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ORIGINAL RESEARCH

Instant Effect of Chiropractic Upper and Middle Thoracic Zone Manipulations on Autonomic Nervous System

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Abstract
Objective: This study aims to compare the instantaneous effects of chiropractic upper and middle thoracic manipulations on the autonomic nervous system.
Material-Method: The study included 30 healthy volunteers aged 18-45 years. Manipulation was applied to the upper thoracic (T1-4) area (n=15, 8 female, 7 male) and to the middle thoracic (T6-9) area (n=15, 7 female, 8 male). Before the application, heart rate, body temperature and skin conductivity (EDA) measurements were performed using the Empatica E4 wristband device. Thoracic HVLA (high velocity low amplitude) manipulation was performed in the supine position. After the application, the measurement made with the Empatica E4 device was repeated. The mean body temperature and skin conductivity values were calculated for the analysis of the data. Heart rate data were evaluated using Kubios heart rate variability (HRV) standard program. Detailed information about the effects of upper and middle thoracic area manipulation on the autonomic nervous system was obtained according to the analysis results of the data obtained before and after manipulation. Correlation analysis of pre- and post-manipulation data and difference analysis between the two groups were performed based on significance level $p<0.05$.
Results: As a result of the research, no significant changes in parasympathetic nervous system values such as RMSSD, pNN50, PNS Index and sympathetic nervous system values such as Stress Index and SNS Index were observed after upper thoracic manipulation. After middle thoracic manipulation, significant decreases occurred in sympathetic nervous system values such as Stress Index, SNS Index, while significant increases occurred in parasympathetic nervous system values such as RMSSD, pNN50, PNS Index. It was observed that there was no significant change in temperature and EDA.
Conclusion: As a result of our measurements and analyzes, it was seen that chiropractic upper and middle thoracic manipulations had different instantaneous effects on the autonomic nervous system.
Keywords: Chiropractic, Autonomic Nervous System, Heart Rate Variability, Body Temperature, Skin Conductivity

INTRODUCTION

Although the physiological mechanisms underlying spinal manipulative techniques are still unknown, several hypotheses have been put forward that offer mechanical, neurophysiological and psychological reasons. The mechanical force used during manipulation has a direct effect on the central nervous system, creating positive neurophysiological responses. The effects of manipulation are only beyond biomechanical changes. It has both somatic and autonomic effects on the nervous system. The somatic and autonomic regulatory areas in the central nervous system usually respond to the same type of afferent inputs [1].

It is difficult to directly observe the effect of manual therapy on the central or peripheral nervous system. In the absence of direct observation, conclusions are drawn from neurophysiological responses indirectly associated with specific mechanisms. Studies measured the associated responses of hypoalgesia and sympathetic activity to form a mechanism mediated by periaqueductal gray matter [2] and the dorsal horn of the spinal cord [3]. In cases where direct observations are not possible, directly measurable associated responses are used to demonstrate specific neurophysiological mechanisms. [1]

Chiropractors have suggested the positive effects of manipulation on the musculoskeletal system and internal organ health[4]. Although various studies have associated chiropractic vertebral subluxation and manipulative therapy in the spine with autonomic function, few studies have been conducted to link specific results to manipulated specific levels. [5,6]

Despite limited evidence that changes in autonomic activity are associated with chiropractic manipulation, autonomic-mediated reflex responses, including changes in heart rate, blood pressure, pupil diameter, and skin temperature, as well as endocrine and immune system effects, have been clearly demonstrated. [4]

Some of the findings, such as heart rate, blood pressure, and skin temperature, are consistent with chiropractors' observations about the relationship between spinal dysfunctions and visceral disorders. [7]

Our aim in the study is to determine the instantaneous effect of chiropractic upper and middle thoracic manipulations on the autonomic nervous system by looking at body temperature, skin conductivity and heart rate variability.

MATERIALS AND METHODS

The study was planned in accordance with the Helsinki Declaration Principles. It is a clinical study involving the pre- and post-test model.

In the laboratory of Yeditepe University Physical Therapy and Rehabilitation Department, 30 healthy volunteers aged 18-45 years with no limitation of movement in the thoracic area and without pain in their daily lives or during palpation were included in the study.

In addition to chronic discomfort and regular drug use, history of trauma or surgery in the thoracic area was questioned. The positive ones were not included in the study. Pain was evaluated by palpation for volunteers who met the inclusion criteria and stated that they did not have pain affecting their daily lives in the thoracic areas. Then, the range of motion of the joint in the direction of flexion, extension and lateral flexion was measured for the thoracic area using the inclinometer. Seven out of 37 people with pain and/or limited movement were excluded from the study and 30 people were randomly divided into 2 groups. It was paid attention that the numbers of men and women in the groups were proportional. Both groups were named as the research group and spinal manipulation was applied in the supine position in the upper thoracic (T1-4) and middle thoracic (T6-9) areas. The time required for each person to participate in the study was calculated as a total of 15 minutes, 5 minutes pre-manipulation measurement, 5 minutes application and 5 minutes post-manipulation measurement. Application is for one time only and no follow-up process is planned.

Before the application, heart rate, body temperature and skin conductivity measurements were performed using the Empatica E4 device. The device was placed on the left wrist and the data were recorded for 5 minutes and the measurement was repeated after the application. The average of recorded body temperature (Temp) and skin conductivity (EDA) data was calculated. HRV data (RMSSD, PNS index, Stress index, SNS index, pNN50, Power LF, Power HF and LF/HF ratio) were obtained by transferring to Kubios program and calculating the parameters of heart rate variability.

Mean, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data. The distribution of the variables was measured by Kolmogorov Simonov test. Independent sample t test and Mann-Whitney u test were used in the analysis of quantitative independent data. Matched sample t test and Wilcoxon test were used in the analysis of dependent quantitative data. Chi-squared test was used for the analysis of qualitative independent data. Analysis of data has been conducted with SPSS 26.0 program.

Permissions

Approval was obtained from Yeditepe University, Clinical Researches Ethics Board on 17.06.2020 with the decision number 1241.

RESULTS

Ages of the patients in the middle and upper segment groups (p=0.445) and gender distribution (p=0.715) did not differ significantly ($p > 0.05$) (Table 1).

In the middle and upper segment groups, the mean EDA (p=0.052) value before manipulation did not differ significantly ($p > 0.05$). In the middle and upper segment groups, the mean EDA (p=0.152) value after manipulation did not differ significantly ($p > 0.05$). In the middle segment group, the mean EDA value after manipulation (p=0.798) did not differ significantly from the pre-manipulation value ($p > 0.05$). In the upper segment group, the mean EDA value after manipulation did not differ significantly ($p > 0.05$) from the pre-manipulation (p=0.410). The mean EDA change (p=0.740) after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups (Table 2).

Table 1. Distribution of age and gender

		Middle Segment			Upper Segment			P
		Mean±*sd.*/ %n		Median	Mean±*sd.*/ %n		Median	
Age		32.8±7.2		32.0	30.3±10.4		26.0	0.445 ^{t}
Gender	Female	7	%46.7		8	%53.3		0.715 x^2
	Male	8	%53.3		7	%46.7		

^{t} Independent sample t test / X^2 Chi-Square test

Table 2. Comparison of EDA values by upper and middle segments

	Middle Segment		Upper Segment		P
	Mean ±sd.	Median	*Mean* ±sd.	Median	
Mean EDA					
Pre-manipulation	1.42±1.45	0.93	0.83±1.46	0.36	0.052^{m}
Post-manipulation	1.39±1.23	1.17	1.06±1.77	0.51	0.152^{m}
Pre-manipulation / Post-manipulation Change	-0.04±1.01	0.07	0.23±0.61	-0.02	0.740^{m}
Intra-Group Change P	0.798^{W}		0.410^{W}		
Max EDA					
Pre-manipulation	2.05±1.97	1.53	1.15±2.04	0.43	0.051^{m}
Post-manipulation	2.03±1.79	2.07	1.62±2.75	0.66	0.130^{m}
Pre-manipulation / Post-manipulation Change	-0.02±1.55	0.05	0.47±1.14	0.05	0.561^{m}
Intra-Group Change P	0.910^{W}		0.280^{W}		
Min EDA					
Pre-manipulation	0.93±1.30	0.39	0.46±0.63	0.26	0.152^{m}
Post-manipulation	0.86±0.90	0.53	0.61±0.86	0.26	0.229^{m}
Pre-manipulation / Post-manipulation Change	-0.07±0.94	0.10	0.16±0.41	0.00	0.934^{m}
Intra-Group Change P	0.691^{W}		0.421^{W}		

^{m} Mann-Whitney u test/ ^{w} Wilcoxon test

In the middle and upper segment groups, the pre-manipulation max EDA (p=0.051) value did not differ significantly ($p>0.05$). Max EDA (p=0.130) value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the post-manipulation max EDA (p=0.910) value did not differ significantly from the pre-manipulation value ($p > 0.05$). In the upper segment group, the post-manipulation MAX EDA (p=0.280) value did not differ significantly from the pre-manipulation value ($p > 0.05$). The amount of change in max EDA (p=0.561) after manipulation in the middle and upper segment groups did not differ significantly ($p > 0.05$) (Table 2).

In the middle and upper segment groups, the pre-manipulation min EDA (p=0.152) value did not differ significantly ($p > 0.05$). MIN EDA (p=0.229) value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the min EDA value after manipulation (p=0.691) did not differ significantly from the pre-manipulation value ($p > 0.05$). In the upper segment group, the min EDA value after manipulation (p=0.421) did not differ significantly from the pre-manipulation value ($p > 0.05$). The amount of min EDA (p=0.934) change after manipulation in the middle and upper segment groups did not differ significantly ($p > 0.05$) (Table 2).

In the middle and upper segment groups, the mean Temp (p=0.055) value before manipulation did not differ significantly ($p > 0.05$). The mean Temp (p=0.065) value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the mean Temp value after manipulation (p=0.409) did not differ significantly from the pre-manipulation ($p > 0.05$). In the upper segment group, the mean Temp value after manipulation (p=0.508) did not differ significantly from the pre-manipulation ($p > 0.05$). The mean change in Temp (p=0.808) after manipulation in the middle and upper segment groups did not differ significantly ($p > 0.05$) (Table 3).

In the upper segment group, the pre-manipulation max Temp (p=0.036) value was significantly lower than the middle segment group ($p < 0.05$). Max Temp (p=0.026) value was significantly lower in the upper segment group after manipulation than in the middle segment group ($p < 0.05$). In the middle segment group, the post-manipulation max Temp value did not differ significantly from the pre-manipulation value ($p > 0.05$). In the upper segment group, the post-manipulation max Temp value did not differ significantly from the pre-manipulation value ($p > 0.05$). The amount of max Temp change after manipulation in the middle and upper segment groups did not differ significantly ($p > 0.05$) (Table 3).

In the middle and upper segment groups, the pre-manipulation min Temp value did not differ significantly ($p > 0.05$). Min Temp value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the min Temp value after manipulation did not differ significantly from the pre-manipulation ($p > 0.05$). In the upper segment group, the min Temp value after manipulation did not differ significantly from the pre-manipulation ($p > 0.05$). The amount of min Temp change after manipulation in the middle and upper segment groups did not differ significantly ($p > 0.05$) (Table 3).

Table 3. Comparison of temp values according to the upper and middle segments

	Middle Segment		Upper Segment		P
	$Mean$ ±sd.	Median	$Mean$ ±sd.	Median	
Mean Temp					
Pre-manipulation	25.6±1.3	25.9	24.4±1.8	24.3	0.055^{t}
Post-manipulation	25.4±1.4	25.8	24.3±1.7	24.4	0.065^{t}
Pre-manipulation / Post-manipulation Change	-0.2±0.7	-0.2	-0.1±0.5	-0.1	0.808^{t}
Intra-Group Change P	0.409^{E}		0.508^{E}		
Max Temp					
Pre-manipulation	25.9±1.3	26.0	24.7±1.7	24.7	**0.036^{t}**
Post-manipulation	25.9±1.4	26.4	24.6±1.6	24.8	**0.026^{t}**
Pre-manipulation / Post-manipulation Change	0.0±0.8	-0.1	-0.1±0.6	-0.3	0.748^{t}
Intra-Group Change P	0.946^{E}		0.509^{E}		
Min Temp					
Pre-manipulation	25.2±1.4	25.6	24.1±1.9	24.1	0.076^{t}
Post-manipulation	24.9±1.5	25.6	24.0±1.7	24.0	0.145^{t}
Pre-manipulation / Post-manipulation Change	-0.3±0.7	-0.2	-0.1±0.6	-0.2	0.362^{t}
Intra-Group Change P	0.111^{E}		0.666^{E}		

^{t} Independent sample t test / ^{E} Paired sample t test

The pre-manipulation RMSSD (p=0.018) value was significantly higher in the upper segment group than in the middle segment group ($p< 0.05$). The RMSSD (p=0.115) value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the RMSSD value after manipulation (p=0.001) increased significantly compared to the pre-manipulation ($p < 0.05$).

In the upper segment group, the RMSSD value after manipulation (p=0.125) did not differ significantly from the pre-manipulation ($p > 0.05$). The RMSSD value decreased after manipulation in the upper segment group and increased in the middle segment group and the amount of change (p=0.000) showed a significant difference ($p < 0.05$) (Table 4).

In the middle and upper segment groups, the pre-manipulation PNS (p=0.052) index did not differ significantly ($p > 0.05$). PNS (p=0.136) index after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. The PNS (p=0.000) index value increased significantly ($p < 0.05$) in the middle segment group after manipulation compared to the pre-manipulation value. In the upper segment group, the post-manipulation PNS (p=0.347) index value did not differ significantly from the pre-manipulation value ($p > 0.05$). The amount of PNS (p=0.000) index change after manipulation was significantly lower in the upper segment group than in the middle segment group ($p < 0.05$) (Table 5).

Table 4. Comparison of RMSSD values according to upper and middle segments

	Middle Segment		Upper Segment		P
	$Mean \pm$sd.	Median	$Mean \pm$sd.	Median	
RMSSD					
Pre-manipulation	36.0±14.5	31.0	48.6±14.1	53.2	**0.018^{m}**
Post-manipulation	54.9±22.4	58.3	44.1±21.0	37.9	0.115^{m}
Pre-manipulation / Post-manipulation Change	18.9±17.6	12.1	-4.4±13.0	-5.4	**0.000^{m}**
Intra-Group Change P	**0.001^{W}**		0.125^{W}		

^{m} Mann-whitney u test/ ^{W} Wilcoxon test

The pre-manipulation stress index (p=0.074) did not differ significantly ($p > 0.05$) in the middle and upper segment groups. The post-manipulation stress index (p=0.724) did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the post-manipulation stress index (p=0.074) value decreased significantly compared to the pre-manipulation value ($p < 0.05$). In the upper segment group, the post-manipulation stress index (p=0.330) value did not differ significantly from the pre-manipulation value ($p > 0.05$). The difference in post-manipulation stress index in the upper and middle segment groups (p=0.004) was found to be significant ($p < 0.05$) (Table 5).

Table 5. Comparison of PNS ındex, stress ındex and SNS ındex values according to upper and middle segments

	Middle Segment		Upper Segment		P
	$Mean \pm$sd.	Median	$Mean \pm$sd.	Median	
PNS Index					
Pre-manipulation	-1.1±0.7	-1.2	-0.6±0.5	-0.5	0.052^{t}
Post-manipulation	-0.3±0.9	-0.3	-0.8±0.8	-0.8	0.136^{t}
Pre-manipulation / Post-manipulation Change	0.8±0.6	0.7	-0.1±0.5	-0.3	**0.000^{t}**
Intra-Group Change P	**0.000^{E}**		0.347^{t}		
Stress Index					
Pre-manipulation	15.0±5.4	14.3	12.0±3.3	11.7	0.074^{t}
Post-manipulation	12.2±2.9	11.5	12.7±4.3	11.8	0.724^{t}
Pre-manipulation / Post-manipulation Change	-2.8±3.4	-2.3	0.7±2.7	0.9	**0.004^{t}**
Intra-Group Change P	**0.006^{E}**		0.330^{E}		
SNS Index					
Pre-manipulation	2.2±1.5	1.8	1.5±1.0	1.3	0.121^{t}
Post-manipulation	1.3±1.0	1.1	1.6±1.1	1.7	0.361^{t}
Pre-manipulation / Post-manipulation Change	-1.0±0.7	-0.8	0.1±0.6	0.2	**0.000^{t}**
Intra-Group Change P	**0.000^{E}**		0.448^{E}		

^{t} Independent sample t test / ^{E} Paired sample t test

The pre-manipulation SNS index (p=0.121) did not differ significantly ($p > 0.05$) in the middle and upper segment groups. The SNS index after manipulation (p=0.361) did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the SNS index (p=0.000) value decreased significantly ($p<0.05$) after manipulation compared to the pre-manipulation value. The SNS index after manipulation (p=0.448) value in the upper segment group did not differ significantly from the pre-manipulation value ($p > 0.05$). The change in SNS index (p=0.000) after manipulation in the upper and middle segment groups was found to be significant ($p < 0.05$) (Table 5).

In the upper segment group, the pre-manipulation pNN50 (p=0.025) value was significantly higher than the middle segment group ($p < 0.05$). In the middle and upper segment groups, pNN50 (p=0.141) value did not differ significantly ($p > 0.05$) after manipulation. In the middle segment group, the pNN50 (p=0.001) value increased significantly after manipulation compared to the pre-manipulation value ($p < 0.05$). In the upper segment group, the pNN50 (p=0.100) value after manipulation did not differ significantly from the value before manipulation ($p > 0.05$). The post-manipulation pNN50 (p=0.000) change difference in the upper and middle segment groups was found to be significant ($p < 0.05$) (Table 6). In the middle and upper segment groups, the pre-manipulation power LF (p=0.950) value did not differ significantly ($p > 0.05$). Power LF (p=0.422) value after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the post-manipulation power LF (p=0.917) value did not differ significantly from the pre-manipulation value ($p > 0.05$). In the upper segment group, the post-manipulation power LF (p=0.229) value did not differ significantly from the pre-manipulation value ($p > 0.05$). In the middle and upper segment groups, the amount of power LF (p=0.517) change after manipulation did not differ significantly ($p > 0.05$) (Table 6).

In the middle and upper segment groups, the pre-manipulation power HF (p=0.548) value did not differ significantly ($p > 0.05$). In the middle and upper segment groups, power HF (p=0.361) value after manipulation did not differ significantly ($p > 0.05$). In the middle segment group, the power HF value after manipulation (p=0.156) did not differ significantly from the pre-manipulation ($p > 0.05$). In the upper segment group, the post-manipulation power HF (p=0.125) value did not differ significantly from the pre-manipulation value ($p > 0.05$). In the middle and upper segment groups, the amount of power HF (p=0.576) change after manipulation did not differ significantly ($p > 0.05$) (Table 6).

In the middle and upper segment groups, the pre-manipulation LF/HF ratio (p=0.548) did not differ significantly ($p > 0.05$). The LF/HF ratio (p=0.290) after manipulation did not differ significantly ($p > 0.05$) in the middle and upper segment groups. In the middle segment group, the post-manipulation LF/HF ratio (p=0.394) did not differ significantly from the pre-manipulation ($p > 0.05$). In the upper segment group, the post-manipulation LF/HF ratio (p=0.156) did not differ significantly from the pre-manipulation ($p > 0.05$). The amount of LF/HF ratio (p=0.633) after manipulation did not differ significantly in the middle and upper segment groups ($p > 0.05$) (Table 6).

Table 6. Comparison of pNN50, power LF, power HF and LF / HF ratio values by upper and middle segments

	Middle Segment		Upper Segment		P
	$Mean \pm$sd.	Median	$Mean \pm$sd.	Median	
pHH50 %					
Pre-manipulation	12.2±10.2	6.1	22.0±14.7	23.0	**0.025**^{m}
Post-manipulation	25.6±15.2	25.4	19.3±16.9	12.2	0.141^{m}
Pre-manipulation / Post-manipulation Change	13.4±12.4	9.4	-2.7±9.0	-2.6	**0.000**^{m}
Intra-Group Change P	**0.001**^{W}		0.100^{W}		
Power%LF					
Pre-manipulation	60.8±15.3	64.4	61.2±12.4	63.9	0.950^{t}
Post-manipulation	61.4±14.5	60.1	65.8±15.1	71.0	0.422^{t}
Pre-manipulation / Post-manipulation Change	0.5±19.4	4.0	4.6±14.2	1.6	0.517^{t}
Intra-Group Change P	0.917^{E}		0.229^{E}		
Power % HF					
Pre-manipulation	25.5±11.4	26.6	24.2±14.6	23.0	0.548^{m}
Post-manipulation	21.9±11.7	20.2	19.7±12.9	13.8	0.361^{m}
Pre-manipulation / Post-manipulation Change	-3.6±12.4	-4.1	-4.6±12.2	-7.8	0.576^{m}
Intra-Group Change P	0.156^{W}		0.125^{W}		
Min EDA					
Pre-manipulation	3.3±2.6	2.3	4.1±3.7	3.1	0.548^{m}
Post-manipulation	3.9±2.9	3.2	5.3±3.6	5.2	0.290^{m}
Pre-manipulation / Post-manipulation Change	0.6±2.5	0.3	1.1±3.0	1.4	0.633^{m}
Intra-Group Change P	0.394^{W}		0.156^{W}		

^{E} Paired sample t test / ^{m} Mann-whitney u test/ ^{t} Independent sample t test / ^{W} Wilcoxon test

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DISCUSSION

In our study, we aimed to measure the instantaneous effect of chiropractic upper and middle thoracic manipulations on the autonomic nervous system. The study was conducted in a controlled and prospective manner on 30 individuals aged 18-45 years. HVLA manipulation used in our study is generally used in pain treatment, movement limitations, postural disorders and joint dysfunctions. When the sources related to the chiropractic method are examined, it is seen that this interaction is generally ignored although information about the autonomic nervous system is given.

While RMSSD, pNN50, HF Power, which are heart rate variability parameters, reflect parasympathetic nervous system activity, LF Power, Stress Index are values related to sympathetic nervous system activity.[8] PNS Index and SNS Index are the results related to parasympathetic and sympathetic activities specified in Kubios software.[9] As a result of the research, no significant change was observed in parasympathetic nervous system values such as RMSSD, pNN50, PNS Index and sympathetic nervous system values such as Stress Index and SNS Index after upper thoracic manipulation. After middle thoracic manipulation, significant decreases occurred in sympathetic nervous system values such as Stress Index, SNS Index, while significant increases occurred in parasympathetic nervous system values such as RMSSD, pNN50, PNS Index. It was observed that there was no significant change in temperature, EDA, HF Power, LF Power and HF/LF Ratio values. There is no study using exactly the same parameters in the literature review.

In a study conducted by Budgell and Polus on 28 individuals aged 18-45 years, the effect of thoracic HVLA manipulation on heart rate variability (HRV) in healthy adults was investigated. [10] In this study, it was reported that thoracic HVLA manipulation on HRV resulted in short-term changes and although there was no statistically significant effect, it could partially affect the autonomic system.

In the study conducted by Welch and Boone, the effect of chiropractic manipulation of cervical and thoracic joint dysfunctions on the autonomic nervous system was investigated.[11] Blood pressure and heart rate were measured in all individuals between the ages of 25-55. In the study, it was found that cervical manipulation was statistically effective on blood pressure, while thoracic manipulation was not statistically effective.

Çakır et al. investigated the instantaneous effect of chiropractic thoracic manipulations on the autonomic nervous system.[12] In this study, only HRV measurement was performed in people with dysfunction in the thoracic region. Segments to be manipulated have been determined according to movement limitation. They reported a decrease in parasympathetic nervous system data and an increase in sympathetic nervous system data.

The review of the effects of spinal mobilization on the sympathetic nervous system by Kingston et al. was conducted in asymptomatic individuals.[13] In these studies, it was concluded that spinal mobilizations had an effect on the sympathetic nervous system. Segments have not been evaluated in this study. Welch and Boone (2008) reported that the cervical area exhibited parasympathetic stimulation while the thoracic area exhibited sympathetic stimulation. However, none have been subjected to HVLA manipulation. [7]

Win et al. investigated the effects of upper (C1 - C2) and lower (C6-C7) cervical spinal manipulation on blood pressure and heart rate variability in individuals with neck pain.[14] The study was conducted on 20 people between the ages of 19 and 23 years. As a result of the study, it was concluded that manipulation of the upper cervical area increased parasympathetic activity while manipulation of the lower cervical area increased sympathetic activity.

Sillevis et al. examined the instantaneous effects of thoracic spine manipulation on the autonomic nervous system with pupil diameter measurements. 101 people aged between 18-65 years were included in the study provided that they had dysfunction at T3-T4 levels and compared the effects of placebo and HVLA manipulation. They stated that pupil diameter did not change after manipulation and that there was no sympathetic or parasympathetic response.[15] The possible cause of the discrepancy with our study may be the measurement methods.

In a study conducted by Zhang et al., they examined the effects of chiropractic treatment on HRV and pain. In the study, 96 chiropractic practitioners were given HRV measuring devices and 10 patients were asked to record their pre- and post-application data for 4 weeks. When the one-time measurements were removed, the study was carried out in 539 people. Chiropractic applications showed a significant improvement in HRV at week 1 and week 4.[16]

Grimm et al. stated that the correction of dysfunctions in the musculoskeletal system also had an effect on the autonomic nervous system in chiropractic applications. However, in this study, no distinction was made between area, application and measurement and a general opinion was mentioned.[17]

Picchiottino et al. investigated the instantaneous effect of joint manipulative treatments on the autonomic nervous system and stated that mobilizations had an effect on the sympathetic activity of the skin and were ineffective on HRV, and that HVLA manipulations could have an acute effect on cardiovascular autonomic activity and various parameters of autonomic activity. [18]

Our study was limited to 30 asymptomatic individuals. Applications were performed on different segments of the thoracic area and instant measurements were taken. Autonomic nervous system results obtained by different measurement methods and evaluating long-term effects may vary. As a result of the study, it was observed that upper thoracic manipulation had no effect on the autonomic nervous system. This may be due to the initially high levels of parasympathetic activity such as RMSSD and pNN50% in the upper thoracic group. The fact that the values such as Stress index and SNS index did not decrease in the upper thoracic group compared to the middle segment group may be due to the sympathetic innervation of the heart originating from the upper thoracic segments. Since middle thoracic manipulations increase parasympathetic activity and decrease sympathetic activity, it can be associated with vagal control, but this should be supported by studies evaluating other parameters as it is a multifactorial condition. This study does not explain why mid-thoracic manipulation increases parasympathetic or vagal activity. Studies involving more participants, using different techniques and investigating longer-term effects are important in terms of explaining the relationship between chiropractic manipulations and the autonomic nervous system. The results of studies evaluating lower thoracic and lumbar area manipulations with similar protocols and methods may shed light on our understanding of the effect of the level of chiropractic applications on the autonomic nervous system.

CONCLUSION

As a result of our measurements and analyzes, it has been observed that chiropractic upper and middle thoracic manipulations have different instantaneous effects on the autonomic nervous system. While HVLA manipulation in the upper segments of the thoracic area does not lead to a significant change in the autonomic nervous system, HVLA manipulation in the middle thoracic segments causes an increase in parasympathetic nervous system values and a decrease in sympathetic nervous system values. There is a need for more comprehensive research to examine this difference in healthy people as a result of upper and middle thoracic manipulation.

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