# Upper Cervical Post X-Ray Reduction and Its Relationship to Symptomatic Improvement and Spinal Stability

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## ABSTRACT

**Study Design:** *A retrospective study of patient records.*

**Objective:** *The purpose of this study was to determine if a statistically significant difference in symptomatic improvement existed between patients in two groups with different amounts of initial corrections in cervical misalignment, as shown by x-ray analysis.*

**Background:** *It is hypothesized by upper cervical specialists that different adjustments yield different corrections and thus varied results. It is thought that patients who receive high reductions of the occipito-atlantoaxial subluxation will improve symptomatically much sooner and to a greater extent. It is also felt that this same group of patients will require an adjustment less frequently, when compared with patients in the low post x-ray correction group.*

**Methods:** *A specially designed computerized database was used to tabulate data from 458 patient files. Misalignment factors were measured using the Grostic Procedure, and all of the doctor's files were reviewed for this study. The percent correction of misalignment seen on x-ray analysis after the first adjustment, the symptomatic improvement rating, the number of visits and adjustments in the first week, and the number of visits and adjustments in the first month were collected for analysis.*

**Results:** *Statistical analysis showed significant relationships between the percent correction and the symptom rating, and the number of adjustments needed in the first week and the first month. Comparing the data between patients with x-ray corrections less than 50% with those with corrections greater than or equal to 50% showed significant differences. On the average, the symptom rating went from 2.55 to 2.69 (z-test scores, $p<0.02$) in the low versus high correction group. The average number of adjustments in the first week went from 2.46 to 2.11 ($p < 0.001$), and the average number of adjustments in the first month went from 4.87 to 4.59 ($p < 0.05$).*

**Conclusion:** *The patients in this doctor's practice had better outcome on the average, based on the improvement of clinical signs and the reduced need for follow-up adjustment, when the occipito-atlanto-axial subluxation complex was reduced by at least 50% after the first adjustment. While the adjustment is almost always effective in correcting the clinical indicators of the need for adjustment, fewer adjustments are needed if the initial misalignment correction is more complete. Based on these findings, post-adjustment x-rays are recommended after the first adjustment to ascertain that the adjustment was effective in eliminating at least 50% of the misalignment noted on x-ray analysis.*

**Key words:** post-adjustment x-ray, Chiropractic, adjustment, Grostic Procedure, occipito-atlantoaxial subluxation complex.

## INTRODUCTION

The traditional definition of the vertebral subluxation complex is a "vertebra that has lost its proper juxtaposition with the vertebra above, below or both to the extent that it causes biomechanical and neurological dysfunction" (1). A more modern definition has been proposed by the Association of Chiropractic Colleges: "A subluxation is a complex of functional and/or structural and/or pathological articular changes that compromise neural integrity and may influence organ system function and general health."

While both definitions consider neural dysfunction an inte-

gral part of the subluxation, the second is more vague in its description of articular changes which may accompany that neural dysfunction. One type of articular change that may be present in subluxation is joint misalignment. Many chiropractors feel the vertebral misalignment must be reduced in order to achieve long-term improvement in biomechanical stability and nerve interference. The term 'adjustment' is used to describe the type of chiropractic care that is used to reduce vertebral misalignment. In contrast, another term used to describe chiropractic care is 'manipulation' or 'spinal manipulative therapy' (SMT). The difference between the terms 'adjustment' and 'manipulation' has been a matter of some debate, in and outside of the chiropractic literature (1–6).

D. D. Palmer clearly delineated the difference between adjustment and manipulation in his book *Science, Art and Philosophy of Chiropractic*. The founder of chiropractic stated that an adjustment only occurred when the vertebrae returned to their normal position and the nerve interference was reduced (1). The Hole-in-One (HIO) technique, promoted by B. J. Palmer, and later techniques stemming from it were developed to measure vertebral alignment in the upper cervical area and effects of the correction of misalignment. One technique in particular, the Grostic Procedure, was developed by John F. Grostic as a means of accurately measuring vertebral alignment. Grostic developed a line drawing procedure using the nasium and vertex radiographic views to locate the atlas with respect to the skull and lower cervical spine, and methods for application of a specific vectored adjustment to correct misalignments. In recent years, the Grostic Procedure of x-ray analysis has been tested for reliability and generally found to have acceptable intra- and inter-examiner reliability (7–9).

The Grostic Procedure does not dictate the normal position of the upper cervical spine for all patients. It instead provides a system of measurement that makes it possible to locate the position of the upper cervical spine that results in the removal of abnormal clinical findings for the longest period of time. The Grostic Procedure has made it possible to observe clinically the effect of various positions of the upper cervical spine on the findings of clinical tests. The observation of the technique developers has been that the normal position, while somewhat variable, is not nearly as variable as one might think. It has been reported that the closer the upper cervical spine is to the orthogonal position, the longer the patient's clinical findings remain normal (10).

In the Grostic Procedure, the initial x-ray analysis is used to derive an adjustment vector. After the first adjustment, a post-adjustment x-ray is recommended to test the results of the adjustment. If some degree of residual misalignment is found, the adjustment vector may be varied and another adjustment given. The goal on the first visit is to remove as much of the patient's misalignment as possible, based on the notion that the patient will recover more quickly from neurological and functional disorders if this is achieved. There are anecdotal reports that patients whose misalignments are cleared on the first visit require fewer follow-up adjustments as well. The ability to hold an adjustment longer is considered to be a sign of spinal stability.

Published studies exist, based on reviews of chiropractors' patient files, that demonstrate a measurable decrease in atlas laterality and atlas rotation after chiropractic adjustment (11, 12). In a 1976 study, Gregory and Seemann tested the hypothesis that a patient's prognosis is best when the misalignments are reduced by the highest level using the NUCCA technique. They found that patients with 70% and higher reductions did have the best results (13).

The use of post x-rays might be criticized because it provides no new information about skeletal or soft tissue pathology, yet exposes the patient to additional radiation. To justify the use of post-adjustment x-rays, it needs to be shown that the information gained about the effectiveness of the adjustment or the need for modification of the adjustment vector justifies the exposure. This study was carried out to test the hypothesis that a greater amount of correction on the post-adjustment x-ray will result in improved clinical outcome. The principal tool of data collection was a computerized database of patient records, the use of which was first reported in another article by the first author (14).

## METHODS

The data for this study was collected from the first author's private practice during his first two years of operation. It was a period of time during which the doctor had purchased an existing practice and was converting it to a specific upper cervical practice. The doctor has maintained a database of clinical findings on his patients and used this database to collect information for this study. Clinical factors such as the clinical impressions, outcomes of tests, and x-ray misalignment factors are stored in the database. Data on the number and timing of visits and the number of adjustments given were collected through a manual review of patient files.

Routinely, initial lateral cervical, nasium, and vertex radiographs were taken of all new patients and analyzed using the Grostic Procedure. Efforts were made to limit radiation exposure of patients whenever possible by using filters, high-speed film, and high kVp technique (84–88 kVp). The film-screen combination utilized was an 800 speed system from Kodak. A typical case had the following factors: lateral cervical - 10 MAS, nasium 30 MAS, and vertex 40 MAS. Lead compensating filters were used on all nasium x-rays. A vertex filter was developed toward the end of the study. These filters have been shown to reduce the x-ray exposure to the head by 78–90%.

The x-ray analysis results in a 'listing' composed of angular measures of the vertebral misalignment: the upper angle, lower angle, atlas rotation, and axis rotation. After the patient's first adjustment, the nasium and vertex radiographs are retaken to assess the change in misalignment. The post-film is analyzed using the same procedure as the pre-film, and a percentage change is calculated, based equally on the four x-ray misalignment factors listed above. The percentage change can at most be equal to 100%,

TABLE 1
Descriptive Statistics

| | Count | Min | Avg | Max | STD |
|---|---|---|---|---|---|
| % X-Ray Correction | 458 | –48 | 40.5 | 100 | 28.4 |
| Symptom Score | 458 | 0 | 2.60 | 3 | 0.759 |
| Adj 1st Week | 398 | 1 | 2.32 | 5 | 0.873 |
| Visits 1st Week | 398 | 2 | 3.80 | 7 | 0.841 |
| Adj 1st Month | 246 | 1 | 4.76 | 10 | 1.62 |
| Visits 1st Month | 246 | 5 | 9.03 | 14 | 1.77 |

but it can also be a negative number if the patient's misalignment worsened, or if the misalignment was overcorrected.

On a routine visit, patients were judged to require an upper cervical adjustment when a functional short leg was found in the supine position (15). Other measures of neurological involvement used to corroborate the leg check findings include cervical palpatory tenderness and spasm, postural distortion, and positive instrumentation such as neurocalograph, infrared thermography, and surface EMG. Likewise, patients were assessed to be "holding" their adjustment when the above analyses were found to be negative.

All patients were assigned a rating based on the symptomatic changes resulting from a course of care, usually after the fourth week. The rating is a general clinical impression based on the results of several clinical measures, including the visual analog pain scale (16), the Oswestry low back pain questionnaire (17), and Neck Disability Index (18) forms. Initial and re-exams utilizing objective tests included the following: x-ray, computerized surface electromyography (EMG), postural analysis, bilateral weight deviation, chiropractic thermographic instrumentation, wellness evaluations, and standard orthopedic/neurological exams.

Symptomatic results were rated as either good, fair, poor or unknown. A rating of "good" is given to a patient who made a complete recovery with at most only minor problems on occasion.

A rating of "fair" is given to a patient who improved significantly but not completely or a patient with multiple problems who does not completely recover from them all. A "poor" rating is given to a patient who has received little or no symptomatic improvement and is considered a failed case. An "unknown" rating is given to a patient where an objective assessment cannot be made because the patient discontinued care after less than two weeks.

For the purposes of this study, the following factors were extracted from either the clinical database or the paper files and tabulated for analysis:

1. percentage change in x-ray listing
2. symptomatic improvement rating
3. the number of visits for the first week of care
4. the number of times an upper cervical adjustment was required in the first week.
5. the number of visits for the first month of care
6. the number of upper cervical adjustments given in the first month.

The tabulated data were then entered into a computerized

TABLE 2
Statistical Analysis

| | N (<50%) | Avg (<50%) | N (>=50%) | Avg (>=50%) | z-score | p (one-tailed) |
|---|---|---|---|---|---|---|
| Symptom Score | 289 | 2.55 | 169 | 2.69 | –1.894 | 0.0145 |
| Adj 1st Week | 241 | 2.46 | 147 | 2.11 | 3.998 | 0.000016 |
| Adj 1st Month | 149 | 4.87 | 97 | 4.59 | 1.334 | 0.045 |

FIGURE 3
Average Number of Adjustments in the First Month

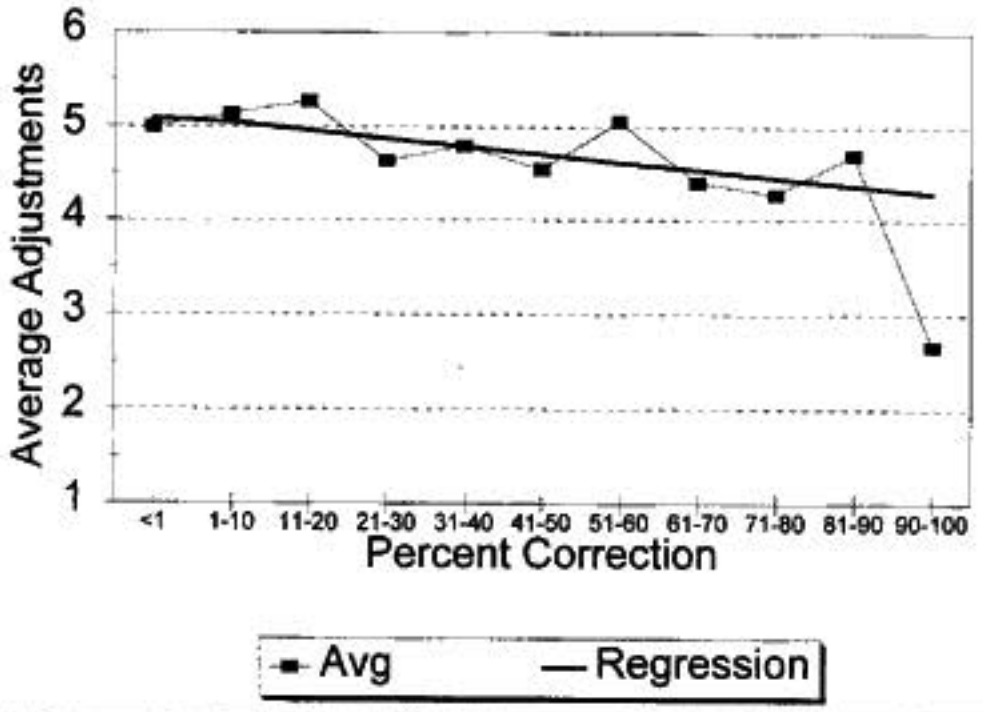
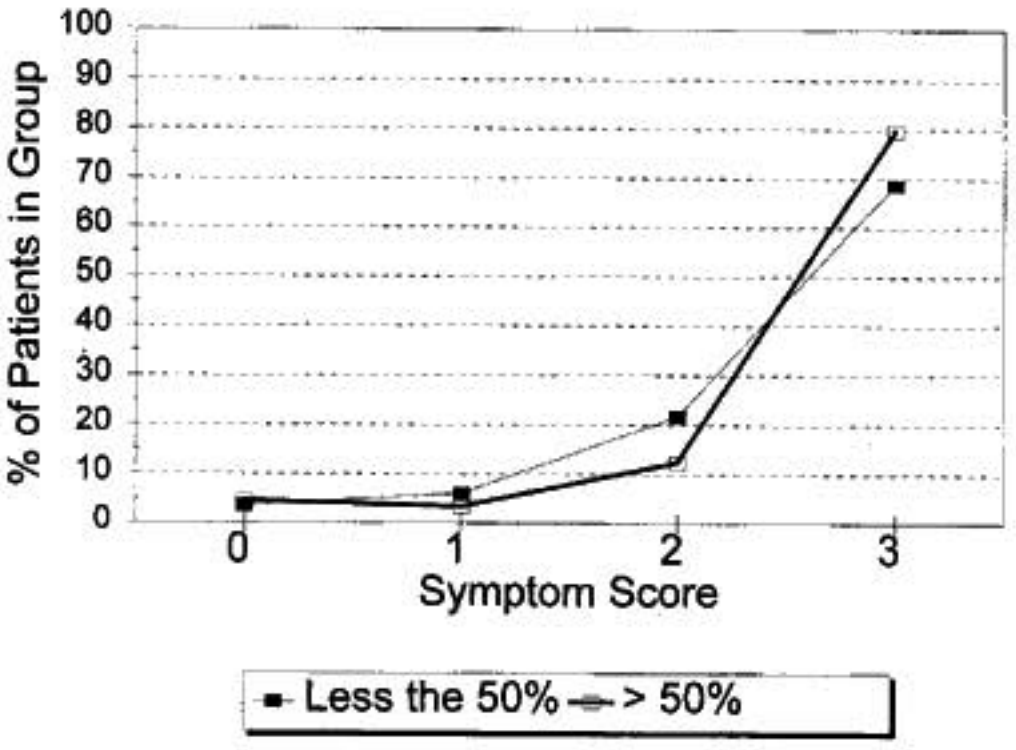



FIGURE 4
Symptom Score by % Correction




to 2.2. In the region where the x-ray correction was greater than 60%, the regression line is flat and the average number of adjustments required is two.

Figure 3, likewise, shows the regression line for adjustments in the first month as a function of the x-ray correction. There is an overall negative relationship, indicating that the greater the percent correction, the lower is the number of adjustments required. Unlike the other two regression lines, the relationship is uniform throughout the entire range of x-ray corrections. The very low point for x-ray corrections >90% represents only three patients, and doesn't influence the regression line significantly.

On the basis of the above analysis, the same three parameters were divided into two data sets based on whether the x-ray correction was less than 50% or greater than or equal to 50%. Histograms were plotted to show the distribution of the three factors. Figures 4–6 compare the distributions of each factor for the two sets, where x-ray correction is less than or greater than 50%.

The histogram in Figure 4 shows the percentage distribution of the symptom score. For instance, 80% of the patients whose x-ray correction was greater than 50% had a symptom score rated as 3 (good), while only 70% of the patients whose correction was less than 50% achieved the same level of symptomatic improvement. Patients were more likely to have a symptom score of 1 or 2 if the x-ray correction was less than 50%.

Figure 5 and Figure 6 show the distribution of adjustments needed, broken down by x-ray correction. For instance, in Figure 5, 35% of the patients whose x-ray correction was less than 50% required three adjustments in the first week, while only 23% of those with x-ray correction greater than 50% required that same number of adjustments. In general, the distributions of adjustments needed for both the first week and the first month was shifted to the left if the x-ray correction was greater than 50%. Table 2 shows the results of the z-test for the three factors. In all cases the z-test shows a statistically significant difference between the groups, based on the division at the 50% x-ray correction point.

## DISCUSSION

The data presented here shows that better percent correction leads to improved symptomatic outcome as well as increased spinal stability, as indicated by a decreased need for follow-up adjustments. It should be noted that the percent correction report-

ed is measured by x-ray analysis after the first adjustment and does not necessarily represent the ultimate correction achieved by the patient. Both the average symptom score and the average number of adjustments in the first week showed a break in the regression lines. (See Figures 1 and 2). The breaks suggest that the best clinical outcome can be achieved if the x-ray correction after the first adjustment exceeds 50%.

Overall, 75% of the patients had good symptomatic outcome from the care provided. The difference between the high correction group (>50%) and the low correction group was not dramatic in terms of symptomatic recovery. It appears that good outcome can be achieved with low initial misalignment correction, but the increased number of adjustments needed shows that the desired outcome takes more work. If a poor correction is achieved after the first adjustment, a change will be made in the adjustment technique so that future adjustments should yield a higher structural and symptomatic improvement.

An area needing more clarification is the relationship between neurological signs and misalignment reduction. All patients in this study were adjusted to remove the neurological indicators of subluxation, but this may have been achieved without maximal correction of the misalignment. Hypothetically, even a small amount of misalignment correction can remove enough stress from the nervous system that the patient will be checked "clear", but there could be minor nerve interference that is hard to detect with our present methods. Our data supports the hypothesis that better clinical outcome occurs when the initial adjustment produces a 50% or better reduction in misalignment, even when neurological findings are negative. Post-adjustment x-rays are needed to show that the adjustment was effective at reducing the misalignment to at least this level. Particularly for new practitioners, the role of the post-adjustment x-ray is to reveal what mistakes were made with the adjustment and/or analysis and what changes, if any, are needed to maximize future corrections. Post x-rays can also prevent the misalignment from becoming worse, as in the occasional case where one or more of the misalignment factors are increased after the first adjustment.

The patient management on which this article is based may not be typical of chiropractic practices in general. As seen in Table 1, the average number of visits in the first week of care is less than 4, and the average number of visits in the first month is only 9. Also, patients are not adjusted at every visit. Patients are checked at each visit for signs of neurological dysfunction and only adjusted if clinical indicators deem it necessary. The data presented in this study show that patients were adjusted at slightly more than half of their visits. This type of patient care is very different from that described by Kirkaldy-Willis (19), who gave

FIGURE 5
First Week Adjustments by % Correction

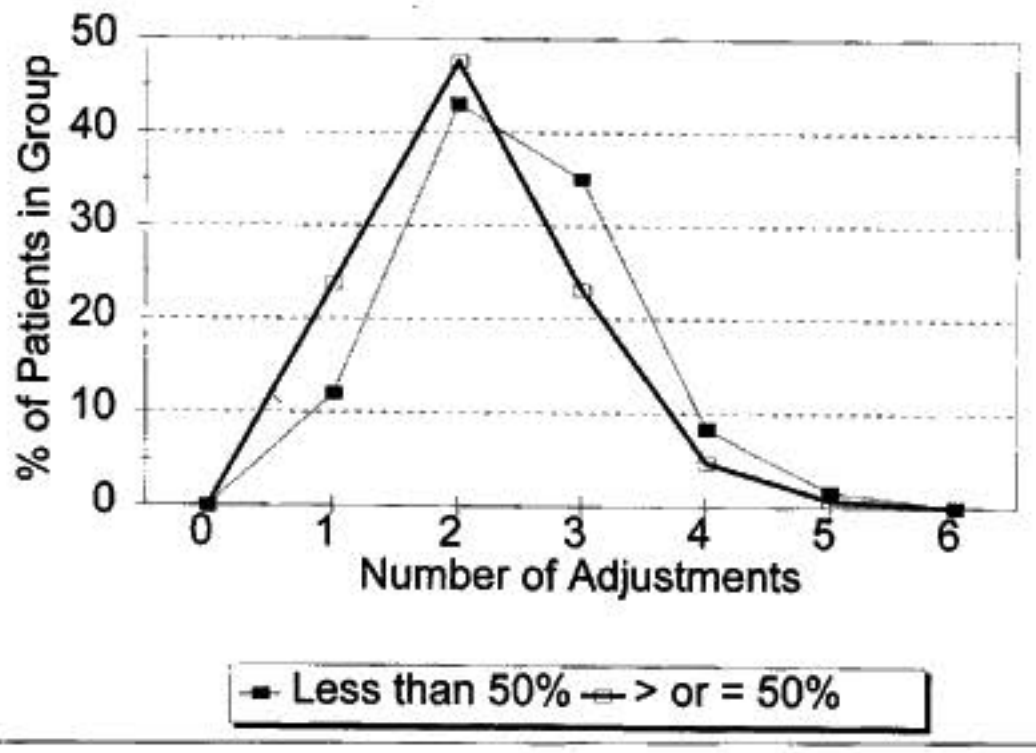
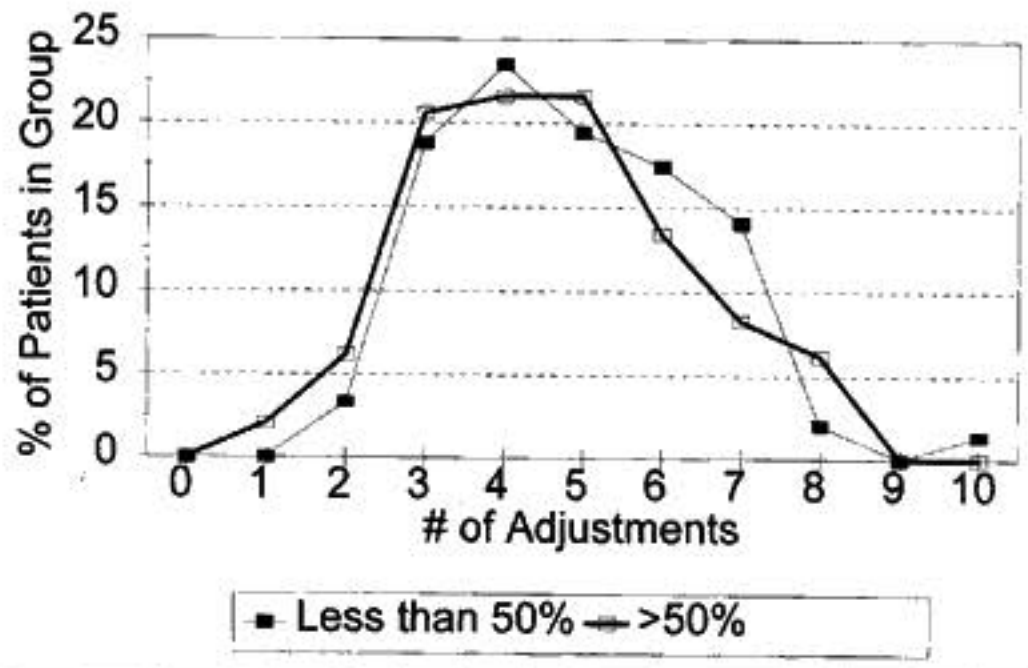



FIGURE 6
Adjustments in 1st Month by % Correction



patients daily side posture manipulation for two to three weeks.

The case management in this study may also not be typical of upper cervical specific chiropractic practice for three reasons. First, the practice being described had recently been purchased from a full-spine practitioner and many of the patients had already been adjusted by other means than specific upper cervical. Palmer et al. have reported that patients who have had long term repetitive manipulation tend to have atypical upper cervical misalignment patterns that are harder to correct (20). Such patients may be less biomechanically stable and might not be able to hold their adjustments for very long.

Secondly, care was not restricted to the upper cervical area. Although specific upper cervical technique was the primary method of care for all patients, some patients may have received specific adjustment or intersegmental traction to other regions of the spine as well.

Thirdly, the doctor was newly graduated and was not achieving a high correction rate in his early days in practice. After further experience and training in specific upper cervical technique, the correction rate improved. The percent correction overall reported in this study (40.5%) may not be representative of that achieved by an upper cervical practitioner after several years of experience.

One possible criticism of this study is that the doctor was not blinded to the x-ray analysis or the rating of the patients' symptomatic responses. It is hoped that this shortcoming could be overcome in future studies of this kind.

## CONCLUSION

The patients in this doctor's practice had better outcome on the average, based on the improvement of clinical signs and the reduced need for follow-up adjustment, when the occipito-atlantoaxial subluxation complex was reduced by at least 50% after the first adjustment. While the adjustment was almost always effective in correcting the clinical indicators of the need for adjustment, fewer adjustments were needed if the initial misalignment correction was more complete. These reductions were calculated from all four of the main misalignment components in an objective manner, and all of the doctor's files were reviewed for this study.

Based on these findings, post-adjustment x-rays are recommended after the first adjustment to ascertain that the adjustment was effective in eliminating at least 50% of the misalignment noted on x-ray analysis. ◆

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## REFERENCES

1. Palmer DD. Textbook of the Science, Art and Philosophy of Chiropractic for Students and Practitioners. Portland, OR, Portland Printing Co., 1910.

2. Gregory R. The chiropractic challenge: manipulate or adjust. Upper Cervical Monograph, 1986; 4(2): 8–9.

3. Gregory R. Manipulate or adjust – Is there a difference? Upper Cervical Monograph, 1986; 4(1): 9–10.

4. Barge F. The future of chiropractic? It depends upon our field of vision. Today's Chiro, 1990; 19(6): 118.

5. Williams SE. The Final Push. Marietta, GA, Life Chiropractic College, 1987; 21.

6. Barge F. Are You The Doctor, Doctor? Marietta, GA, Bawden Printing, Inc., 3rd edition, 1989; 76.

7. Jackson BL, Barker WF, Bentz J, Gambale AG. Inter- and intra- examiner reliability of the upper cervical x ray marking system: a second look. J Manipulative Physiol Ther 1987; 10(4): 157–163.

8. Jackson BL, Barker WF, Gambale G. Reliability of the upper cervical x ray marking system: A replication study. J Clinical Invest Research 1988; 1(1): 10–13.

9. Rochester RP. Inter and intra examiner reliability of the upper cervical x ray marking system: a third and expanded look. Chirop Res J 1994; 3(1): 23–31.

10. Grostic JD. The origins of the grostic procedure. International Rev of Chiropractic, March 1978; 34.

11. Grostic JD, DeBoer KF. Roentgenographic measurement of atlas laterality and rotation: a retrospective pre- and post manipulation study. J Manipulative Physiol Ther 1982; 5: 63–71.

12. Aldis GK, Hill JM. Analysis of a chiropractor's data. Journal and proceedings. Royal Soc., New South Wales. 112: 93–99, 1979.

13. Gregory R, Seemann D. An analysis of some hypotheses about the atlas subluxation complex. Digest Chiropr Econ, 1976.

14. Eriksen K. Comparison between upper cervical x-ray listings and technique anaylses utilizing a computerized database. Chirop Res J, 1995; 3(2): 13–24.

15. McAlpine JE. Measurement of the functional short leg phenomenon. Anatomical vs. functional. Today's Chiropr, September/October 1984.

16. Whitton ME. Outcomes assessment: its relationship to chiropractic and managed health care. ACA J Chiro, 1994; 31(7): 37–40.

17. Fairbank JCT, Cooper J, Davies JB, O'Brien JP. Oswestry low pack pain. Physiotherapy 1980; 66: 271–273.

18. Vernon H, Mior S. Neck disability index: a study of reliability and validity. J Manipulative Physio Ther 1991; 14(7): 409.

19. Kirkaldy-Willis WH, Cassidy JD. Spinal manipulation in the treatment of low-back pain. Can Fam Phys 1985; 31: 535–540.

20. Palmer T, Denton K, Palmer J. A clinical investigation into upper-cervical biomechanical stability: Part I. Upper Cervical Monograph 1990; 4(10): 4.