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The Ponticulus Posticus of the Atlas Vertebra and Its Significance

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I. INTRODUCTION

The ponticulus posticus (posticus ponticularis)[1] is a bridge of bone on the atlas vertebra sometimes surrounding the vertebral artery and the first cervical nerve root. It has been investigated periodically for the last hundred years, yet due to its supposed insignificance, what little has been discovered about this anatomical variant has been largely ignored. It has been described as both acquired and congenital and is accepted by most texts as an ossification of the oblique ligament of atlas.[2,3,4,9,11] This variant has been renamed more than once: **Foramen Atlantoideum** by Bolk in 1906, **Foramen Sagitale** by Loth and Niemiryce in 1916, **Foramen Atlantoideum Vertebrale** by Deseze and Djian in 1953[6], **Foramen Retroarticulare Superior** by Brocher in 1955, **Canalis Arteriae Vertebralis** by Wolf and Heidegger in 1961, **Kimmerle's Variant** and **The Foramen Arcuale** by von Torklus and Gehle in 1972,[7] and the **Retroarticular Vertebral Artery Ring of Atlas** in 1973 by Lamberty and Zivanovic.[5]

Gray's and other anatomy and spinal texts describe this bony arch as an ossification of the inferior or "free" end of the posterior atlanto-occipital membrane, sometimes called the oblique ligament of atlas as the membrane acquires a

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Observer Reliability and Objectivity Using Rotatory Measurements on X-Rays

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Abstract

The acceptance of spinographic analysis as an accurate measurement has been suspect due to the problems of magnification, distortion, line drawings and observer error. These problems can be solved by properly aligned x-ray, patient placement and competent observers. The results of this investigation show that a very high rate of reliability can be demonstrated between and among observers.

Key Words Spinographic analysis, magnification, reliability coefficient, upper cervical, alignment, patient placement, pre and post x-rays, reliability, objectivity.

The use of x-rays as a diagnostic tool has been useful to health care specialists, but the acceptance of x-ray as a basis for precision measurements has met with mixed reaction. Since there has been little research to support the position that precision measurement can be used with x-rays, the prevailing notion is that precision measurement cannot be utilized for that purpose. Phillips[8] has summarized the basic problems to be: 1) magnification and distortion, 2) observer error, and 3) errors with line drawings. Resolution of these problems is further complicated because all three elements are inter-related. For an example, if magnification, distortion and line drawings cannot be solved, then high observer reliability is not possible.

The purpose of this study was to show that high observer reliability can be solved. Magnification does create problems for linear measurement and line drawings but not for system that uses rotatory measurement. Problems with distortion can be reduced by proper alignment of the x-ray and patient placement. Specifically, two questions were examined in the investigation. The first, was concerned with the ability of an observer to obtain consistent measurements with the same set of x-rays over a period of time (the reliability of the observer). The second question was concerned with the ability of several observers to read the same set of x-rays and obtain consistent measurements (observer objectivity).

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The Ponticulus Posticus

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more fibrous texture where it crosses over the vertebral plexus,[5] vertebral artery and the first cervical spinal nerve lying in the retro-condylar groove of atlas.[3,5,9] Most studies done on the ponticulus posticus since 1881 have been described as morphological in approach and were set up to determine rate of occurrence and associated symptomatology.

Recorded occurrence has ranged from 7.4% by Loth-Niemirycz in 1916[5] to 37% by Dubreuil-Chanbardel in 1921.[10] Most studies find the occurrence to fall usually between 17% and 21% when incomplete rings are taken into consideration.

Radojevic and Negovanovic in 1963 compared cervical X-rays of patients and indicated that most X-rays visualizing ponticulus posticus were of patients with suspected epilepsy, cerebral tumor, headache and occipital neuralgia. Ercegovac and Davidovic in 1970 alleviated symptoms of vertebro-basilar insufficiency in 8 cases by surgically removing the bony rings of atlas. Clinical diagnosis of these 8 patients included stress, psychogenic, depression, and muscular neck pain.[5] Lamberty-Zivanovic state that "the symptoms of vertebro-basilar insufficiency may be caused by the bony rings around the vertebral artery in the absence of identifiable arterial disease and that it may be a predisposing factor when arterial disease is present."[5]

Upon our investigation of the ponticulus posticus, it was soon realized that all studies done previously were not consistent with each other and often conflicted. Major questions were left unanswered:

1) As it appears that the ponticulus most often accompanies a straight or military cervical curve, is there a relationship?

2) Is the bony arch an acquired calcification of the posterior atlanto-occipital membrane?

3) Is the posterior atlanto-occipital membrane a ligament or a membrane?

4) Do other osteophytic variations occur in association with the ponticulus?

5) What is the clinical significance, especially in relation to cervical manipulation or forceful adjustments?

6) With all previous concentrations on the effects of the ponticulus on the vertebral arteries, what is the importance of the C-1 nerve sharing this foramen?

II. METHODS AND MATERIALS

Our approach to the study of ponticulus posticus was an attempt to use all available means of assimilating as much information as possible, as objectively as possible. Cineradiographic video tapes of cervical range of motion studies with patients demonstrating a ponticulus posticus were provided by Dr. Roy W. Sweat, who also sponsored cervical and central nervous system dissection at Life Chiropractic College with Dr. Macon Weaver. In dissection, special attention was given not only to the atlas vertebra, but the posterior atlanto-occipital membrane, the vertebral arteries, the first cervical spinal nerve, the meningial attachments and the upper cervical spinal cord.

Five dry specimens were located from various private collections, two complete with axis and skull. Numerous X-rays were made of the dry specimens, including specific chiropractic views for comparison with patient X-rays. The structures were also photographed, including duplication of the chiropractic X-ray views. One dry specimen ponticulus was dissected for observation of the bony matrix. The dry cervical spine of a raccoon was prepared for comparison to the human specimens. It was also photographed.

1,000 lateral cervical X-ray films were selected in alphabetical order from an upper cervical chiropractic practice. All films were taken between 1952 and 1984 and were provided from the case files of Dr. Hugh L. Crowe. With the alphabetical selection, familial relationship could be included but not conclusive, since all family members were not always patients and others had name changes. All films were taken on an aligned X-ray machine at 40 inches with proper patient placement in an attempt to minimize head tilt and rotation and with the central beam directed at the atlas vertebra. All lateral films exhibiting two-thirds or more of a foramen created by the bony bridge were pulled for further study.

Out of the 1,000 lateral views, 189 patients exhibited either a complete or incomplete, unilateral or bilateral ponticulus posticus. Care was taken in differentiating atlas variations from interfacing with the mastoid process, incorrect patient placement (head rotation) and improper exposure technique. The curvature of the cervical spine was compared and recorded as being normal (lordotic), hyperlordotic, military (straight), or kyphotic. Note was made as to whether incomplete ponticulae originated from the posterior arch, lateral mass, both, or neither. A regular check list of other osseous conditions or anomalies was kept including osteophytes, elongated external occipital protuberance, platybasia, block vertebrae, ligamentous calcifications, sesamoids, and ankylosis.

Aligned and properly placed nasium views of the 189 cases were studied next. The nasium view is taken anterior to posterior with the central ray along the sagittal plane of the atlas vertebra and when made correctly offers an undistorted picture of the occipital condyles, the atlas, the axis and their relationship to each other. Note was made on the visibility of the ponticulus posticus making confirmation of the side of unilaterality often possible. A regular check list was made of other osseous conditions or anomalies, including ponticulae laterally to the transverse process, paramastoid processes, elongated styloids, and irregular occipital condyles.

Aligned and properly placed vertex views of the 189 cases followed. The vertex view is taken posterior to anterior, perpendicular to the sagittal plane of atlas highlighting C-1 and the foramen magnum. Visibility of ponticulus was noted, but more difficult due to interfacing of the axis vertebra, the hyoid bone, the posterior arch of atlas and the occiput. Occasionally the side of unilaterality was confirmed from the vertex view. A regular check list kept of other

osseous conditions and anomalies included bipartite facets of the superior lateral masses of atlas, cleft vertebrae, and odontoid irregularities.

Finally, the case histories of the 189 patients in the study were reviewed, making note of their entry complaints and their symptomatic response to specific upper cervical chiropractic adjustments. Symptomatic response was recorded in a subjective manner from patient's follow-up comments and categorized as excellent, good, moderate, none, adverse, or unknown. Note was also made objectively by recording from the pre and post-adjustment pictures the amount of reduction in the misalignment factors of the atlas subluxation complex.

Although tedious and time consuming, many statistics taken from the X-ray studies were nonconclusive. Many of these will be deleted from further discussion.

III. RESULTS AND DISCUSSION

A. Anatomical:

The lateral masses of atlas are subject to a wide number of anomalies including lateral and posterior pons, spurs, bipartite facets, and bridges of bone forming a foramen between the lateral mass and the transverse process or posterior arch, and sometimes from transverse process to posterior arch. By far the most commonly seen variation is the ponticulus posticus. Our method of study indicates 18.9% of patients demonstrate on X-ray an arch of bone forming at least two-thirds of a foramen bridging the lateral mass to the posterior arch on at least one side of the first cervical vertebra. Simple pons were not included. The results demonstrated not only a high number of incidents, but the highest percentage being bilateral, complete ponticulus posticus, forming distinct foramina posterior to both lateral masses (Fig. 1).

	BILATERAL	UNILATERAL	
COMPLETE	65 or 34.5%	R	21 or 11.1%
		L	18 or 9.5%
		U	8 or 4.2%
INCOMPLETE	22 or 11.6%	R	16 or 8.5%
		L	16 or 8.5%
		U	5 or 2.6%
UNILATERALLY COMPLETE	R 5 or 2.6%	R = Right L = Left U = Side Undeterminable	
	L 2 or 1.1%		
	U 11 or 5.8%		

Fig. 1

The case files of 189 patients exhibiting ponticulae were studied, noting their name, age, sex, race, occupation, and familial relations also in the study. Racial and occupational considerations were nonconclusive.

The female to male ratio fell at 84 to 105, indicating that gender is not a factor in the occurrence of ponticulae.

Most textbooks state outright that the ponticulus forms in late life and is not seen in children.[1,6,9,11] Lamberty-Zivonovic reported ponticulae on the skeletons of a 2 year-old, a 4 year-old and the X-ray of a 13 year-old.[5] Of our 189 subjects ranging from 5 to 77 years with an average of 36.6 years, fifteen were 15 years of age or younger, ten being under 12 years including a 5 year-old and two 6 years of age. Three children, ages 9, 12, 14 years displayed bilateral, complete ponticulae. These figures suggest that the ponticulus posticus is not a calcified ligament, as ligamentous calcification occurs years following the final formation of bone, and then following prolonged stress.[5]

30 subjects in the study had other family members included also. Of the 30, 12 were first generation, 17 were second generation and one was third generation. Due to the number of variants affecting a statistical approach, we cannot be conclusive but these figures strongly indicate that the ponticulus posticus is a genetically inherited variant as opposed to beg an acquired anomaly. There were also case records available on subject's relatives that were not included in the 1,000 surveyed due to name changes resulting from marriage, etc. These were reviewed concurrently, but not applicable statistically. Offspring tend to carry over the appearance of the ponticulus, especially when both parents demonstrate the variant.

Other evidence of the ponticulus posticus being a congenital structure developed from the cineradiographic studies and the cervical dissection studies. It was noted that during flexion and extension of the cervical spine on cineradiograph that the ponticulus posticus moved freely with the atlas and did not interfere in articulation. In determining as to whether the posterior atlanto-occipital membrane is indeed a membrane through dissection, several pertinent anatomical considerations were discovered. Only occasionally are the attachments of the dura mater reported to include the posterior atlanto-occipital membrane.[3] We found in all three cervical spines dissected the anterior surface of this ligament intimately attached to the dura mater of the posterior cervical spinal cord. Thus may be the reason it is denoted as a membrane, but in reality it is a ligament contiguous below with the ligamentum flava and above with the periosteum of the interior and the exterior walls of the foramen magnum as only a ligamentous structure would be. The oblique ligament of atlas is simply the inferior border of the posterior atlanto-occipital ligament.

In the comparison of the cervical curvature of the 189 lateral X-rays, further evidence concluded that the ponticulus posticus is not related to ligamental stress. 18 subjects exhibited a hyperlordotic curve, 22 exhibited a straight military curvature, and 61 exhibited a kyphotic curve, totalling 101 or 53% having abnormal cervical curvature.

Statistics on variations accompanying the ponticulus posticus from X-ray seemed insignificant. Bipartite facets of the superior lateral masses were visible in 10.5% of 189 vertex views. Lateral ponticulae were noted from the nasium view in 3.2% of the study. Two patients exhibited paramastoid processes and one an elongated external occipital protuburance. On the other hand, both dry specimens complete with axis, atlas, and skull contained variations in occipital foramina unilaterally on the same side as the atlas

ponticulus of one set and bilaterally, the same as the ponticulus, on the other set. The particular foramina most notably altered were the condylar canal, the hypoglossal canal, and the jugular notch. The condylar canal lies posterior and lateral to the hypoglossal canal and transmits a vein from the sigmoid sinus. The hypoglossal canal lies superior to the occipital condyles on the internal foramen magnum and transmits a meningial branch of the pharyngeal artery along with the hypoglossal nerve. The jugular notch lies anterior to the occipital condyles and is separate from the jugular foramen.[9] Gray's Anatomy mentions inconsistencies such as absence of a condylar canal, the hypoglossal canal being subdivided, and the jugular notch being closed forming a foramen as being seen commonly, but makes no reference to these variants being associated with the presence of ponticulus. In the two dry upper cervical specimens, one contained a left unilateral incomplete ponticulus posticus, an absent condylar canal unilaterally on the left, and a subdivided hypoglossal canal left ipsilaterally. The other dry specimen had bilateral ponticulae and bilaterally closed jugular notches forming foramen. A future study might show more evidence of a relationship in occipital and atlas foraminal variations.

An accepted frame of reference in the anatomy of vertebrates is the fact that the head tends to increase and the tail to decrease in size the more advanced the animal due to increase in brain size and less need for speed and agility.[8] In 1912, Le Double described the arcuate foramen[2] (or foramen arcuale[7]) of the ponticulus posticus as being a normal feature of most vertebrates, including primates.[5] *Hyman's Comparative Vertebrate Anatomy* relates that typically in mammals the atlas is a ring shaped bone with wide lateral projections which represent ribs and are perforated by the vertebrarterial canal. Also that the neuroarch of atlas is perforated for the passage of the first spinal nerve, a situation also encountered in lower vertebrates.[8] A macerated specimen of a raccoon's cervical spine showed the foramen for the first cervical nerve to be located and positioned identically to the ponticulus posticus of a human specimen, where the foramina transversarium were inconsistent in that they were situated perpendicular in their planes relative to articulation with both the occiput and axis.

Although most reports done on the ponticulus posticus describe it as originating from the lateral mass when incomplete,[2,9,10,11] Lamberty-Zivanovic noted that most common variation in their study of the incomplete bridge was absence of the middle part.[5] In our evaluation, origin of the incomplete ponticulus posticus appears to be from the lateral mass 21.7%, from the posterior arch 7.9%, both the lateral mass and the posterior arch 5.8%, and originating from neither (or floating) 1.6%.

Bone is formed by one of two processes, in both of which scleroblasts produce and arrange the bone configuration in a manner that enhances or facilitates localized primary nucleation of hydroxyapatite crystals. They in turn initiate calcification. Scleroblasts are influenced not only by the intercellular and the extercellular micro-environments, but by the function performed by mature tissue.[1,8,10]

The two processes that form bone tissue are intramembranous and endochondral ossification. Intramembranous ossification is a result of fibroblasts modulating into osteoblasts with irregular lamellarization of the bony matrix, also termed "woven," "fibrous," and "coarse-bundled" bone. With endochondral ossification, a preformed cartilaginous model is replaced by endochondral (replacement) bone.[8]

The ponticulus posticus of one dry human atlas specimen was opened for examination of the bony matrix and the lamellar patterns. A distinguishable cortex and cancellous bone matrix with easily distinguishable circular lamellar patterns was observed, indicating endochondral ossification and supporting Hayek's view that the posterior ponticle derives from the embryonic tissue of the dorsal arch of the pro-atlas.[7]

B. Clinical:

Several studies (Bidmond 1951, Williams and Wilson 1962, Radojevic and Negovanovic 1963, Ercegovac and Davidovic 1970, Lamberty-Zivonovic 1973 and others[5]) have indicated that in the presence of the bony ring of atlas, there is occlusion upon the vertebral artery and that patients with the ponticulus posticus often display symptoms of vertebro-basilar insufficiency such as headache, vertigo, and diplopia. In 1972, Graham and Adams reported two cases of idiopathic thrombosis of the vertebro-basilar arterial system in the absence of identifiable arterial disease but in the presence of ponticulus posticus.[5] White and Panjabi point out the stretching and kinking effect upon the vertebral artery with head rotation in the presence of the bony arch.[11] In discussing the ponticulus, Ruth Jackson states that "following injuries to the upper part of the cervical spine adhesions may form between the artery, the first nerve root, and the bony arch or canal through which they pass."[4]

In our study, notes were kept of patients' two major complaints upon entrance. Out of the 189 case studies, only 60 entered with complaints of headache, vertigo, or diplopia. Subjective symptomatic response of these 60 patients to vectored Grostic atlas adjustments following a two-week period showed excellent response in 26.7%, good in 30%, moderate in 25%, no response in 8.3%, and 10% were not followed up or response unknown.

Overall symptomatic response from the entire study, all symptoms considered, fell at excellent in 32.3%, good in 28%, moderate in 23.8%, no response 8.5%, and response unknown in 7.4%. No adverse response to these adjustments was found.

Possible symptoms of cerebro-vascular disease represented 25.9% of the entrance complaints of the patients in our study, but neuromuscular complaints far outweighed those of circulation in nature. Neck, back, brachial and lumbo-sacral complaints totalled 68.1%. This figure is probably influenced due to the practice being chiropractic, but is still very significant when compared to other complaints (see Fig. 2).

Although symptomatic response to minimal force vectored cervical adjustments was favorable, the percentage of actual reduction in the misalignment factors (atlas laterality,

Back Pain (Dorsal, Lumbar, Sacral)	84 or 36.2%
Headache, Vertigo, Diplopia	60 or 25.9%
Neck, Brachial Symptoms	55 or 23.7%
Hip, Leg Pain	19 or 8.2%
Tension, Hyperactivity, Insomnia, High Blood Pressure	10 or 4.3%
Respiratory Distress	4 or 1.7%

Fig. 2
Incidence of 232 Entrance Complaints/ 189 Patients Exhibiting Ponticulus Posticus

rotation, horizontal plane line, and relationship to the lower cervical angle), taken from the post-adjustment nasium and vertex X-ray views of subjects with bilateral complete ponticulae, was only 53.7%. 100 of the same doctor's pre and post-adjustment X-rays selected randomly and covering the same time period as the films exhibiting ponticulae, but excluding any atlas bony arch were reviewed. These showed a higher rate of total reduction at 67.5% indicating that the bilateral ponticulus posticus may restrict the atlas in its ability to be adjusted towards normal due to adhesions of the vertebral artery, nerve, and canal.

We propose that the effects of the passage of the first cervical nerve through the arcuate foramen of atlas are and can be more detrimental than the effects of vertebral artery embarrassment, especially in the presence of adhesions, much in the same way that migration of the cervical spine in any direction can traction cervical nerves and cause symptoms of nerve root irritation.[4] Very possibly the symptoms of vertebro-basilar insufficiency were alleviated by Ercegovac and Davidovic[7] by the elimination of adhesions irritating the first cervical nerve root or the inadvertent manipulation of the atlas vertebra.

IV. CONCLUSIONS

1. Of 1,000 examined lateral cervical X-ray views, 189 demonstrated two-thirds or more of a foramen created by ponticulus posticulus.

2. No relationship was determined between the stressful curvature of the cervical spine and the ponticulus posticus as only 53% of the subjects demonstrated abnormal curvature.

3. Although the posterior atlanto-occipital membrane is indeed a ligament, it is unlikely that the ponticulus posticus is the ossification of that ligament when considering the age of 7.9% of the subjects as being children, and the pattern of bone matrix derived from apparent endochondral ossification.

4. Osteophytic variations appear to be limited in conjunction with the ponticulus posticus, yet several occipital foramen were noted as being altered ipsilaterally to ponticulae.

5. Minimal force vectored adjustments of the atlas appear to be somewhat restricted in the presence of a bilateral ponticulus posticus, although symptomatic response is favorable. On the other hand, forceful traction or rotary type manipulations would seem contraindicated due to the possibility of adhesions involving the first cervical nerves and the vertebral arteries.

6. The common occurrence of the ponticulus posticus exemplifies the need for radiographic study previous to any cervical manipulation.

7. Symptoms most commonly encountered in our study indicate the likeliness of additional nerve pressure being created by an atlas with the ponticulus posticus than one without this variant.

8. The ponticulus posticus of the human atlas vertebra is a regressive, genetically inherited vestige of the foramen for the first cervical nerve, commonly seen in most vertebrates, most notably quadrupeds.

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Observer Reliability and Objectivity

(Continued from page 1)

Magnification

Using rotatory measurement eliminates the problems that a linear analysis has with magnification, because the angle relationship remains constant regardless of the relative distance between the object and the ray (Luster and Keats).[6] Since magnification tends to increase outward in all directions from the epicenter of the film (Hildenbrandt)[5] the analyses should be made from the center of the film whether it is locating structures of the skull or forming angle relationships. These procedures tend to reduce errors that occur where the analysis originates at the periphery of the film.

The rotatory measurement used in this study was the NUCCA system which is described in detail in Gregory.[4] Basically, the system measures the relationships between the frontal and transverse planes of the atlas, skull and the lower cervicals (C2-C7). Data was taken from the nasium x-ray (frontal) and the vertex x-ray (transverse), the independent variables. Specifically, two elements were measured. From the nasium film an element called the height vector was taken from four ratios. One of the ratios perhaps the most important, laterality, is illustrated in Figure 1. From the vertex film, the element is called the rotation vector and is calculated by comparing the center of the skull and the center of the atlas. See Figure 2. By determining these two elements an objective index as to how precise the observer reads the films can be established.

Distortion

Proper alignment of x-ray requires that two planes be established so that all units of the equipment are 90 degrees to each other. On the long axis, the exact center of the bucky, the film, the object, the head clamps and the focal spot should bisect this plane (see Figure 3). The short axis is set at right angles to the long axis. The tube arm, x-ray head, bucky and head clamps are set 90 degrees to the long axis and the main tracks of the x-ray.

Distortion can also occur if the patient's head is not placed 90 degrees to the focal spot, because the side of the head that is nearest to the ray will appear larger and the radius of the head will shorten and appear flatter on the side of the head furthest from the ray. These differences are

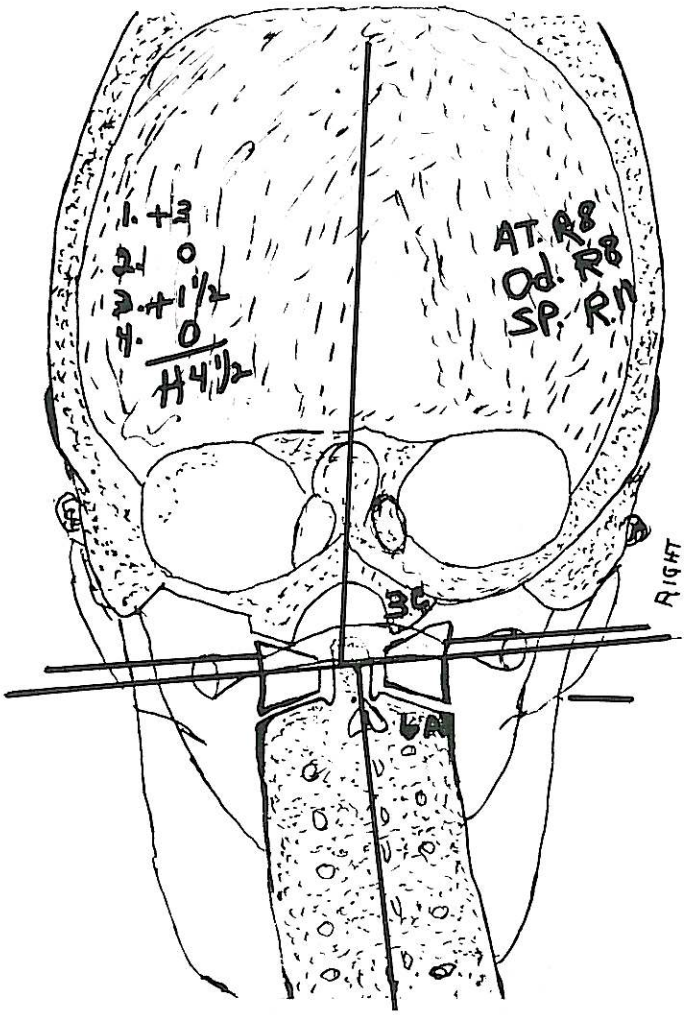

Figure 1

The height vector is the sum of four ratios from the nasium film. Laterality is formed by the atlas plane line and the central skull line.

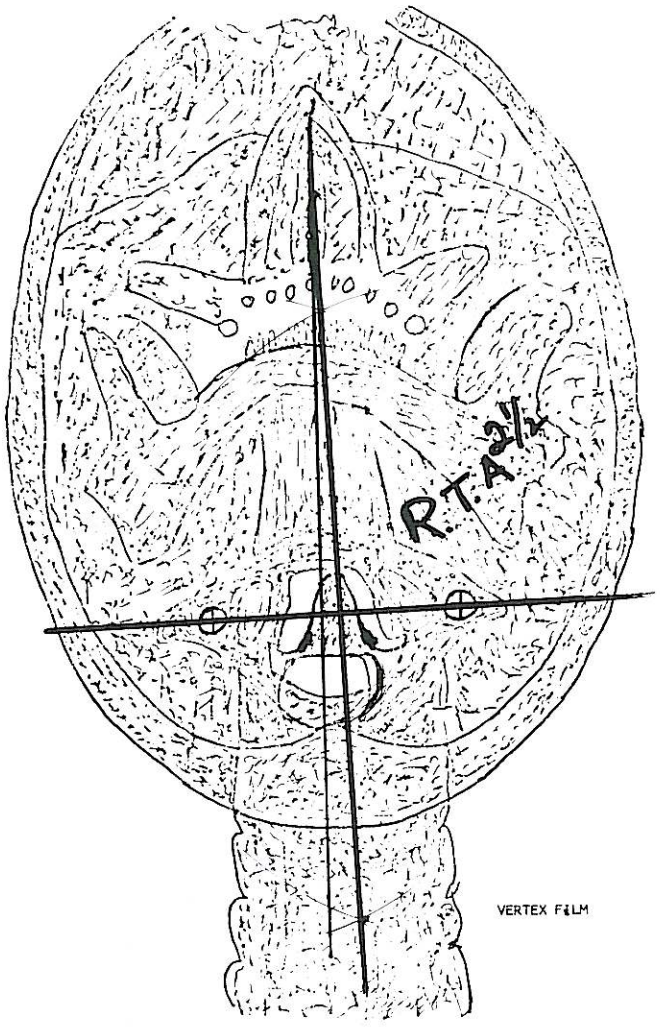

Figure 2

Rotation is the angle formed by the atlas line and the skull line.

sometimes viewed as bone or tissue anomaly. In cervical analysis sometimes one of the occipital condyles will appear shorter than the other because the condyle is not the same distance to the focal spot (Gregory).[3]

Important in reducing distortion problems is the use of a scissors type head clamp which is fastened to the bucky. The head clamp is aligned so that the center of the head clamps always bisect the center of the bucky. The head clamp acts as the centering device which assures the head will bisect the center of the bucky. The head clamps also insure the head will not move during the exposure. See Dickholtz.[1]

If distortion, patient placement and magnification are not controlled, then any attempt to judge observer reliability is non-productive. Phillips[7] found little agreement between spinographic systems when he attempted to compare three different methods of x-ray analysis. The outcome was predictable because no standard was used across all three systems as to how the x-rays were to be produced.

Explicit is the assumption that consistent observation within and between observers is only possible if the above variables are controlled. Therefore consistent agreement within and between observers should indicate that it is possible to utilize a spinographic system for precision measurement.

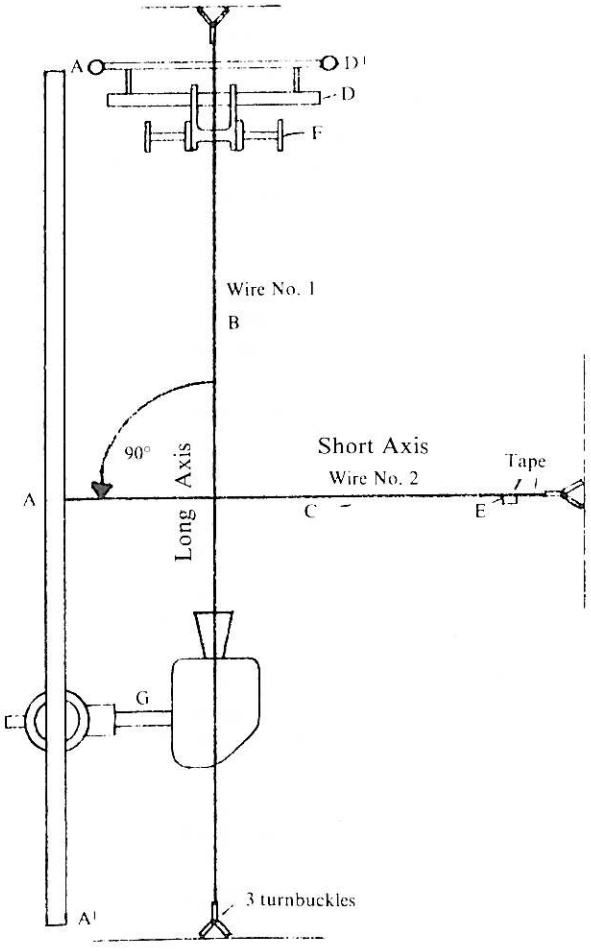

Figure 3
A properly aligned x-ray requires all of the components to bisect the long axis which is 90 degrees to the short axis.

METHOD

Participants

The observers for the study were five experienced practitioners using the NUCCA system of spinographic analysis. All were engaged in private practice with a range of one to forty years experience. Three participants were from the mid-west, one was from the south-west and one was from Canada.

The x-rays that were to be analyzed by the observers were taken randomly from the files of patients who had been treated previously in Monroe, Michigan. Pre and post x-rays were kept in the file, but for the purposes of the study, only the nasium and vertex films of the pre-test were used. A total of ten sets were picked with file numbers ranging from 1802-5827, a span of several years.

Equipment

The ten sets of x-rays were taken on the same x-ray equipment which was manufactured by Borg-Warner. The films were taken at KVP-90 and MA 15. For the nasium, the exposure time was 1-1¼ seconds and for the vertex view, exposure time was 2-2½ seconds. The focal spot to film distance was 42 inches. The focal spot aperture was 2.5 mm. The head clamp was made by Utterbach and the x-ray tube was made by Picker.

A total of 50 sets of films were duplicated after the original line drawings of the ten sets had been erased. Each of the five observers received the same set of 10 x-rays for the analysis.

Procedure

For the inter-observer study, the five observers were asked to analyze the films at their respective offices. The analyzed films were then returned to the investigator by mail. The observers were blind as to what data would be used in the study. They were told the investigation was concerned with observer reliability.

The intra-observer study was conducted with two observers. They were asked to re-analyze the same set of films after approximately one month to determine the internal consistency of the observer. The Pearson Product Moment coefficient of correlation was used in the analysis of data for both studies.

Results

The observers who participated in the study were trained in the NUCCA system of spinographic analysis. Therefore the following results can only be generalized to those who use the analysis system. The investigator disqualified one set of x-rays on the grounds the nasium film was too difficult to read. Under most conditions the patient would have been re-xrayed.

Table 1 shows the reliability coefficients (rc) for the intra-observer study with Observer #1. The rc for rotation from the first analysis to the second is .97. The rc for the height vector from the first analysis to the second is .94.

Table 2 shows the rc for the intra-observer study with Observer #2. The rc for rotation from the first analysis to the second is .98. The rc for the height vector from the first to the second analysis is .99.

Table 3 shows shows the rc for the inter-observer study for the five observers with regard to rotation. Observer #1 was the standard use for comparing the five observers. The rc's ranged from .81 to .99 over the five observers. The mean for group was .93.

Table 4 shows the rc's for the five observers with regard to the height vector. Again Observer #1 was used as the standard. The rc's ranged from .87 to .99. The mean for the group was .96.

Table 1.
Intra-Observer Reliability Coefficient for Observer #1 Rotation and Height Vector N=9

	Rotation #2	Height #2
Rotation #1	.97	—
Height #1	—	.94
Mean Deviation	.54°	52″
	p .01 r=.735	

Table 2.
Intra-Observer Reliability Coefficients for Observer #2 Rotation and Height Vector N=9

	Rotation #2	Height #2
Rotation #1	.98	—
Height #1	—	.99
Mean Deviation	.42°	25″
	p .01 r=.735	

Table 3.
Inter-Observer Reliability Coefficients for Five Observers - Rotation N=9

	O #1	O #2	O #3	O #4
O #1	—	—	—	—
O #2	.81	—	—	—
O #3	.82	.58	—	—
O #4	.95	.67	.83	—
O #5	.99	.82	.80	.94
Mean	.93		p .01 r=.735	

Table 4.
Inter-Observer Reliability Coefficients for Five Observers - Height Vector N=9

	O #1	O #2	O #3	O #4
O #1	—	—	—	—
O #2	.87	—	—	—
O #3	.91	.89	—	—
O #4	.97	.91	.93	—
O #5	.99	.86	.89	.97
Mean	.96		p .01 r=.735	

Discussion

The goal of this study appears to have been met. High reliability coefficients were realized for intra-observer reliability and inter-observer objectivity. Downie and Starr[2] indicate that reliability coefficients of over .90 are extremely high. The investigator feels that coefficients above .90 are an acceptable standard for this type of analysis, because an index of .90 translates into slightly less one degree of variation per film. This small error would not be detrimental to the patient except where laterality or rotation would be changed to the opposite side.

This study suggests that x-rays can be used with precision if a rotatory system of measurement is utilized. The key to the successful use of spinographs for precision measurement is to have properly aligned x-ray equipment and insure the patient is positioned to the bucky in a standardized manner. Consistency is also enhanced if the observer is a competent analyst.

As a final note, the analysis system used in this study has been in place for better than 40 years. From the one file over 7000 patients have benefitted from this type measurement both pre and post analysis. There are flaws in the system but over-all the analysis has been beneficial in the reduction of the cervical subluxation.

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Manipulate or Adjust — Is There A Difference?

By Ralph R. Gregory, D.C.

Editorials, obviously derogatory to upper cervical techniques, and which accuse by inference upper cervical practitioners of spreading dogma, propagating mistruths, disseminating myths, indulging in fantasy, not relating pre-and-post x-rays to clinical results, and asserting that no difference exists between an adjustment and a manipulation, are in evidence lately.

Of these apparent accusations, only three deserve comment: (1) that the "old theory of listing a position of a vertebra and specifically adjusting to reduce the listing; that is repositioning (a vertebra) by using a specific line of drive is fantasy;" (2) that "our profession has waited 90 years for just one random pre and post x-ray study that could show a relationship between static x-ray markings and clinical results," and (3) that "A chiropractic adjustment IS a manipulation."

Before discussing these three items, the point should be made that no one can logically defend or condemn any system which he has neither learned nor practiced. The writer speaks, therefore, only for the National Upper Cervical Chiropractic Association, Inc. (NUCCA) and its research arm, the National Upper Cervical Chiropractic Research Association, Inc. (NUCCRA) and confines his remarks to the Atlas Subluxation Complex System (ASC), a neologism NUCCA copyrighted in 1973.

Regarding the "fantasy" statement, a line of drive is a mathematically obtained resultant of the misalignment factors of the C1 subluxation, the sizes of the condyles of occiput and the superior articulating surfaces of C2, obtained from the x-ray analysis and essential to determining the final resultant along which the adjustic force must travel to reposition the ASC. To label such a procedure "fantasy" exposes one to the charge of ignorance of simple physics because pre-determining direction is essential to any physical activity in which force is used to move an object to a definite position.

In statement number two, we read of the 90 years that the profession has waited for a pre-and-post study relating to clinical results. Pre-and-post x-ray has not been utilized for that long a time, and probably not more than 50 years. The research of attempting to relate or correlate the two — x-ray to clinical results — is fairly new. NUCCRA has already established a large data base that correlates the distortion-symptoms of the body to the effects of a C1 subluxation on the body, and the resultant effect of the removal or correction or reduction of the misalignment factors of the C1 subluxation on the distortion-symptoms. This study covers a ten-year period, and required specially built equipment, the Anatometer. This study is basic to further research regarding relating the C1 subluxation to clinical results. Simply stating that symptoms disappear following any treatment is not proof of any system. Measurement is proof.

The third statement that "A chiropractic adjustment IS a manipulation" deserves more detailed comment. It is interesting to note that D.D. Palmer in his SCIENCE, ART, AND PHILOSOPHY (pp. 11) wrote: "Adjustments are only made when a vertebra is returned to normal position," thereby giving the term adjustment the sense of misalignment-correction. Palmer was aware that chiropractic is a mechanical science and subject to the laws of mechanics and physics, unlike medicine, a chemical science.

Biomechanics is the application of mechanical laws to living structures. If a state of vertebral misalignment exists in the human spine after either an adjustment or a manipulation, how can that spine be even remotely considered as biomechanically restored? or capable of "restoring normal spine biomechanics and its resultant effects on the neurobiological homeostasis of the patient?" Obviously, those who believe that vertebral misalignments cannot be corrected would hardly be inclined to place any value on misalignment-correction — or, for that matter, on post-x-rays or any other kind of measurement. Nor do they explain how manipulation aligns the vertebral facets to the degree they were designed to be in order to achieve a state of biomechanical function. To them, then, the terms manipulation and adjustment would seem synonymous.

One critical writer states that the "description" of a manipulation is exactly the same as a chiropractic adjustment. A description is supposed to be an explanation, a making clear, a breakdown of the details. The writer states in his "description" that an adjustment "uses a dynamic, short, sharp, high velocity, low amplitude force...". This is not the "use" of a NUCCA C1 adjustment. In fact, if the ASC were adjusted in this manner, harm could result from increased misalignment and/or change of type subluxation. Speed is detrimental to a C1 adjustment, the amount of force used is determined by the subluxation's resistances, and "shortness" or control of depth is checked from within the adjuster's body. What the writer means by the word "sharp" is obscure: nothing is intense or severe about a NUCCA C1 adjustment.

The area of the spinal column to be adjusted, however, has a bearing on the meaning of the terms. Dorsal and lumbar vertebrae are architecturally designed so that their articulations form a built-in pathway which guide these vertebrae toward or to normal position whenever a force is applied, even approximately. In the occipital-atlanto-axial spine, the articulations are so structured that the adjustic force must be applied with extreme accuracy to control direction (line of drive), depth, and force. This is the reason that the occipital-atlanto-axial area is the most difficult to adjust. A force applied to the dorsal and/or lumbar spine of the manipulative variety could conceively restore the misalignments of these areas.

A search of the dictionaries informs us that to manipulate connotes a skillful use of the hands, management or control of tools, implements, persons, or mon-physical problems

and situations. To work with the hands (Latin: manus-hand). To adjust is to bring two or more things to agreement, to set right, to fit, arrange in order, to bring to a true or effective relative position (Latin: ad-near to plus quixta, close by, near).

In manipulation, the hands are the main instruments used: in adjusting, the adjuster's body is the tool. While both are arts, the adjustment is an art predicted on relevant scientific principles and the laws of physics, mechanics, and kinesiology. Therefore, in their performance considerable difference obtains. The adjuster's action lines are specifically predetermined as to their direction prior to adjusting a given C1 subluxation and must be exactly coplanar with the computations derived from the x-ray analysis. The post-x-ray will show the accuracy of the delivery of the adjustment as reflected in the reduction of the correction of the misalignment factors.

For example, the adjuster's pelvic lever and shoulder lever must angle to the proper degree suitable to the C1 subluxation being addressed, the triceps muscles must be correctly used and to a degree sufficient to overcome the subluxation's resistances, the wrist levers must properly align, and the adjuster's spinal column must be positioned accurately — all the result of physical laws that apply. About fifty steps must be executed by the adjuster's body if a maximum correction of the misalignment factors is to be obtained.

In the objective to be obtained, therefore, lies the real and practical sense in which the two terms differ in meaning. One may manipulate to suit his means; one adjusts only to fit the misalignment factors of the C1 subluxation as analyzed from the patient's x-ray. The manipulator's objective may be with the loss of the paraphysiological motion of the joints involved but the adjuster's concern is with the correction of all the vertebrae that compose the C1 subluxation including the pelvis. This restoration of the spinal column to the vertical axis of the body makes the ASC a full-spine technique.

An adjustment, therefore, as practiced by the NUCCA practitioner is a motor skill. "A motor skill is a group of simple natural movements combined in a new or unusual manner to achieve a predetermined objective." (See UNDERSTANDING THE SCIENTIFIC BASES OF HUMAN MOVEMENT by Gowitske & Milner, 2nd Ed., pp. 317).

The adjustment, then, is a complex skill, using the entire body to deliver with extreme accuracy the force required to reposition several misaligned and subluxated vertebrae and the pelvis, and to balance the body's neurological state. The point at which the terms adjustment and manipulation differ in their meaning is in how they are accomplished and in the objective to be sought in their performance. Thus one can only conclude that the terms are not synonymous because they are not too similar, equivalent, or interchangeable in all situations.

The Ruth O. Gregory Memorial Fund

To the many and generous contributors to the RUTH O. GREGORY MEMORIAL FUND, NUCCRA extends its thanks. Your contributions to the Fund have helped to finance C1 subluxation research, advance your profession, and assist your colleagues to practice subluxation-reduction, thereby helping your profession, your patients, and yourselves.

The NUCCRA Directive Board in November of 1982 unanimously voted to establish a Memorial Fund as a tribute to Ruth O. Gregory in appreciation for the time and effort which she so unselflessly gave to the NUCCA-NUCCRA Organizations. This Fund is to exist as long as the Organizations exist. It was her great desire that chiropractic become more scientific and of greater benefit to mankind. She saw bona fide research as the only way to achieve these goals. To this end, she devoted time, effort, and money.

Since her death in June of 1982, many donations have been received from doctors, students, and lay persons who knew her. These donations have been used for the sole purpose of furthering NUCCRA research.

It is the feeling of the NUCCRA Directive Board that, through this Memorial Fund, Ruth O. Gregory's great interest in the development of chiropractic will live on, and the advancement of chiropractic continue to the benefit of all.

Recent donators to the Ruth O. Gregory Memorial Fund are:

Mrs. Marynelle Shields	Indiana
Dr. Steve Duff, Jr.	California
Dr. & Mrs. Marshall Dickholtz, Sr.	Illinois
Mrs. Lena Dorrance	Michigan
Dr. Donald Moon	Ohio
Mr. & Mrs. M.J. Anderson	Ohio
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Dr. M. E. Madden	Texas
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The 1985 November NUCCA Seminar

The 1985 November NUCCA Seminar was held at the Howard Johnson Motor Lodge in Monroe, Michigan from November 2 through November 6, 1985. The H. J. Conference Room was filled to capacity with doctors from throughout the United States, Canada, and one from Japan, Dr. N. Ikuse. Students from Chiropractic Colleges also attended.

The seminar was supervised by Daniel Seemann, Ph. D., The University of Toledo, and approved for license-renewal in several states and provinces. Assisting Dr. Seemann were Drs. M. Dicholtz, Sr., K. E. Denton, Teresa A. Palmer, Lloyd Pond, Lonnie Pond, Glenn Cripe, A. A. Berti, Larry Schrock, and R. R. Gregory.

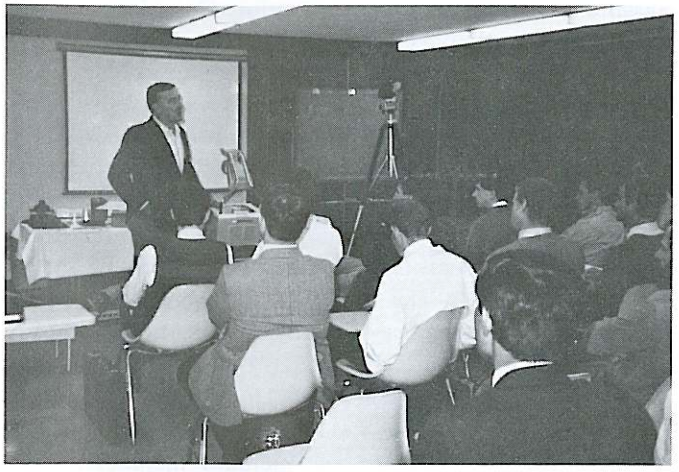
Participants were divided into categories corresponding to subjects taught: x-ray analysis, leg checking exercises, biomechanical problems, x-ray procedure, and patient placement. It was a "hands on" program.

Previously prepared videotapes on adjusting technique, analysis, x-ray machine alignment, and adjusting errors were shown.

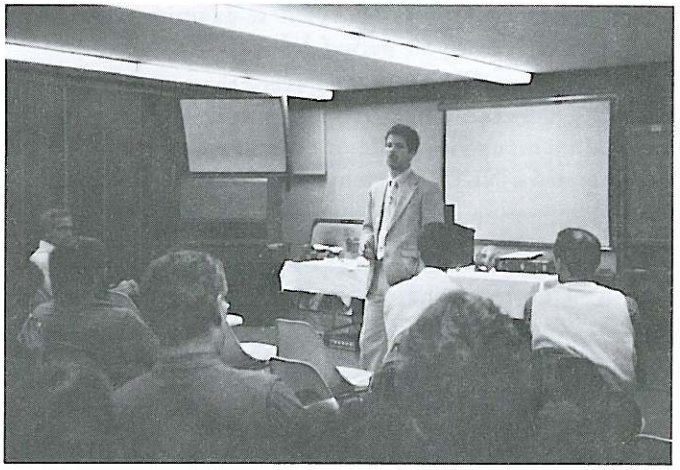
General discussion of all the exercises was participated in by the registrants and compared with school solutions.

Dr. D. C. Seemann and James F. Palmer of The University of Toledo discussed NUCCRA research projects.

Dr. Albert Berti discusses biomechanics with a group of doctors at the seminar.



Dr. Daniel C. Seemann lectures to the 1985 November NUCCA seminar.



James F. Palmer, M.S., The University of Toledo, presents a research update report.

Notice

The **NUCCA Board** of **Directors** has decided to make the **NUCCA** collection of video tapes available to members. The price for tapes has been set at $100.00 per classroom hour. Available tapes include.

Osseous Structure Identification (45 min.) $90.00
This tape is essential to correct **NUCCA** x-ray analysis.

NUCCA X-Ray Analysis (60 min.) $100.00
Step by step procedure in analysis.

Leg Check and **Headpiece Placement** (45 min.) $90.00
Leg checking according to reference planes, Headpiece placement for all basic types.

Adjusting the **A.S.C.** (3½ hours) $300.00
Inclusive of proper procedure and most common errors.

Errors in **Adjusting** the **A.S.C.** (2 hours) $200.00
Compliments above tape.

Patient Placement for **X-Ray** **$90.00**
How to align the patient for all cervical views.

X-Ray Alignment (45 min.) $90.00
Step by step procedure for aligning equipment.

Biomechanics of the **Four Basic Types** (1 hour) $100.00
Detailed discussion of C1 production and correction.

Questions and **Answers,** A **Self Evaluation** of **C1 Adjusting** the **A.S.C.** (1 hour) $100.00

High Quality video tapes only are used for reproduction which carry a lifetime guarantee. Please specify BETA or VHS. Allow 4-6 weeks for delivery. Prices are subject to change with cost of reproduction.

NUCCA CERTIFICATION

A certification program has been initiated by the National Upper Cervical Chiropractic Association, Inc. (NUCCA). The purpose of the program is to NUCCA-qualify doctors in the NUCCA work. Doctors who successfully complete the program will be eligible to conduct and teach basic classes. A certification committee will be established from the initial group of doctors first certified. Examinations will be given at NUCCA seminars and conventions.

Doctors who wish to be NUCCA-certified must meet the following prior conditions: (1) be in practice for a period of at least three years, (2) have possession of, or access to, equipment and instrumentation recommended by NUCCA, and (3) permit NUCCA inspection of their office facilities. The entire examination must be completed in two years. Certificates will be issued successful candidates.

Doctors who have not engaged in practice for three years but who have attended NUCCA seminars are eligible to take the examination which covers a two-year period. A fee is charged each candidate. In the event of failure of the examination, or any part thereof, the candidate is re-examined in the part of the examination he failed without paying an additional fee, provided re-examination takes place within the two-year period.

Certification will be evaluated every three to five years, and certified doctors will be requested to either take an oral examination on updated data or provide evidence that they have attended a NUCCA seminar at least once each year.

The examination is in three segments, as follows:

1. X-RAY AND INSTRUMENTATION
   - A. Understanding of x-ray alignment procedures
   - B. Theory about distortion, magnification, collimation
   - C. Produce ten sets of cervical films suitable for analysis
   - D. Examination on x-ray procedures
   - E. Submit a set of x-ray alignment films
   - F. Examination on instrumentation

2. FILM ANALYSIS
   - A. Knowledge of osseous structures
   - B. Read ten sets of cervical spinal x-rays with an inter-observer reliability of .90
   - C. Examination of film analysis

3. ADJUSTING
   - A. Submit ten sets of consecutive pre and post cervical x-rays. The post x-rays presented to the examining board be those taken after the initial adjustment. Reductions in the height and rotation vectors to be evaluated at the discretion of the examining board.
   - B. Oral examination in which the candidate is given various listings for which he is to explain reduction procedures.
   - C. Written examination on adjusting. 100 questions with a passing grade of 85.

The 1986 NUCCA Convention and Educational Conference

The 1986 NUCCA Convention and Educational Conference will be held at the Howard Johnson Motor Lodge, 1440 North Dixie, Monroe, Michigan (48161). It will start on Monday, May 5th at 8:00 a.m. and close on Thursday, May 8th at 12:00 noon. The Educational Conference will be under the supervision of Daniel C. Seemann, Ph.D., The University of Toledo.

Convention Chairman will be Dr. D. Gordon Hasick, Calgary, Alberta, Canada.

The theme of the Educational Conference will be: The application of biomechanics to the spinal column.

Past NUCCA educational conferences and seminars have been accepted by many state boards for license-renewal. Participants in the 1986 educational conference who intend to apply for license-renewal credits in their states and in the Canadian provinces must attend all the educational sessions. Their attendance will be monitored by NUCCA and recorded on NUCCA attendance cards.

Subjects will include basic (beginners) film analysis, classifications of the C1 Subluxation Complex, patient placement for each type subluxation, mechanical levers, resistances to the adjustment inherent in the subluxation, anatometer exercises, supine leg check exercises, biomechanical problem exercises, adjustment problem exercises, and adjusting technique. This will be "hands on" instruction and answers will be compared with school solutions.

Prepared videotape presentations will include: Identification of Osseous Structures in Upper Cervical Film Analysis; Adjusting Errors; X-Ray Machine Alignment, and Patient Placement For Upper Cervical X-Ray. Videotapes will also be shown on adjusting techniques as time permits.

The fee for a professional is $350.00. For doctors in practice for two years or less, the fee is $200.00. Students are admitted for $150.00. The fee includes membership in NUCCA for one year. **A $25.00 charge is added to all registrant's fees who have not sent in their $50.00 deposit by the deadline date.**

Income above expenses will be donated to NUCCRA research, Dr. D. C. Seemann and James F. Palmer, University of Toledo, will discuss on-going research projects at the Convention that NUCCRA is engaged in.

NUCCA will host a banquet on Tuesday evening, May 7th at 7:30 p.m.

The deadline for registering for the 1986 NUCCA Convention and Educational Conference is March 20th, 1986. It is advisable to register early because of the limited number who can be accommodated.

Further information may be obtained by writing NUCCA, 217 West Second Street, Monroe, Michigan, 48161.