

THE EFFECT OF CHIROPRACTIC SPINAL MANIPULATIVE THERAPY ON SALIVARY CORTISOL LEVELS

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Abstract:

Objective: This study examines the effect of chiropractic spinal manipulative therapy on salivary cortisol levels.

Design: Prospective case series over six weeks duration. The trial consisted of establishment of each individual's baseline cortisol level, a two week treatment period (4 treatments), and a two week post treatment period.

Setting: Macquarie University Chiropractic Research Centre.

Participants: Nine subjects (six male, three female), employed in a large corporation, volunteered to the trial of spinal manipulative therapy.

Main Outcome Measures: Saliva samples were analysed using an Amerlex Radioimmunoassay Kit to determine the cortisol concentrations present.

Results: Statistical interpretation, after exclusion of an apparent outlying subject, revealed results of statistical significance ($p < 0.001$) for reduction of salivary cortisol over the complete five week study. In addition, there was no apparent alteration in salivary cortisol levels immediately preceding and 15 minutes after spinal manipulative therapy.

Conclusion: The initial evidence is inconclusive, however, the potential relationship demands further investigation. Additional research is necessary in measuring the physiological effects of Chiropractic spinal manipulative therapy. This method is currently being used in a larger randomised controlled trial.

Key Indexing Terms (MeSH): Salivary cortisol, chiropractic, spinal manipulation.

INTRODUCTION

Stress, is a term which is gaining increasing notoriety in society today. Some doctors term stress the "RSI of the brain", as it is becoming more costly within our advancing society. Whether claims are legitimate or not, stress is already costing a lot in human resources and money. Compensation claims accepted for stress in public servants are increasing at a rate of 20% a year and are expected to cost \$50 million by the end of this financial year (1). Since 1989, the number of claims accepted by the Commonwealth has almost doubled (2). In 1993/4

there were 1,600 claims filed and there are no signs of it levelling off (3). Comcare Australia, an occupational insurer, run by the Commonwealth Government, estimates that by June 1998, over 3200 claims will have been lodged. Based on the present average cost of a stress compensation claim, the Commonwealth alone faces a liability of up to \$82 million a year (4).

Selye defined stress as "the non specific response of the body to any demand", which was more than the medical definition of essentially the rate of wear and tear in the body. Selye assessed the changes or responses in the body to stress and the effects that this would produce to an individual. He proposed over thirty observable signs which indicate a reduction of the body's ability to tolerate stress. These signs include irritability, hyperexcitation, depression, many other psychological distortions, insomnia, migraines, neck pain and/or tension and back ache (5).

Research into the effectiveness of chiropractic intervention for spinal conditions has shown good results in reduction of back and neck pain (6-22). The relationship of pain in the development of stress or stress related illness is area which remains uncertain. However, some studies have indicated a possible causative relationship (5,7,23).

A number of studies have analysed the relationship of salivary cortisol with stressful events (24-27). These studies have shown that salivary cortisol levels often increase in relation to increases in the level of stress. A possible mechanism for this is that stressors have shown to be able to override the feedback systems, which leads to enhanced frequency and amplitude of cortisol pulses being released from the adrenal glands (27). This prompts a higher heart rate, shaking, tremors, churning of the stomach and sweat glands working overtime. As a result, it can lead to a loss of ability to concentrate and solve problems. From this it has been demonstrated that the level of stress of a patient can be correlated with secreted cortisol levels (24).

Glucocorticoids have widespread effects on the body because they influence the function of most cells in the body. For example, glucocorticoids are required for maintenance of normal alpha rhythm in the EEG, for normal function of smooth and striated muscle, they facilitate fat absorption, they decrease the number of

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lymphocytes, they increase the numbers of red blood cells. In addition, large doses of synthetic corticosteroids have been shown to inhibit the normal antibody response in the body (28).

MEASUREMENT TECHNIQUES

A number of different techniques have been described and utilised in which cortisol measurement may be monitored. Urinary analysis: This technique is limited due to there being a latency period in which there is a time delay before the hormone becomes apparent in the urine (24,29,30). Additionally, the subject compliance may be limited due to the unpleasant nature of collecting urine over six week period. This may also contribute to stress levels, thereby giving false readings.

Blood analysis: The use of blood testing for cortisol analysis must be questioned due to possible rises in the cortisol levels because of the invasive nature of vein puncture required for blood sampling. Because the circulatory cortisol is not subject to the latency period (24,30), false increases may occur due to the physical stress of sampling. This is added to the anticipatory stress experienced by the subject's knowledge of the impending needle.

Salivary Cortisol: This is the technique of choice as it appears to be a simple, stress free, non-invasive, reliable collection procedure. It also closely reflects the plasma levels of cortisol, not suffering from the large lag-time involved with urine analysis (31,32).

A substantial literature review for the measurement of cortisol in saliva was conducted by Kirschbaum and Hellhammer, who showed the saliva values are a reliable reflection to the plasma values (27).

Physiological Effects Of Chiropractic Spinal Manipulation.

A literature review has revealed several studies considering the possible physiological effects of spinal manipulation (14,18-20,33-39). It has been postulated that stimulation of the sympathetic nervous system leads to alteration of cardiac output and vessel diameter (34).

Assessing the possible physiological effects of chiropractic spinal manipulation and stress is significant as it may show a correlation between the use of standard chiropractic procedures and stress management (15,22,26,40). Stress has previously been documented as having correlation with hypertension, coronary artery disease, myocardial infarction, headaches or migraines, and other significant pathological conditions (25).

Despite the studies on spinal manipulation, hypertension and cardiac function, there is a dearth of research on spinal manipulation and stress (26,41). A possible mechanism for a relationship of spinal manipulation and stress alteration may be due to changes in control of melatonin following spinal cord injury (42).

Some studies have demonstrated reduction in migraine (19,20,43,44), cervicogenic headache (22,45,46), cervical radiculopathy (47), chronic neck pain (48,49), hypertension (50), following chiropractic spinal manipulation. These symptoms are commonly found in stress related illness. In addition, Korr studied the neurobiologic mechanisms of spinal manipulation through changes in nociceptive input from the cutaneomuscular system and subsequent increases in sympathetic outflow. In some situations, these increases in sympathetic outflow reached 200-300% (35).

This study was conducted to assess if chiropractic spinal manipulation has the potential to reduce salivary cortisol levels, then it may also have some implications in the prevention of stress conditions (51). The possible economic gain associated with this project must also be considered in terms of the cost of stress leave taken from work annually, the increased productivity of "stress leave" workers and the cost to individuals and society of the numerous debilitating disease where stress is a predisposing factor.

METHODS

The experiment was a case series, in which the subjects acted as their own controls, and were informed they were receiving a therapeutic treatment. The subjects were not blinded and no placebo treatment was given. The chiropractor performing all the treatments to the group was aware of the therapeutic nature of the treatment. However, the chiropractor did not contribute to the assessing of the samples of saliva collected.

Experimental procedures were performed over a five week period, and was divided into 3 stages:

- (a) 2 weeks of pre-experimental evaluation of the subject's salivary cortisol levels.
- (b) 2 weeks of experimental evaluation in conjunction with pre- and post-treatment evaluation of the salivary cortisol levels.
- (c) 1 week of post-experimental reevaluation of the subject's salivary cortisol levels.

Participant details such as history of pain or disability, an orthopaedic and neurological examination, specific chiropractic techniques, spinal motion and static palpation (excluding X-rays unless already taken) were used prior to the patients receiving any treatment, to

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assess which areas of the persons spine needed chiropractic intervention. This also determined participants who would be excluded from the study, due to potential contra-indications to chiropractic spinal manipulation.

The remaining patients underwent the initial 2 weeks of salivary collection, taken at lunch times (12 midday) on Wednesdays and Sundays. These have been shown to be the most and least stressful periods of the week, respectively (25). The collection procedure required a minimum of 2ml of saliva to be collected in a centrifuge tube and stored immediately on ice. This allowed assaying to be completed in one period.

Over the subsequent two weeks each subject was required to receive four chiropractic spinal manipulation treatments. The initial treatment was conducted on a Wednesday and a saliva samples was collected immediately prior to and at the conclusion of this consultation. The final week of the experimental protocol consisted of salivary collection, following the same procedures as that of the initial two weeks. All of the stored saliva samples were analysed using an Amerlex Radioimmunoassay Kit to determine the cortisol concentrations present as an indicator of each subject's individuals stress levels.

Chiropractic SMT is defined as a passive manual manoeuvre during which the three joint complex is carried beyond the normal physiological range of movement without exceeding the boundaries of anatomical integrity (11). SMT requires a dynamic force in a specific direction, with a short amplitude to correct a problem of reduced vertebral motion. Chiropractic SMT was performed at vertebral levels determined to be restricted in motion as determined by orthopaedic and physical tests assessed by the author.

RESULTS

Twenty eight employees agreed to participate following information given to them in an informed consent letter. Following an interview with the author and from information gained in a history questionnaire, a total of 18 people were found to be suitable for the study. People were excluded from the study if they were receiving current treatment from either a chiropractor or a physiotherapist. In addition, people were excluded if there were any contra-indications for them receiving spinal manipulation. People also decided not to participate due to embarrassment of the saliva collection.

A total of nine people withdrew during the study. Four people withdrew due to time constraints not allowing them to complete the entire treatment schedule, two

following soreness after manipulation, one due to a motor vehicle accident, one due to a change of job, one was not able to be contacted.

The nine remaining subjects consisted of 6 males a 3 females, and were aged between 22 and 51 years of age. Saliva samples were collected and analysed by RIA to determine the initial cortisol concentrations present in each subject. The baseline salivary cortisol level for each participant sample given on three Wednesdays prior to treatment is shown in Table 1 (samples 1,3 & 5). Table 2 shows a one way ANOVA result for these samples and demonstrates no significant difference between the samples.

Table 1. Initial Salivary Cortisol Concentrations Present In Each Subject.
(Wednesday Samples)

Subject	Sample 1	Sample 3	Sample 5
1	0.69	0.48	0.43
2	0.77	0.21	0.42
3	0.65	0.47	0.38
4	0.33	0.3	0.33
5	0.75	0.56	0.48
6	0.56	0.37	0.55
7	0.22	0.29	0.39
8	0.32	0.33	0.25
9	0.26	0.19	0.21

Key: Figures shown are mgrams/100ml
Sample 1= 1st Wednesday; Sample 3= 2nd Wednesday;
Sample 5= 3rd Wednesday

Table 2 : One-way ANOVA for: Sample 1; Sample 3; Sample 5;

Source	SS	df	MS	F
Groups	0.1153	2	0.0576	2.2557*
Error	0.6132	24	0.0255	
Total	0.7285	26		

* $p > 0.05$

The initial cortisol concentrations present in each subject samples given on the two Sundays prior to treatment commencing, were assessed by paired t-test, which determined no statistical significance (Table 3). Therefore, the participants in the study had similar findings to previous studies that identified Wednesdays as having consistently higher levels than Sundays. A one way ANOVA for differences in initial cortisol concentrations present for different days, confirms a large statistical significant difference between the samples taken on different days (Table 4).

A one way ANOVA for the baseline salivary cortisol Wednesday samples for each participant, compared to the final salivary cortisol level was assessed (Table 5). This demonstrates no statistical significant difference

between the samples, which initially suggested that there was no alteration in salivary cortisol levels following the SMT intervention.

Table 3. Initial Cortisol Concentrations Present (Sunday Samples)

Subject	Sample 2	Sample 4
1	0.22	0.22
2	0.17	0.12
3	0.16	0.13
4	0.24	0.13
5	0.15	0.14
6	0.2	0.2
7	0.18	0.19
8	0.25	0.27
9	0.16	0.08

Key: Figures shown are mgrams/100ml
Sample 2= 1st Sunday; Sample 4= 2nd
Sunday Paired t test comparing Column 2
with Column 4: 9 pairs For the differences:
mean = 0.0278; sum = 0.2500 Variance =
0.0019 Std dev = 0.0441 t = 1.8898 with 8
df Pr [t >= 1.8898] = 0.0477 (one tailed),
(2p = 0.0955)

Table 4. Differences in Initial Cortisol Concentrations Present for different days.

[One-way ANOVA for: Sample 1; Sample 2; Sample 3; Sample 4]

Source	SS	df	MS	F
Groups	0.6773	3	0.2258	12.8768*
Error	0.561	32	0.0175	
Total	1.2383	35		

*p<0.0001

A one way ANOVA for the baseline salivary cortisol Wednesday samples for each participant, compared to the final salivary cortisol level was assessed (Table 5). This demonstrates no statistical significant difference between the samples, which initially suggested that there was no alteration in salivary cortisol levels following the SMT intervention.

Table 5. The baseline salivary cortisol level for each participant, compared to the final salivary cortisol levels, (ANOVA).

[One-way ANOVA for: Sample 1; Sample 3; Sample 5; Sample 9]

Source	SS	df	MS	F
Groups	0.2143	3	0.0714	2.1139*
Error	1.0812	32	0.0338	
Total	1.2955	35		

*p>0.05

However, Table 6 represents a one way ANOVA for the baseline salivary cortisol Wednesday samples for each participant, compared to the final salivary cortisol level, with subject 2 excluded. This demonstrates a very large statistical significant difference between the samples.

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Table 7 represents a one way ANOVA for the baseline salivary cortisol Wednesday samples for each participant, with subject 2 excluded. This demonstrates no statistical significant difference between the samples. Therefore it appears that the removal of this subject does not alter the establishment of the baseline levels for the study.

Table 6. The baseline salivary cortisol level for each participant, compared to final salivary cortisol levels (ANOVA), with subject 2 excluded.

Source	SS	df	MS	F
Groups	0.3651	3	0.1217	7.2751*
Error	0.5353	32	0.0167	
Total	0.9004	35		

*p<0.001

Table 7. The baseline salivary cortisol level for each participant, (ANOVA), with subject 2 excluded.

Source	SS	df	MS	F
Groups	0.1118	2	0.0559	2.6362*
Error	0.5091	24	0.0212	
Total	0.6209	26		

*p>0.05

DISCUSSION

The baseline salivary cortisol level for each participant, calculated by averaging the three pre-treatment Wednesday measurements, when compared to the final salivary cortisol levels determined no statistical significance by analysis of variance (ANOVA). Thus there appears to be no statistically significant difference in salivary cortisol levels were measured following a two week course of chiropractic spinal manipulation. However, further statistical interpretation revealed a possible change. That is, the exclusion of an apparent outlying subject gave results of statistical significance (p<0.001) for reduction of salivary cortisol over the complete five week study (Table 6).

The basis for exclusion of the outlying subject is the great variation of salivary cortisol level after the completion of chiropractic spinal manipulation intervention. The subjects' salivary cortisol level was initially 0.7700 then decreased to 0.3750 during manipulation and then increased to 0.9200 one week after the trial. One possible suggestion is that a stressful event occurred after the manipulation trial was completed. Alternatively, the subject may have a condition which leads to wide variation in salivary cortisol levels.

The results also showed no statistically significant short term change in salivary cortisol levels in the samples taken immediately pre- and post-manipulation. This appears to indicate that chiropractic spinal manipulation is not a source of measurable stress. A study on SMT and substance P levels found similar findings (52).

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Future studies will need to measure any potential stressful events that may influence salivary cortisol levels. Several standardised psychological profile questionnaires are available which may prove appropriate. For example, the "Trier Social Stress Test" (53), a modified Zung Depression Scale or a brief symptoms inventory checklist can provide a reliable tool for psychobiological research (23).

Some limitations which were encountered during the course of this project, are detailed below. Unfortunately, patient compliance throughout the duration of the experiment was poor, with only 50% of eligible participants completing the entire procedures. This high incompleteness rate may be attributed to a number of factors which include:

- 1) The personal embarrassment of the collection process was significantly high amongst the female participants, and consequently resulted in their limited compliance.
- 2) The prolonged nature of the protocol, the participants lost interest in the project and failed to complete the experimental requirements.
- 3) Treatment not being conducted "in house" meant that participants needed to travel to a clinic at specific times, which were often busy.

CONCLUSION

The relatively small sample size and the lack of a control group, make conclusion drawn from the study very limited. However, the results appear to indicate that chiropractic spinal manipulation may have an effect on salivary cortisol levels. The potential significance of the study indicates more research in this field should be a priority.

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