various regions of the spine a multifactorial repeated measures ANOVA with factors TIME (pre/post), GROUP (adjustment/control) and REGION (cervical / thoracic / lumbar) was carried out, with appropriate further analysis as required according to significant findings. Systolic and diastolic blood pressures were assessed separately. The significance level for all statistical tests was set at p=0.05. Data were initially entered onto a Microsoft Excel spreadsheet before being transferred to a SPSS Statistics 17.0.1 spreadsheet for statistical analysis.

Ethical Considerations and Trial Registration

Ethics approval for this study was granted by the Northern Y Regional Ethics Committee (Ref NTY/07/07/083) and the trial was registered with the Australian New Zealand Clinical Trials Registry (Ref ACTRN12607000020482).

RESULTS

Participants

Seventy participants were recruited for this study with an average age of 28 years (Range 18-53, median 25). Fifteen participants were involved in more than one trial visit with the maximum number of visits by any one participant being 4. A total of 118 visits took place where data was collected. Fifty eight participants were randomised to the adjustment group and 60 to the control group. Subgroups based on spinal region ranged from 18 to 20 participants in size.

Blood pressure findings

The multifactorial repeated measures ANOVA assessing for any regional effect from the adjustment revealed a significant overall interactive effect for the factors TIME (pre / post) and GROUP (adjustment / control) [F (1, 103) = 4.23, p = 0.042] for systolic blood pressure. Further analysis of the adjustment group revealed a significant overall effect only (i.e. no interactive effect) [F (1, 49) = 10.89, p = 0.002] with systolic blood pressure decreasing significantly (-3.9 +/- 10.3mmHg) following an adjustment. No other significant differences were found in the adjustment or control groups. Results are presented in Tables 1 and 2 and Figures 1 and 2.

Discussion

In this study there was a significant drop of on average 3.9mmHg in systolic blood pressure following a single chiropractic adjustment, with no change in diastolic blood

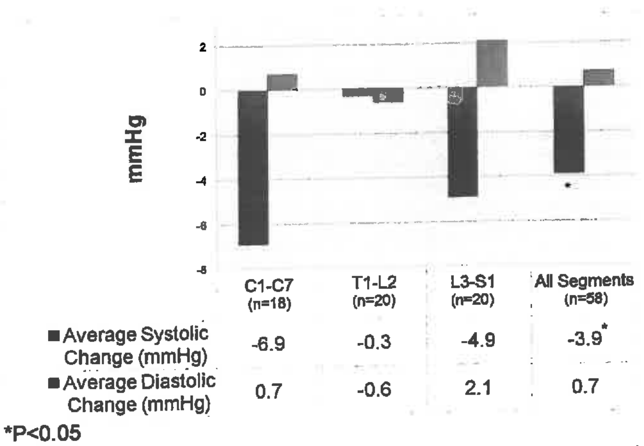

Figure 1: Graph of blood pressure changes for the adjustment group.

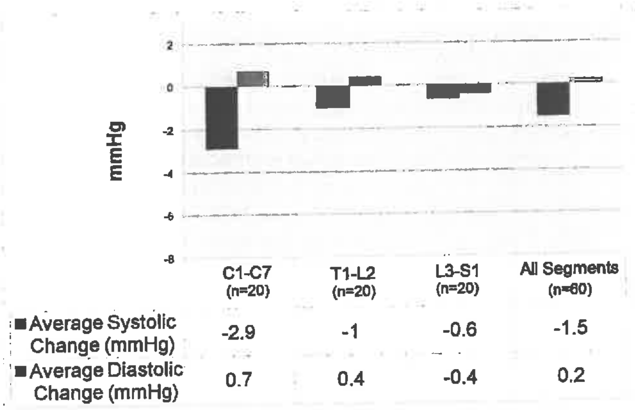

Figure 2: Graph of blood pressure changes for the control group.

pressure. This finding is consistent with the study by Knutson that reported similar findings following a vectored atlas adjustment.[11]

When considering regional effects of a chiropractic adjustment on blood pressure the results are inconclusive. The direction of blood pressure change that was observed was not dependent on the region of the spine adjusted and statistical analysis revealed no significant difference between regions with respect to blood pressure changes. Although there was no statistical difference there appeared to be a more pronounced effect of cervical or lumbopelvic adjustments on systolic blood pressure (see Figure 1), in a manner consistent with a sympathetic inhibitory or parasympathetic excitatory response. In an unblinded pilot study blood pressure increased following an adjustment to the thoracic spine.[13] However, in the present study there appeared to be little impact of a thoracic adjustment on blood pressure with an average decrease of only 0.3mmHg for systolic and 0.6mmHg for diastolic blood pressure.

The decrease in systolic blood pressure observed following cervical adjustments may be due to activation of cervicosympathetic reflex pathways as has previously been hypothesised.[11] However, if the average decrease of 4.9mmHg that occurred following a lumbopelvic adjustment was due to the adjustment itself then other reflex pathways are likely involved as it is unlikely that cervical afferents were directly stimulated by the lumbopelvic adjustment.

It was interesting to note that only systolic blood pressure changed significantly in the present study. This is consistent with the results reported by Knutson,[11] but contrast with the findings of Welch and Boone who recently reported changes in diastolic blood pressure following an adjustment with no change in systolic blood pressure.[12] It is unclear why these conflicting findings occurred as it appears as though chiropractic technique choice and blood pressure monitoring equipment were similar in the present study and the Welch and Boone study.

Although the results of this study are statistically significant the average decrease of 3.9mmHg in systolic blood pressure following a chiropractic adjustment is unlikely to be clinically relevant. However, in individual participants the greatest change in systolic blood pressure was a decrease of 40mmHg following a cervical adjustment and an increase in diastolic blood pressure of 24mmHg following a lumbar adjustment. This suggests that chiropractic adjustments may result in clinically relevant changes in blood pressure in some patients. Considering our subject population were normotensive patients, this could be explored further in, for example, hypertensive populations.

Limitations

Fifteen participants were included in more than one visit in this trial. This may have led to potential bias due to the non-independence of the sample. Future trials should include only one visit with each participant in order to eliminate this potential bias. Alternatively a cross-over design could be utilised.

The sample size for this study was calculated using an anticipated effect size of 0.4 in order to detect differences in blood pressure changes between spinal regions adjusted. The actual effect size found in this study was 0.27. In order to detect statistically significant differences in blood pressure changes between the different regions of the spine adjusted using an effect size of 0.27, with α of 0.05 and power of 0.8, a sample size of 99 would be required in the adjustment group. It is therefore possible that a type II error was made in this study as the calculated power for the experimental group (n=58) was only 0.53. Future studies should increase the sample size in order to reduce the likelihood of making a type II error.

The participants in this study were relatively normotensive. The reflex effects of a chiropractic adjustment on normotensive patients may not be as clinically relevant as the reflex effects that may occur in a patient with abnormal blood pressure. Future research could focus on reflex effects in patients with abnormal blood pressure. Alternatively statistical methods could be utilised to control for baseline variation in blood pressure between participants as well as other differences that were not controlled for in this study, such as gender and age, which may have an impact on autonomic reflex responses.[28,29]

CONCLUSIONS

In this study an adjustment to any segment in the spine resulted in a statistically significant average decrease in systolic blood pressure of 3.9 mmHg. The direction of blood pressure change that was observed was not dependent on the region of the spine adjusted. However, visual analysis suggests cervical and lumbopelvic adjustments had a greater influence on systolic blood pressure than thoracic adjustments. Diastolic blood pressure remained relatively constant. Average changes in blood pressure were unlikely to be clinically significant. However, in individual participants some blood pressure changes were considered to be clinically relevant following an adjustment. Understanding the effect that spinal adjustments can have on blood pressure may be important to the chiropractor when adjusting patients with hypo- or hypertension.

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