ORIGINAL RESEARCH

Changes in Pulmonary Function Associated with Upper Cervical Specific Chiropractic Care

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Abstract — A study was conducted on 55 patients in the private office setting to assess the influence of upper cervical adjustments on pulmonary function. Subjects were monitored before and after chiropractic care by spirometric indices which measured forced vital capacity (FVC) and forced expiratory volume in one second (FEV-1). Of the 55 subjects, 33 (60%) presented with lung function outside of the normal range. The 33 subjects outside of the normal range showed the greatest increases in FVC and FEV-1 over the two week course of the study, although subjects within normal range also showed improvement in the spirometric tests. Additionally, significant positive changes were observed in subjects of both sexes representing the age range of 48-80 years, when compared to the younger age range of 18-47 years. The magnitude of these finding resulted in both a statistically significant functional effect, as well as a moderate clinical effect determined by effect size measurements for FVC and small clinical effect for FEV-1. This study indicates that subjects show improved pulmonary function in FVC and FEV-1 after receiving chiropractic care for the correction of upper cervical vertebral subluxation.

Key Words: Vertebral subluxation, upper cervical adjustment, pulmonary function, spirometric indices.

Introduction

In consideration of upper cervical vertebral subluxation,[1,2] it has long been hypothesized that the misalignment component could affect the medulla oblongata since its lower end traverses the foramen magnum and extends into the upper cervical spine.[3-7] Hammer [8] and Alistair et al [9] have proposed that the brainstem may receive insult from the arch of the atlas or the base of the occipital condyles. Palmer [10-14] suggested that the atlas and axis may misalign in a three directional torqued fashion, decreasing the size of the neural canal, which could place a circumferential constriction upon the contents of the neural canal, creating pressure on the medulla.

When pressure is applied to the medulla, it could affect vital functions associated with the cardiovascular system, the gastrointestinal system, or the respiratory system. [15]

Interference to the brainstem's affect on respiration has been postulated by Lennon et al[16] to be associated with the position of the head on the neck. They state that when postural efficiency is optimized, not only is breathing also optimized, but other functions of the human body-mind also improve.

In the present study, the hypothesis that upper cervical vertebral subluxation could place pressure on the brain stem was tested by measuring changes in respiratory function in subjects receiving upper cervical chiropractic care. The model of respiratory function was well suited to the study objective since reliable tests were available for assessing changes in pulmonary function. Spirometry measures the forced vital capacity (FVC) and the expiratory flow rates which occur during the FCV maneuver. Specifically, FVC is the volume of air exhaled during forced expiration and is considered an objective index for measuring restriction disorders or other dysfunctions of the pulmonary system.[17] Changes in the pulmonary system which can lead to a reduction in FVC include: 1) a collapsed airway which traps air in the alveoli, 2) decreased elasticity of the lung tissue lessening the subject's ability to exhale, 3) bullae and blebs in emphysematous lungs infringing upon the volume of functional alveoli thus decreasing the volume of exhalation, 4) subject discomfort after prolonged exhalation due to hypoxemia or other causes which result in inhalation before exhalation is completed.

FVC, and the average flow rate during the first second of forced expiration (FEV-1), are considered to be the most valuable tests for objective assessment of airway integrity and extent of obstruction,[18] with FEV-1 being the most reproducible of the two measurements.[19] FEV-1 has been shown to decrease in direct proportion to degradation of airway obstruction.[18] Consequently, when FEV-1 increases it is viewed as an index of enhanced respiratory function in "normal" subjects as well as those presenting with pulmonary dysfunction.

This approach to monitoring respiratory function in association with chiropractic care has some precedent as Masarsky et al[20] showed increases in both FVC and FEV-1 after four to six adjustments to the spine. Consequently, in addition to the practicality of measuring lung function, it is also recognized that the outcomes of the study, in the aspect

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Table 1. Spirometric Changes* in FVC and FEV-1 in Subjects Before and Two Weeks After Receiving Upper Cervical Adjustments

Subject Category	FVC (ml)	FEV-1 (ml)
Prior to Adjustment	3307.6 ± 721.7	2589.0 ± 669.3
After Adjustment	3516.2 ± 794.2	2731.0 ± 734.7

*After adjustment values were significantly increased ($p < 0.05$) from pre-adjustment values in both FVC and FEV-1, as determined by a two tailed t-test for paired samples.

of its relation to chiropractic care, could be of interest to other health professionals since the efficiency and effectiveness of breathing is generally accepted as an indicator of overall health. [16]

Methods and Materials

Subject Population

The subject population was composed of individuals responding to an advertisement for research on pulmonary function between November of 1995 and May of 1996. From this population subjects were chosen based on the following inclusionary criteria of: 1) being at least 18 years old, 2) never having received a toggle torque recoil upper cervical adjustment, 2) showing evidence of the presence of vertebral subluxation according to the Kale Thermoscribe II Pattern Analysis, [21] 4) willingness to keep constant their existing life style habits, 5) willingness not to utilize any adjunctive care such as spinal manipulation, mobilization, or physiotherapy modalities during the study period. Fifty five subjects qualified and completed the study which was conducted in the private office setting. Those qualifying were informed of the nature of the study and consent was obtained.

Chiropractic Care and Instrumentation

All subjects received chiropractic care by the upper cervical technique taught through the Kale Certification Residency Course. [21] As part of this techinque, each subject was analyzed for the presence of vertebral subluxation in the upper cervical spine utilizing the Thermoscribe II, [21] a dual thermocouple instrument, which scans the surface of the skin detecting heat differentials on each side of the spine. Heat differential patterns were used by the practitioner in conjunction with information regarding osseous segment juxtapostional relationships derived from three cervical radiographic views (anterior/posterior open mouth, neutral lateral, and base posterior). All x-rays were taken with a Fisher high frequency spinographic unit with turntable chair and laser aligned tube with tilting bucky. [22-27] The information described, complemented by a laser aligned posture constant spinograph, [27] served to identify the appropriate cervical location and vectors for administration of a high velocity low amplitude (toggle recoil) adjustment. All adjustments were administered on a knee-chest table as described by Palmer. [1] After the adjustment, the subject rested for a minimum of 30 minutes in the supine position. [28] Although subjects were not subjected to x-ray after the initial visit, frequency of adjustments was determined by information derived from the other parameters described, on each visit.

Pulmonary Function Tests

Upon presentation, the age, gender, and height of each subject was determined to calculate the ideal (predicted) lung function values for FVC and FEV-1.[16] Spirometry tests were performed on each subject with a Multi Spiro SA/100 computerized spirometer.[16] A spirometric test was performed approximately 15 minutes prior to each subject's first adjustment. A post spirometric test was conducted two weeks following the initiation of care, regardless of how many adjustments were administered during the interim.

Analysis of Data

The data were analyzed by a two tailed t-test for paired samples ($p < 0.05$) in regard to pre to post comparisons. Gender and age group comparisons were similarly tested by employing a two tailed t-test assuming unequal variances. The data were further grouped into age ranges to test for age related effects. These groups were statistically analyzed as described for the population as a whole. Group A ranged from 18-47 years and Group B from 48-80 years. Group A was comprised of 13 males and 16 females, and Group B was composed of 11 males and 16 females.

Table 2. Pre Versus Post Upper Cervical Adjustment Spirometric Changes in Age Grouped Subjects Compared to Ideal (Predicted) FVC.*

Subject Category	Pre-Adjustment (% of FVC)	Post-Adjustment (% of FVC)
Total Population		
1. 18-80 Years	**25.0 ± 12.4**	**19.2 ± 11.4**
Age Range		
2. 18-47 Years	**21.8 ± 10.0**	19.0 ± 9.9
3. 48-80 Years	**28.6 ± 14.0**	**19.3 ± 13.0**

* FVC values are considered "normal" or "typical" if they fall within ± 20% of the ideal (predicted) value calculated from the individual's height and sex (see Methods). Values greater than this range may be considered "abnormal" or "atypical." The closer a value gets to zero, the closer it is to matching the ideal or predicted FVC value.

Bold numbers represent statistical significance ($p < 0.05$) determined by a two tailed paired sample t-test, or t-test for unequal variances (see Methods). In the above data, post-adjustment values were significantly increased in approaching the ideal values for the total population, as well as the 48-80 year age category. Pre-adjustment values for the 18-47 year age category were significantly closer to ideal than the pre-adjustment values for the 48-80 year age group, but not different than the post-adjustment value for the 18-47 year age group.

Results

Pre-chiropractic versus Post-chiropractic Pulmonary Function

Within the population of 55 subjects, FVC (ml) increased significantly ($p < 0.05$) from mean pre-adjustment values of 3307.6 ± 721.7 to mean post-adjustment values of 3516.2 ± 794.2. Likewise, FEV-1(ml) also increased significantly ($p < 0.05$) from 2589. 0 ± 669.3 to 2731.0 ± 734.7 (Table 1). There were no significant differences between age ranges or gender, with both groups exhibiting significant changes with regard to FVC and FEV-1 measurements of pulmonary function.

Pre vs Post Chiropractic Care Changes in Subjects Compared to Ideal (Predicted) FVC.

Atypical Subjects

When evaluating the population with regard to ideal or predicted FVC pulmonary function, 33 out of 55 subjects (60.0 %) initially presented outside of the "normal" or "typical" range of ± 20.0 % of predicted values.[16] When these subjects were evaluated post chiropractic care, 31 of the 33 showed an increase in FVC. Within this group, 14 of the 33 subjects tested within the 20.0 % range, showing an average 9.0% increase in FVC. Two of the 33 subjects, initially testing outside of the ± 20.0 % range showed a decrease in FVC of 1.7% and 13.9% respectively.

Typical Subjects

Interestingly, among the 22 "typical" subjects within ± 20.0 % of ideal or predicted values, 16 improved further by an average 6.0 %, while six showed an average decrease in FVC of 5.5%. Two of these subjects decreased outside of the ± 20.0 % predicted range.

Age Differences

An evaluation of the data revealed an age related difference with regard to the subject population when compared to the ideal or predicted FVC (Table 2). In this regard, an overall significant increase ($p < 0.05$) was shown within the subject pop-

Table 3. Pre Versus Post Upper Cervical Adjustment Spirometric Changes in Age Grouped Subjects Compared to Ideal (Predicted) FEV-1.*

Subject Category	Pre-Adjustment (% of FEV-1)	Post-Adjustment (% of FEV-1)
Total Population		
1. 18-80 Years	**23.8 ± 15.4**	**18.6 ± 13.8**
Age Range		
2. 18-47 Years	22.3 ± 16.0	18.2 ± 14.2
3. 48-80 Years	25.5 ± 14.9	19.0 ± 13.6

* FEV-1 values are considered "normal" or "typical" if they fall within ± 20% of the ideal (predicted) value calculated from the individual's age, height and gender (see Methods). Values greater than this range may be considered "abnormal" or "atypical." The closer a value gets to zero, the closer it is to matching the ideal or predicted FEV-1 value.

Bold numbers represent statistical significance ($p < 0.05$) determined by a two tailed paired sample t-test (see Methods). In the above data, post-adjustment values were significantly increased in approaching the ideal values for the total population only. Although pre and post values in the two age groups followed a similar trend to FVC, they were not statistically significant.

ulation between pre and post chiropractic care, when compared to ideal or predicted FVC (25.0 ± 12.4 versus 19.2 ± 11.4). Further analysis by age groupings indicated that the significant difference was attributable to the 48-80 year group. This group of 26 subjects showed pre-chiropractic percent comparisons to ideal FVC of 28.6 ± 14.0 which fell outside of the ± 20.0 % range considered to be "normal" or "typical." Following chiropractic care, this same age group showed a significantly increased FVC ($p < 0.05$) to 19.3 ± 13.0 percent of the ideal or predicted FVC, thus placing them within the ± 20.0 % range. The 29 subjects comprising the 18-47 year age group also showed an increase in FVC, though not significantly different, from 21.8 ± 10.0 to 19.0 ± 9.9. Additionally, the 48-80 year age group, in regard to the percent of ideal or predicted FVC, was significantly farther outside the ± 20.0 % range before chiropractic care than the 18-47 year age group.

Pre versus Post Chiropractic Changes in Subjects Compared to Ideal (Predicted) FEV-1.

Atypical Subjects

The population showed 25 subjects (45.0 %) outside of the ± 20.0 % range of ideal or predicted FEV-1. Among these subjects, 21 showed increases in FEV-1 after the two week period of chiropractic care. Of this number, 7 increased to within the 20.0 % range of ideal, with an average 20.0 % increase in FEV-1. Two subjects showed no change. Three subjects further decreased in FEV-1 by 10. 5%, 10.3%, and 6.2%, respectively.

Typical Subjects

Thirty subjects (55.0 %) fell within the ± 20.0 % range of ideal or predicted FEV-1. Among this group, 14 subjects increased closer to the ideal FEV-1, averaging a 6.0 % change. Seven subjects decreased in FEV-1 an average of 3.0 % over the two week period of chiropractic care. One subject decreased to an FEV-1 value outside of the ± 20.0 % range.

Age Differences

Among all subjects, pre-chiropractic care compared to post-chiropractic care FEV-1 values were significantly different ($p < 0.05$) when compared to the ideal FEV-1, with mean values being 23.8 ± 15.4 and 18.6 ± 13.8, respectively. Although there were no statistically significant age related differences in FEV-1

Table 4. Effect Sizes* Based on FVC and FEV-1 Values (ml) Before and After Upper Cervical Adjustments in Subjects with Abnormal and Normal Presenting Values

Variable	Subjects Presenting Abnormal	vs.	Presenting Normal
1. FVC (ml)			
Pre- vs. post adjustment	351.8 ± 305.9		211.8 ± 239.2
Effect size	0.50		
2. FEV - 1 (ml)			
Pre- vs. post adjustment	146.1 ± 364.2		68.8 ± 245.6
Effect size	0.20		

*Effect size, which measures the before and after change by the following relationship: initial mean - final mean/ initial standard deviation, is considered small at 0.2, moderate at 0.5, and large at 0.8.

values, a trend similar to FVC was observed (Table 3). In the 18-47 age range, the pre-chiropractic care mean value was 22.3 ± 16.0, while the post-chiropractic mean value was 18.2 ± 14.2. In the 48-80 age group respective FEV-1 values were 25.5 ± 14.9 and 19.0 ± 13.6.

Thus, in regard to both FVC and FEV-1, the older age category initially presented with lower percentages of the ideal or predicted values, but demonstrated a greater magnitude of change after the two week period of chiropractic care.

Gender Differences

When the subject population was sorted by gender and age group, a wide variation was observed in FVC and FEV-1, both before and after chiropractic care. In the 18-47 year age group, pre to post chiropractic care values for males, in regard to FVC, were 344.6 ± 414.3, while values for females were 98.1 ± 127.3. Values for FEV-1, compared in the same manner were 249.0 ± 466.8 for males and 32.5 ± 219.2 for females.

In the 48-80 year age group, values for FVC were 368.0 ± 164.4 for males and 294.4 ± 299.4 for females. The FEV-1 values were 196.0 ± 326.3 for males and 129.4 ± 236.0 for females.

Due to the large individual variations, there were no statistically significant differences in the pulmonary function values related to gender in either age group. Of interest, however, was the observation that of the 9 subjects that showed no change in FEV-1 values from pre to post chiropractic care, 8 were females in 18-47 year category.

No similar clustering pattern was seen among any of the other categorizations relative to any of the pulmonary function tests before or after chiropractic care.

Discussion and Conclusions

In the present study results indicate that pulmonary function, measured as FVC and FEV-1, both improve significantly in subjects under upper cervical chiropractic care.

The effect is relatively rapid, being evidenced between a two week pre to post study design. These results are consistent with the findings of Masarsky et al[20] who reported increases in these same pulmonary function tests after 4-6 chiropractic visits. Although the Masarsky study was performed on subjects with "normal" respiratory function, more than half of the subjects in the present study exhibited what could be considered "atypical" or "abnormal," respiratory function, in the academic sense. Also consistent with the Masarsky study, however, was the observation that the majority of normal subjects in the present study also showed increases in the spirometric indices following chiropractic care. Moreover, the subjects who began the study with spirometry readings outside of the normal range showed a total increase of almost twice the magnitude of those considered within the normal range for FVC and approximately two and a half times greater for FEV-1. Furthermore, FEV-1 measurements in subjects outside the normal range increased or stayed the same after two weeks in all but three of the 33 subjects in this category. This suggested a positive clinical effect. When clinical effect was evaluated before and after chiropractic care, by effect size (Table 4), a moderate clinical effect of 0.50[29] was shown for the changes occurring with the group outside the range of normal compared to those presenting within the normal range for FVC, whereas a small clinical effect of 0.20 was observed for FEV-1.

Table 5. Effect Sizes* in Pulmonary Function Tests Between Two Age Groups Before and After Upper Cervical Adjustment.

Age Range	*Group*	Pre-Adjustment	Post- Adjustment	Effect Size
18-47 Years				
	FVC (% of Ideal)	21.8 ± 10.0	19.0 ± 9.9	0.28
	FEV-1 (% of Ideal)	22.3 ± 16.0	18.2 ± 14.2	0.26
48-80 Years				
	FVC (% of Ideal)	28.6 ± 14.0	19.3 ± 13.0	0.67
	FEV-1 (% of Ideal)	25.5 ± 14.9	19.0 ± 13.6	0.43

* Effect sizes of 0.2 are considered small, 0.5 moderate, and 0.8 and above large.

Evidence of clinical benefit was also seen in regard to the age effect within the subject population. It was apparent that in the age range of 48-80 years, males and females presented with both FVC and FEV-1 values both outside the range of normal and farther from the ideal or predicted values when compared to the lower age group of 18-47 years.

Moreover, when subjects were compared as a functional age range for the same two pulmonary indices, effect sizes were small (0.28 FVC, 0.26 FEV-1) in the 18-47 year group as compared to moderate for FVC (0.67) and small (0.43) for FEV-1 in the 48-80 year group (Table 5). This information, coupled with the observation that the older age group also demonstrated a significant improvement over the younger age group in FVC (Table 1), following upper cervical adjustments, implies that older subjects of both sexes may gain significant clinical improvement in pulmonary function when under care for vertebral subluxation correction.

Since this study lacked a control group receiving a sham adjustment, or post measurements on subjects receiving no adjustments, the results must be further verified. Future studies should be designed to consider the possible influence of normal variation in the spirometric indices and other factors including spontaneous changes which may have been operable, but undetected, in the present study. However, the consistent improvement in the subjects studied, as well as the magnitudes of change support the tentative conclusion that correction of vertebral subluxation under the care regimen described did affect pulmonary function in a positive manner both functionally and clinically. This information lends credence to the hypothesis that upper cervical subluxation can create insult to the brainstem leading to impaired pulmonary function.

The suggestion of a possible link between the influence of vertebral subluxation correction and enhanced pulmonary function also suggests that various pulmonary dysfunctions may respond favorably in patients under the type of care described in this study. In this regard, in a recent study in which an os odontoideum patient was receiving upper cervical adjustments, Dobson[30] states that the patient secondarily reported a substantial reduction of an asthmatic condition. The results of this study, coupled to the possibility of an effect of vertebral subluxation correction on enhanced pulmonary function support the need for further investigation in this area.

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