

Craniocervical chiropractic procedures – a précis of upper cervical chiropractic

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Presented here is a narrative review of upper cervical procedures intended to facilitate understanding and to increase knowledge of upper cervical chiropractic care. Safety, efficacy, common misconceptions, and research are discussed, allowing practitioners, chiropractic students, and the general public to make informed decisions regarding utilization and referrals for this distinctive type of chiropractic care.

Upper cervical techniques share the same theoretical paradigm in that the primary subluxation exists in the upper cervical spine. These procedures use similar assessments to determine if spinal intervention is necessary and successful once delivered. The major

Examen narratif de procédures de la cervicale supérieure afin de faciliter la compréhension et d'améliorer la connaissance des soins chiropratiques des cervicales supérieures. L'innocuité, l'efficacité, les méconnaissances courantes et la recherche font l'objet de discussion, ce qui permet aux praticiens, aux étudiants en chiropratique, et au public de prendre des décisions éclairées concernant l'utilisation et les recommandations pour ce type particulier de soins chiropratiques.

Les techniques de la cervicale supérieure ont le même paradigme théorique, car les subluxations primaires existent dans la colonne cervicale supérieure. Ces procédures ont recours à des évaluations semblables pour déterminer si une intervention vertébrale est nécessaire et si elle est réussie une fois effectuée. La

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difference involves their use of either an articular or orthogonal radiograph analysis model when determining the presence of a misalignment. Adverse events following an upper cervical adjustment consist of mild symptomatic reactions of short-duration (< 24-hours).

Due to a lack of quality and indexed references, information contained herein is limited by the significance of literature cited, which included non-indexed and/or non-peer reviewed sources.

(JCCA 2015; 59(2):173-192)

KEY WORDS: chiropractic, chiropractic adjustment, cervical, atlas, adverse events, craniocervical

Introduction

The indexed literature reports the existence of many upper cervical (UC) procedures.^{1,2} Presented here is a brief narrative review or narrative description of upper cervical techniques (UCT) with the intention of increasing knowledge and understanding regarding their effectiveness and utilization. Procedural similarities and differences between UCT are examined. As chiropractic goes the way of other healing professions through stratification into specialties, this characterization of upper cervical procedures can create appreciation and clarity both inside and outside the profession.

This paper allows practitioners, chiropractic students, and the general public to make informed decisions regarding utilization and referrals for this unique type of chiropractic care. In the chiropractic profession, only 1.7 percent of practitioners utilize upper cervical chiropractic techniques according to the National Board of Chiropractic Examiners.³ Since this represents such a minority, it is easily understood that few are familiar with UCT.

Origins

UCT have been part of the chiropractic profession since Dr. B.J. Palmer introduced the 'Hole in One' (HIO) upper cervical procedure at the 1931 PSC Lyceum.¹ The 1934 Palmer text, *The Subluxation Specific–The Adjustment Specific* established the foundation for upper cervical

différence principale concerne l'utilisation soit d'une analyse radiographique articulaire ou orthogonale au moment de déterminer la présence d'un désalignement. Des évènements indésirables à la suite d'un ajustement de la cervicale supérieure consistent en des réactions symptomatiques légères de courte durée (< 24 heures).

Étant donné le manque de références indexées et de qualité, les renseignements contenus aux présentes sont limités par l'importance des documents cités, qui comprennent des sources non indexées ou non révisées par des pairs.

(JCCA 2015; 59(2):173-192)

MOTS CLÉS : chiropratique, ajustement chiropratique, cervicale, atlas, évènements indésirables, cranio-cervical

chiropractic.⁴ These procedures follow an articular model in radiographic analysis and include Knee Chest, Toggle recoil, and Blair technique. Dr. A.A. Wernsing, credited for his contributions to Palmer's HIO procedure, pioneered the orthogonal procedures described in *The Atlas Specific*.^{4,5} The theory of measuring atlas misalignment in degrees by using the atlas plane line is one of his many contributions. This branch of UCT adheres to an orthogonal model in the analysis of radiographs and includes Grostic Procedures, National Upper Cervical Chiropractic Association (NUCCA), Orthospinology, Atlas Orthogonality (AO), and Advanced Orthogonal.

Upper Cervical Anatomy

All UCT adhere to a seventy-plus-year empirical observation in the theory that primary misalignment of interest or subluxation occurs in the upper cervical region of the spine or the craniocervical junction (CCJ).^{6,7} As the CCJ begins to appear in the medical literature as a description of the upper cervical region, it is essential to be informed of this change to avoid future confusion in its use in chiropractic. The CCJ is defined as "the junction of the base of the skull and the cervical spine including the occipital bone, surrounding the foramen magnum (occiput), C1 (atlas), C2 (axis), and the intervening tendons and ligaments".⁸ The specialized articulations between the occipital condyles and the complex ligamentous sys-

tem link these three structures into one functional unit.⁹ This includes neurovascular structures extending from the skull base to C2.

Chiropractic vertebral subluxation is defined by the World Health Organization as:

A lesion or dysfunction in a joint or motion segment in which alignment, movement integrity, and/or physiological function are altered, although contact between joint surfaces remains intact. It is essentially a functional entity, *which may influence biomechanical and neural integrity* (emphasis added).¹⁰

This definition is different from that typically used by general medicine. Challenges and discord surrounding the use of subluxation are beyond the scope of this discussion and can be found elsewhere.¹¹⁻¹³ UCT maintain the traditional use of the established term *chiropractic subluxation*.

The theoretical concept that the CCJ operates as one functional unit, globally affecting the spine and substructure physiology, differentiates 'upper cervical procedures' paradigm from other chiropractic procedures. While their analysis procedures differ, UCT universally analyze relative positions of the occiput, atlas, and axis for every patient demonstrating signs of a chiropractic subluxation from their evaluation. Radiographic examination of these structures confirms presence of misalignment allowing each adjustment to be specifically tailored using the patient's osseous measurements. Specific protocols were established that theoretically correct UC misalignments, as measured through radiography. UCT limit intervention to the upper cervical region of the spine. Blair Technique addresses subluxations in the cervical spine from C1 to C4.

Theoretical physiologic mechanisms

It is speculated that the atlas misalignment affects the nervous system through altered weight bearing on the occipital-atlanto-axial joints, thereby stimulating joint mechanoreceptors.¹⁴⁻¹⁶ Resultant reflexes may create a functional leg length inequality (LLI) and observable postural asymmetry.^{15,16} Researchers suggest joint mechanoreceptors are densest per surface area in the cervical spine.¹⁷ Seaman (1997) formulated a neurological mechanism

that implies joint complex dysfunction creates symptoms through joint mechanical receptor dysafferentation.¹⁸ UC misalignment correction may have the greatest potential in modulating afferent input into the central nervous system via this mechanism, which is measured as a decrease in symptoms.

The Dentate Ligament Cord Distortion Hypothesis, posited by Grostic in 1986, provides a possible explanation for spinal cord deformation produced when the atlas is positioned abnormally.¹⁹ This distortion mechanism appears supported by cord deformation observed in MRI studies of the upper cervical spine.²⁰

Recent research focuses on altered cerebrospinal fluid and blood flow dynamics at the atlas in conjunction with or possibly as a result of dentate cord distortion, which may help explain physiologic change observed in recent publications.²¹⁻²³ Continued research in these areas is necessary.

Assessments for Care

Owens (2002) summarized the state of subluxation assessment research.²⁴ Controversy surrounds the chiropractic assessments used to determine the presence and subsequent correction of the "manipulable lesion".^{25,26} As Feise opined, "A jury of researchers needs to define this term, design reliable and valid tests, and establish precise standards for using them".²⁷ Triano et al. (2013) found some of the UCT assessments to have strong evidence in favor for use, to include, palpation, LLI (with limitations) and posture.²⁶ The conclusions were not so good for thermography and x-ray line marking. UCT use these chiropractic assessments to determine *when* to make an intervention whereas other chiropractor procedures use them to decide *where* to make an adjustment.

Recent investigations on rater reliability of the supine leg check (SLC) screening test, prone leg check, and radiograph marking and analysis have reported consistency in their use.²⁸⁻³⁸ One limitation to previous and ongoing upper cervical assessments research is the lack of study in a test's validity, discriminant validity, and specificity or sensitivity. To justify the cost involved for these needed assessment validity investigations, reliability of these assessments must be established and confirmed before beginning any validity research track. Due diligence insists these reliability and validity investigations are ongoing.

Table 1:
Patient Assessments generally used by Upper Cervical Techniques*

UCT: ASSESSMENT:	KNEE CHEST	BLAIR	GROSTIC	NUCCA	ORTHOSPINOLOGY	AO/AdvO
PALPATION tender, spasm, restriction		X	X	X	X	X
FUNCTIONAL LLI		Prone	Supine	Supine	Supine	Supine
THERMOGRAPHY	X	X	X	X	X	X
POSTURE				X	X	
RADIOGRAPHY	X	X	PP	PP	PP	PP
‘X’ indicates assessment is generally used by UCT, ‘PP’ – Pre-post						

An ‘X’ in each box indicates a particular assessment is used by the UCT in the heading. **Prone**, denotes a prone functional leg check; **Supine**, denotes a supine functional leg check; **PP** designates a pre-post adjustment radiographic study; **NUCCA** – National Upper Cervical Chiropractic Association; **AO** – Atlas Orthogonality; **AdvO** – Advanced Orthogonal, **Palpation** includes muscle tenderness, presence of muscle spasms, and for restriction when the joint is moved.

* data from a survey of UC Diplomate candidates serves as a basis for this chart in providing a general representation of UCT.

The authors appreciate Dr. Philip Schalow’s time and effort collecting the data and willingness to contribute this chart to the manuscript.

UC chiropractors are primarily concerned with finding and correcting UC misalignments. Guided by the use of their assessments in patient evaluation, they determine when an intervention is necessary. Symptoms do not dictate patient care but used often as outcome assessments, rating change on a visual analog scale or an 11-point numeric pain rating scale. UC practitioners use other validated functional outcome assessments and patient-reported questionnaires. Practitioners who have attained certification status in practicing their specific UC procedure have been peer evaluated to ensure consistency in patient evaluation and delivery of care in following their established protocols.

A misconception exists that the UC practitioner focuses only on the head and upper neck. In fact, all upper cervical chiropractors continually evaluate the patient’s entire spine at each visit. UCT use similar assessments to determine if spinal intervention is necessary and successful, once delivered (Table 1). UCT maintain a ‘less is more’ approach in providing UC patient care when the patient evaluation, completed on each visit, indicates the necessity. At each visit, the UC adjustment is made only upon

positive findings from patient evaluation. Following each procedure’s protocol for patient evaluation, assessments are routinely used in various combinations of at least two, as part of clinical decision making when determining patient need for an adjustment. Reliability in using individual assessment procedures is different from reliability of using decision rules that use a combination of individual assessments for patient evaluation. Reliability research in support of UC clinical decision-making rules is deficient, creating a priority for future investigation.

Patients are not adjusted on every visit as follow-up visits evaluate the UC alignment status, often referred to as ‘being checked.’ Patient evaluation indicates if the atlas remains in alignment, which is commonly described as ‘holding.’ This is one of the primary goals of UC care and avoids unneeded adjustments. As these assessments are used primarily to determine *when* to make an intervention, they present a challenge in direct comparison to other chiropractic procedures where their assessments’ goal is determining *where* to make an intervention.

UC assessments used include cervical palpation, determination of functional LLI, postural asymmetry assess-



Figure 1.

Supine Leg Check (SLC)

The supine leg check test looks for apparent functional leg length inequality indicating need for further patient evaluation. Leg length appears 'even' in this example.

ment, thermographic (thermometry) spinal analysis, and each UC procedures' radiographic protocol.

Palpation

UCT may palpate for upper cervical joint restriction upon movement, muscle spasms, and tenderness. The AO procedure developed a Scanning Palpation protocol used before and after an adjustment with each finding rated on a scale of one to four. Decreases in ratings combined with other assessments indicate a successful reduction of the subluxation. Preliminary investigation reveals a fair amount of agreement between experienced examiners.³⁹

Functional leg length inequality

The Knee Chest groups generally do not use functional LLI assessment in patient evaluation. Orthogonal groups determine inequality of functional leg length with the patient in the supine position and Blair technique the patient is prone. This screening procedure does not look for an anatomic short leg but apparent asymmetry of observed leg length, describing a functional short or "contractured leg".⁴⁰ Presence of an apparent short leg requires further

patient evaluation to determine the need for UC intervention. The proposed mechanism originates from pelvic obliquity resulting from reflexive balancing of neurologic insult created by atlas misalignment.^{41,42}

Anatomic inequality may interfere with interpretation depending on the inequality cut point where a clinical decision is made. Some orthogonal practitioners use the tape measure method, anterior superior iliac spine (ASIS) to medial malleolus, to rule out possible interfering anatomic discrepancies.^{43,44} Others may use a standing A-P pelvis radiograph with the central ray at the height of the femoral head if one is available from a prior examination.

In 1943, Grostic began recording the results of the supine leg check (SLC). In February 1979, Gregory described proper SLC procedure, use, and interpretation in *The Upper Cervical Monograph, A Model for the Supine Leg Check*.⁴⁰ (Figure 1). Guidelines for the proper use and consistent performance of the test are clearly described in the NUCCA and Orthospinology textbooks.^{41,42}

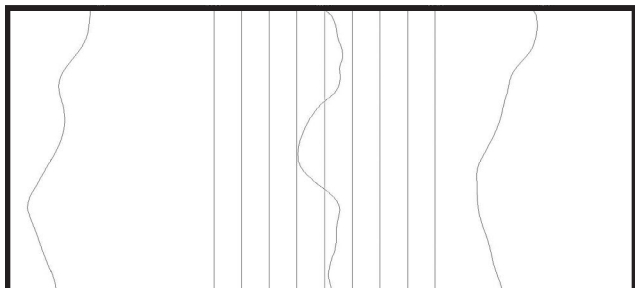
Manello (1992) outlined the state of LLI assessment within the chiropractic profession.⁴⁵ Prone leg check testing in the specific situations studied appears to have the needed inter-examiner reliability for clinical use.^{26,28-31}

Hinson and Brown (1998) studied both intra- and inter-examiner reliability of the SLC, reporting that overall intraclass correlation coefficient (ICC) agreement among examiners was high (0.94).³² Repeated examinations of the same subject indicated high overall intra-examiner reliability (>0.7).³² Hinson found similar findings in an additional study where an intervention was employed.³³ Woodfield et al. performed a SLC inter-examiner reliability pilot study in an attempt to determine means to reduce procedural variability in developing a research plan for future intra- and inter-examiner reliability investigation. Examiners showed moderate reliability in assessing LLI at 1/8-inch increments (quadratic weighted κ statistic = 0.44) and good reliability in determining the presence of LLI (first-order agreement coefficient = 0.76).³⁴

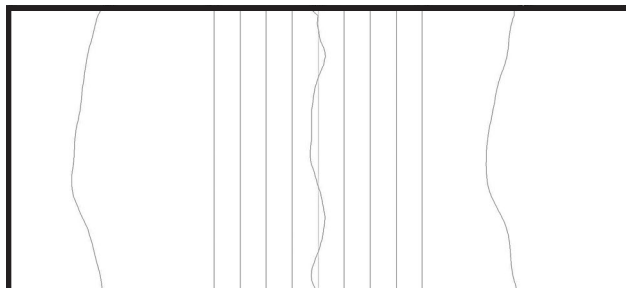
Thermography (thermometry)

Thermographic measurements date back to the early 1920s with the introduction of the thermocouple-based Neurocalometer (NCM), which spawned numerous similar devices over the years. Pattern System Analysis, developed in the 1930s by Palmer, is still used today by Knee Chest

Figure 2.
*Thermographic Scan (Thermogram) from Tytron C-5000 (Titronics, Tiffin, IA 52340)
Used by the Knee Chest and some Blair groups.*



2a. *Thermogram indicates adjustment needed*



2b. *Thermogram is 'clear' indicating no adjustment needed.*

procedures and some Blair practitioners in determining when, not where, to adjust patients (Figure 2).

Paraspinal thermography is theorized to be an indirect measure of nerve function determining an overall degree of neurological disturbance or abnormality used to evaluate a patient before and after an UC procedure. More symmetrical paraspinal temperature readings may indicate an optimal patient response resultant from UC intervention. The assessment is a skin temperature differential analysis; hence, thermometry may be a more descriptive term. The literature provides a good theoretical basis for using thermography as a chiropractic assessment.⁴⁶

In the digital age, more advanced devices such as the Tytron (Titronics, Tiffin, IA 52340) have been developed demonstrating good reliability measuring actual physiological changes rather than changes due to equipment error.⁴⁷ Excellent intra-examiner and inter-examiner reproducibility of paraspinal thermography using an infrared scanner supports previous study findings while adding further evidence that paraspinal thermal scanning is a reliable assessment.⁴⁸

Three subjects naïve to upper cervical chiropractic were studied before and after a Knee Chest adjustment using the Tytron C-4000 paraspinal digital infrared instrument for pattern analysis and the BioSuite HRV in autonomic nervous system assessment measuring heart rate variability (HRV). After an adjustment, a reduction of bilateral skin temperature pattern and improvement in HRV were observed. While this case series is limited by the number of subjects observed, it may indicate a possible

connection between pattern reduction and improved HRV, requiring further study.⁴⁹

Posture asymmetry

Standing postural assessments are used primarily by Orthospinology and NUCCA. Orthospinology advocates the use of Posture Boards, as well as postural analysis software, to visualize structural changes pre and post correction and to correlate with the radiographic analysis.

The NUCCA organization developed and researched the Anatometer™ to measure the degree of pelvic distortion in the coronal and transverse planes (Figure 3).⁵⁰ In



Figure 3.
*The Anatometer
The Anatometer measures postural asymmetry and was designed to decrease the number of radiographs required in patient care.*



4a. The GSA is used by many Canadian NUCCA Practitioners



4b. GSA Shoulder calipers



4c. GSA Hip Calipers

Figure 4.
The Gravity Stress Analyzer (GSA)

some models, two independent weight scales under each foot determine which direction a patient is leaning. By measuring first thoracic (T-1) displacement compared to the center of a patient's foot stance in the coronal plane, changes in the vertical axis (gravity line) can be recorded. The Anatometer assessment follows positive SLC findings. Presence of postural asymmetry indicates the need for a radiographic exam to confirm an atlas misalignment. Postural asymmetry in follow up visits indicates the alignment is not 'holding.' Some practitioners may choose to obtain new films, especially if a new trauma were present, however many will adjust based on previous films and see if symmetry returns. Post-adjustment evaluation for asymmetry confirms restoration of postural balance to the pelvis and entire spine (postural symmetry). The goal of NUCCA care is to return the patient's posture to the vertical axis. While little has been documented in the literature, preliminary studies indicate some reliability in its use.⁵¹⁻⁵³

In Canada, many NUCCA practitioners examine postural asymmetry using the Gravity Stress Analyzer (GSA; The Upper Cervical Store Inc., 1641 17 Ave., Campbell River, BC V9W 4L5, Canada) (Figure 4). Some GSA reliability investigation is reported in the literature, yet more is indicated.⁵⁴ Further research using posture for UCT pa-

tient evaluation is ripe for exploration and necessary for its continued use.

Radiography

UCT use their established radiographic analysis procedures to determine the presence of an upper cervical misalignment. Once visualized and measured, the analyzed images guide the direction of the adjustment. It is the different approach in this analysis of these radiographs that delineates UCT as either articular or orthogonal.

Orthogonal procedures use an orthogonal radiographic series consisting of the lateral cervical, nasium and vertex views (Figure 5). Additionally, some groups use the anterior-posterior open mouth (APOM) view. This reveals in three dimensions the anatomy orientation and degree of misalignment.^{55,56} Measurements quantify the misalignment in degrees for establishing a calculated vector in directing a force into the C-1 transverse process, which is used to realign the atlas and the lower cervical spine. Grostic Procedures, NUCCA, Orthospinology, AO, and Advanced Orthogonal use this orthogonal radiographic analysis model.

The articular radiographic analysis model was originally established by B.J. Palmer. Blair made procedural modifications when creating the Blair Technique. Blair

Figure 5.
Orthogonal Analysis Model Film Series



5a. Lateral



5b. Nasium



5c. Vertex

These films are used to determine atlas misalignment, develop a correction strategy and ensure an appropriate correction has been made.

Figure 6.
Articular Analysis Model Film Series



6a. Lateral Cervical



6b. Base Posterior (BP)



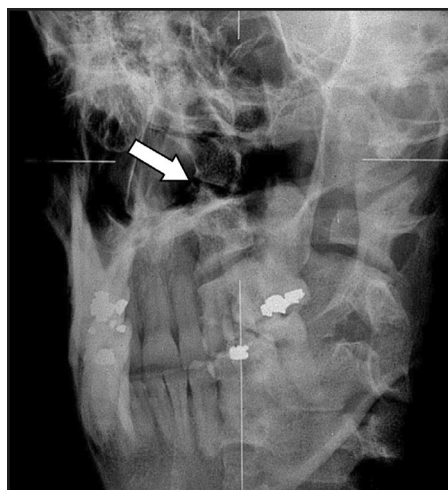
6c. Anterior-Posterior Open Mouth (APOM)

The lateral cervical view is used to determine atlas anteriority, if the atlas is anterior or posterior under the occipital condyles and if the axis (C2) is posterior and/or inferior. The BP is used primarily to determine any rotation of the atlas on the condyles. The APOM view reveals atlas laterality and the pivots of axis.

Figure 7:
Blair Protractoview showing condyle underlap/overlap (see white arrows)



7a. Protractoview C-1
Overlap (left)



7b. Protractoview C-1
Underlap (left)



7c. Protractoview C-1
Juxtaposed (right)

based these changes on the inherent upper cervical anatomic variation present in patients that could affect the misalignment calculations as used by other UCT.

The articular model determines the misalignment of the atlas relative to the individual articulations rather than a line drawing reference to orthogonal planes. To ascertain misalignment presence, Knee Chest technique utilizes the base posterior (BP), anterior-posterior open mouth (APOM), and lateral cervical films (Figure 6). Blair adds stereo lateral cervical in addition to right and left protracto views (Figure 7).

With respect to the Knee Chest procedure, the lateral cervical view is used to determine atlas anteriority, if the atlas is anterior or posterior under the occipital condyles and if the axis (C2) is posterior and/or inferior (Figure 6a). The BP is used primarily to determine any rotation of the atlas on the condyles (Figure 6b). The APOM view reveals atlas laterality and the pivots of axis (Figure 6c).

In Blair radiography, the base posterior is used to measure the convergence angles of the occipital condyles relative to the foramen magnum, using these angles to capture the protracto views. These views visualize precisely how the lateral edge of the lateral masses of the

atlas articulates with the lateral edges of the occipital condyles. Malposition is observed as either joint ‘overlap’ or ‘underlap’ when notated (Figure 7a, b). The stereo lateral cervical views complete the analysis, which includes referencing any non-juxtaposition of the vertebra above relative to the vertebrae below, from C2-C5. The APOM is used primarily to ensure the accessibility and safety in an adjustment.

Patients are not x-rayed on every visit. Initial radiographic exams are not repeated whenever patients display indicators of neurological insult. Through sixty years of empirical evidence, UC subluxation patterns are considered consistent and predictable, hence pre-post radiographs are not indicated after every intervention. This is being considered for future research to support this observation. New radiographs are obtained only if a patient experiences a new trauma.

Radiation exposure is minimized through equipment alignment, x-ray port size reduction, high-speed film-screen combinations; specialized grids, lead foil compensating filters, and lead shielding.^{55,56} Eriksen (2007) describes that in UC radiographic procedures, the use of lead foil compensating filters significantly reduces pa-

tient ionizing radiation exposure.⁵⁷ Compared to images obtained without filtration, a 65% exposure decrease is observed on a nasium view and 75% on a vertex, with an overall reduction of 97% to the majority of the skull and part of the eyes.⁵⁷ Eriksen indicates the total radiation from study x-rays are estimated from 136 to 211 milliroentgens (mR) at skin entrance when using lead filters. Rochester (2009) states, based on linear interpolation of the BEIR VII Phase II data, the elevated risk for thyroid cancer is either zero or very small due to radiation exposure to the patient from 211 mR.^{58,59}

Patient radiation exposure has been measured prior to conducting UC chiropractic clinical investigation. Skin entrance exposure for subjects in the NUCCA migraine pilot trial was measured at 352 millirem (mrem) [3.52 millisieverts (mSv)] for the orthogonal cervical series with two pre-nasium films and an APOM view.²³ Please note that mR is radiation exposure in air and mrem represents exposure in man (1 mR = 1.15 mrem). According to the US National Council on Radiation Protection and Measurements, average annual total of background radiation exposure in the US is 624 mrem (6.24 millisieverts) with additional 280 mrem average if smoking.⁶⁰ World-wide population average exposure is estimated at 240 mrem (2.4 mSv).⁶¹

Radiation safety and the ethical dilemma of unwarranted patient exposure in obtaining post radiographs generate much dissension in the chiropractic profession. Recent discussion over radiation hormesis provides one example.⁶²⁻⁶⁴ It may be that radiation hormesis has been misunderstood, marginalized, and lacks recognition by radiation scientists.⁶⁵ In an attempt to analyze the radiation exposures surrounding recent events at Japan's Fukushima II, comparisons made to current UN radiation standards to those established in 1956-1958 appear to be contradictory.⁶⁶ Cuttler (2014) explains biological mechanisms, beneficial effects, and thresholds for harmful effects of radiation. The author's solution, which may be sound advice for chiropractic: "The remedy for radiation fear is to expose and discard the politicized science".⁶⁶

Evidence-based diagnostic imaging practice guidelines for imaging the spine have been developed. Being supported by more than 385 primary and secondary citations, guidelines are limited only by the quality of the literature available.⁶⁷ Guidelines are not rules requiring use based on clinical judgment and a practitioner's experience. One

example from these best chiropractic practice guidelines describes that patients presenting with uncomplicated neck pain (non-traumatic) are not ideal candidates for diagnostic radiology.⁶⁸

UCT use radiographs following each procedures established guidelines. The NUCCA organization has developed *Standards of Care and Practice Guidelines* creating a Standards and Certification Board to assure they are continually updated.⁶⁹ A patient with uncomplicated neck pain presenting to an UC practitioner would most likely have a radiographic examination only if indicated through patient evaluation, to determine upper cervical misalignments, which would be contrary to the evidence-based guidelines described previously.

Comparisons of plain film radiography UC misalignments to MRI or CT findings have only begun to be studied. Radiograph validity remains relatively unknown, which is the root of this controversy centering on patient radiation exposure concerns. To maintain the credo "to do no harm," judicious use of diagnostic radiography must be on the forefront of every chiropractor's mind. Until a risk-benefit analysis study is undertaken comparing the presumed radiation risk to the patient's assumed benefit in reducing the subluxation coupled with decreasing society's healthcare burden, this political discussion will continue.

Sigler and Howe (1985) questioned intra- and inter-examiner reliability of orthogonal radiographic analysis, reporting the margin of error was unacceptable when contrasted with accuracy measurement tolerances (precision) claimed by the orthogonal groups, 0.5 degrees (± 0.25).⁷⁰ Jackson (1987) and Rochester (1994) reported greater reliability than Sigler and Howe, with the median of the intra-examiner standard deviations for atlas laterality being 0.41 and 0.45 degrees, respectively.^{36,71} In his study, Owens (1992) concludes that inter- and intra-examiner reliability are sufficient to measure lateral and rotational displacements of C 1 (atlas) to within ± 1 degree.³⁵ Other variability in acquiring upper cervical radiographs must be considered. Patient repositioning (post adjustment compared to pre adjustment patient positioning) if not performed within acceptable tolerance may create unacceptable errors to the accurate measurement of changed atlas alignment. Rochester and Owens (1996) report repositioning error is reduced if rotation of the patient's skull with respect to the central ray is procedurally minimized.⁷² What

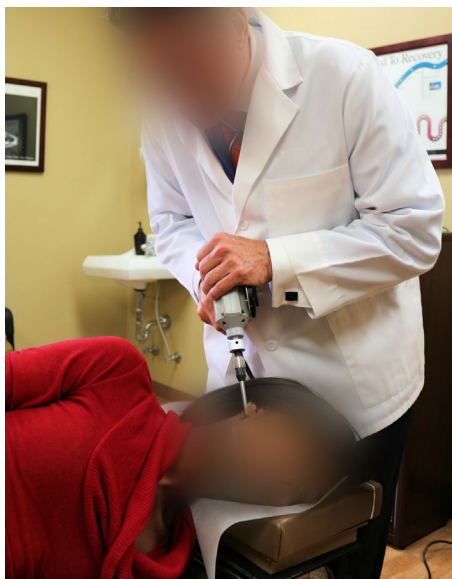


Figure 8.
*Orthospinology Hand-held
Instrument Adjustment*



Figure 9.
*Orthospinology Table Instrument
Adjustment*



Figure 10.
*NUCCA Correction using the
“triceps pull.”*

remains unknown is how much change is due to altered skeletal relationships resultant from the intervention.³⁵

Investigation of reliability of Orthospinology radiographic analysis reveals good to very good reliability for all misalignment components except atlas rotation relative to the occiput, which was fair.³⁶ Reliability of marking and measuring the Blair Protracto view is reported in the literature.³⁷ Preliminary reports in practitioner analysis of NUCCA radiographs report good inter-examiner reliability.³⁸

NUCCA has an intra-examiner reliability study in the planning stages based on results from the inter-examiner reliability study now complete. Radiographic Animation Study (RAS) is a proprietary method used to quantify the precision in patient placement for upper cervical radiographs through digital comparison of pre/post-intervention x-rays.^{73,74} To study patient repositioning challenges, NUCCA has ongoing investigation in RAS analysis in developmental support of the Precision Alignment Device for Radiographic Animation Studies (PADRAS) system designed for exact patient post to pre-repositioning. It is clear many important questions remain unanswered as investigation begins in the use of pre/post radiographs employed by UCT.

UCT Contrasts

Differences between UCT center on the orthogonal or articular radiographic model of analysis of misalignment using upper cervical spinal radiographs. The articular model does not routinely obtain post adjustment films; instead, it relies on post adjustment thermometry or pattern analysis (Figure 2). As a rule, the orthogonal groups obtain post adjustment radiographs to verify if their initial correction strategy was successful. Post films are not obtained after every intervention. Follow-up interventions do not require post films if post-correction assessments show no indication of a misalignment.

Variations in radiographic misalignment analysis are specific to each technique as are their specific adjusting protocols, either by hand or instrument. Orthospinology teaches hand and instrument adjusting protocols, focusing more on the instrument adjustment. Orthospinology uses handheld solenoid-driven and table-mounted cam accelerated instruments which exert a force via stylus with slight excursion (Figure 8). The Advanced Orthogonal and AO groups adjust with table-mounted percussive wave instruments with no stylus excursion (Figure 9). NUCCA adjusts using the “triceps pull” by hand only (Figure 10).

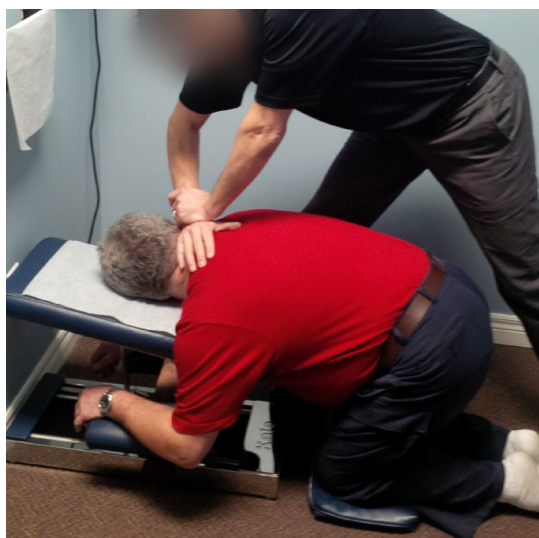


Figure 11.
Knee Chest Adjustment



Figure 12.
Blair adjustment

Articular-based Knee Chest and Blair also adjust by hand only (Figures 11, 12).

Resting for fifteen to twenty minutes after the adjustment is advocated by Knee Chest practitioners. This is based on the practice by Palmer in his research clinic where patients rested for up to three hours.⁷⁵ Although not part of their standard protocol for care, many orthogonal practitioners advocate and practice resting post-adjustment.

Safety

In spite of some publicity, cervical chiropractic manipulations appear to be generally safe, yet further investigation is necessary.⁷⁶⁻⁷⁹ It is important to note that this does not indicate any efficacy in chiropractic care.

A records review of U.K. chiropractors delivering cervical adjustments reported minor side effects were common, but the risk of a serious adverse event immediately or up to 7 days after treatment was low to very low.⁷⁶ A recent patient survey in the U.K. described patients reporting concerns about pain, tingling, and numbness in the limbs following chiropractic care, but there were no serious adverse events.⁷⁷

It is important for all chiropractors to evaluate closely the younger demographic presentation of a headache and

neck pain prodrome indicating undiagnosed vertebral artery dissection when assessing risk of vertebral artery dissection when assessing risk of vertebral artery dissection for cervical spinal manipulation. Any patients presenting with signs and symptoms of elevated risk require immediate referral to the appropriate healthcare provider, preferably an emergency room.⁷⁸ While stating most adverse events reported were benign and transitory, a systematic review of the literature mandated further research in the prevalence of adverse reactions from chiropractic care.⁷⁹

Symptomatic reactions to UCT care

Eighty-three upper cervical doctors following 1,090 patients represented ten UCT in a prospective practice-based investigation of safety, efficacy, efficiency, and patient satisfaction. A variety of patient presentations were found fitting into twenty-eight different chief complaints with 80.9% in headache and musculoskeletal categories.⁸⁰ Consecutive new patients were studied over an initial course of care averaging 17 days while being monitored with an eleven-point numeric rating scale (NRS) and valid functional outcome measures. Statistically significant, clinically meaningful improvements in presenting conditions were observed following a mean of 2.4 upper cervical adjustments over the course of care. No serious adverse events were reported.

Thirty-one percent of patients reported an increase in baseline pain or voiced a new complaint within 24 hours of their adjustment. Intensity was reported as mild, duration as short (<24 hours) and only “little” effect observed on daily activities, similar to the short-term effect of exercise. The majority of symptomatic reactions resolved within 24 hours of onset. It is important to note that the majority of patients returned to a subclinical status in thoracic and lower back pain, respectively, over the study period. Sixty-two percent of neck pain and 68% of headache cases reached subclinical status in 17 days.

Overall, a very high level of satisfaction was reported at 9.1/10 based on the eleven point NRS. Upper cervical chiropractic care may have a fairly common occurrence of mild intensity adverse reactions, short in duration (<24 hours), and rarely severe in intensity.⁸⁰ UCT appear to demonstrate similar or improved patient reported outcomes requiring less overall care relative to other reports in the literature involving chiropractic care.

In general, chiropractic care currently lends some evidence in cost savings for musculoskeletal conditions when compared to physical therapy and medical care.^{81,82}

While specific investigation into these cost-saving aspects is needed, extrapolation of results from the above study offers feasibility for healthcare cost savings through UC chiropractic care requiring future investigation.⁸⁰

UCT Research

A randomized, placebo controlled pilot study investigated NUCCA care of fifty, stage one hypertensive subjects over eight weeks. A significant decline in systolic and diastolic blood pressure readings were reported after successful reduction of the atlas misalignment in twenty-five subjects receiving active NUCCA care. The blood pressure decline in this group was considered equivalent to the use of two antihypertensive medications.⁸³ In twenty-five subjects randomized into placebo care, there was little to no change in blood pressure. In the majority of placebo subjects, the atlas misalignment NUCCA assessments also remained essentially unchanged at the end of eight weeks. This provides some indication that UC chiropractic may be efficacious for non-musculoskeletal conditions.

Changes in blood flow as hypothesized from the hypertension study were investigated through the case study of a migraine patient using Phase Contrast MRI. Resolution

of migraine symptoms with changes in venous pulsatility and cranial outflow followed NUCCA intervention.⁸⁴ A follow-up case series reporting on MRI measured changes in hydrodynamic and hemodynamic parameters following an intervention is currently in press.²³

A retrospective case series using UC instrument adjusting of neck pain patients reports statistically significant and clinically meaningful improvements in neck pain and disability.⁵⁹ No serious adverse reactions were reported. Average length of UC chiropractic care was 13.6 days for the sixty-six patients studied consecutively. A mean of 2.7 adjustments were made during the average 5.7 office visits throughout the course of care. Altered radiographic alignment measurements at the craniocervical junction toward the orthogonal alignment were associated with a better outcome in disability from cervical pain. These findings may provide some evidence that Grostic’s alignment model of reducing atlas laterality toward the orthogonal configuration is valid.⁵⁹ UC instrument adjusting may allow for fewer adjustments and a shorter follow-up period to achieve similar outcomes when compared to other investigations in the literature.⁵⁹

UCT Case Reports

Gleberzon (2001) reported that several case studies (and series) described significant clinical benefits and improvements in quality of life for patients under UC care.⁸⁵ Case studies provide a fundamental foundation to justify use of limited research resources required for conducting larger clinical studies. Case reports are limited to observations of that particular patient, cannot be used for causality, and are not generalizable across a population. Many of these reports could lend support for further research using UC chiropractic care of non-musculoskeletal conditions. There appears to be an abundance of information. A Mantis search for peer reviewed upper cervical case reports from 2002 to 2015, revealed the following non-musculoskeletal topics.

Neurodegenerative Disorders

Parkinson disease (PD)

Six case reports discuss possible palliative effectiveness in patients with Parkinson disease (PD) with one case series reporting on PD and Multiple Sclerosis (MS).⁸⁶⁻⁹² One case from the indexed literature mentioned the possi-

bility of upper cervical trauma in relation to the patient presentation.⁸⁷ Two accounts of NUCCA care describe an improvement in Parkinson symptoms as a possible result of care.^{88,90} Kale Upper Cervical Specific Protocol (Knee Chest), suggest in one case and one case series of three, better overall health, improved ambulation, and fewer Parkinson symptoms.^{89,92} A HIO Knee Chest study describes improvement in a patient's quality of life and motor function after one month of care, as assessed with patient reported outcome measures.⁹¹

Multiple Sclerosis (MS)

No indexed articles describing UC care for MS were found.⁹³⁻⁹⁶ One patient adjusted on a specially designed knee chest table reported no MS symptoms after four months of care with follow-up MRI showing no new lesions.⁹³ A Toggle study used a quadruple scale visual analog scale, neck disability index (NDI), and headache disability index in showing symptomatic improvement from UC care.⁹⁴ NUCCA study reported improvement in neck pain, numbness, fatigue, and balance after thirty visits.⁹⁵

Seizure Disorders:

Three papers were found describing UC care in reducing seizure frequency.⁹⁷⁻⁹⁹ A post-concussion patient under AO care reported a complete recovery from seizures and a normal gait after an adjustment.⁹⁷ In an indexed Blair study of post-traumatic juvenile myoclonic epilepsy (JME), a 25-year-old woman related improvement in seizure episodes and menstrual cycles following twelve weeks of chiropractic care.⁹⁸ Another Blair study of a nine-year-old girl with occipital lobe epilepsy exhibiting left eye twitching noticed significant reduction following the adjustment.⁹⁹ The patient remained free of eye twitch during the two-year follow up period.

Headache and Migraine:

A NUCCA practice based study of forty non-migraine headache patients reported favorable response and overall improvement over a twelve-week study period as measured with a visual analog scale and SF-36 score increase.¹⁰⁰

While diagnosis of migraine headache requires a neurologist input, several papers state success in reducing the frequency and severity of patient reported migraine headache. Five peer reviewed case studies described upper cervical care for migraine.¹⁰¹⁻¹⁰⁵ One case resulting

from head trauma and another with concussion reported improvement in headache intensity and frequency following care.^{101,102} An Advanced Orthogonal Procedure study of a sixteen-year-old adolescent girl with chronic migraine without aura, no longer depends on pain medication to relieve headaches experienced since the age of five.¹⁰³ A NUCCA case documents symptom improvement in migraine associated with Meniere's disease.¹⁰⁴ An indexed Blair study related improvement in migraine concomitant with essential tremor.¹⁰⁵

Seizure and Migraine:

The medical literature reports onset of migraine headache following a seizure as migralepsy, lending to a hypothesis that a similar underlying physiologic mechanism is the same for both conditions.^{106,107} Two papers, one indexed, describe patient improvement (decrease) in seizure frequency and migraine intensity.^{108,109} The AO case suggest an elderly woman who recently fell, hitting her head resulting in a complex presentation of epilepsy and migraine indicated marked improvement after care.¹⁰⁸ The indexed paper describes a patient who fell on their head from a height of ten feet. After seven months of care using a modified Knee Chest table, there were near resolution of many neurologic complaints centered on seizures, sleep disorders, and migraine.¹⁰⁹

Fibromyalgia:

Three peer reviewed studies utilizing the Knee Chest procedure were found reporting decrease in symptom presentation and quality of life improvement in these patients following upper cervical care.¹¹⁰⁻¹¹² One study suggested a patient with fibromyalgia for eleven years following two head traumas and ten automobile accidents, indicated a major decrease in presenting complaints.¹¹⁰ Another study describes a patient relating a reduction in symptoms by eighty-percent after three months of care.¹¹¹ After five knee chest adjustments over a span of eighteen months, another patient implied a reduction of fibromyalgia symptoms in two months and no longer relies on medication.¹¹²

Chronic Fatigue Syndrome

One conference abstract and a peer-reviewed paper report on clinical trials involving upper cervical care for chronic fatigue syndrome.^{113,114} The Conference proceedings outline a case series of seventy subjects randomized into four

groups receiving different therapeutic interventions; supplements only, supplements and diversified chiropractic care, supplements and UC care and UC care only. Those subjects receiving UC care only were reported to have complete resolution of chronic fatigue.¹¹³

One NUCCA case series of nineteen psychiatrist diagnosed chronic fatigue subjects, demonstrated an overall increase in quality of life as measured with the SF-36 over the six month study period.¹¹⁴

Scoliosis:

A ten-year-old girl presented with migraine headaches and a 35-degree scoliosis. After twenty-five weeks of NUCCA care, a ten degree reduction in the Cobb angle was confirmed by an independent medical radiologist while migraine symptoms were reduced significantly.¹¹⁵ Another NUCCA study showed a reduction from forty-four to thirty-two degrees in Cobb angle, measured after 20 weeks of care.¹¹⁶

Blood Pressure (Hypertension):

Hypertension is a popular topic with seven peer reviewed papers found.¹¹⁷⁻¹²³ A 25-year-old female presented with neuromediated hypotension with a history of cervicgia. After eight weeks of AO care, her cervicgia had improved and a sustained improvement of mean pulse pressure was observed.¹¹⁷ One Knee Chest study described a 68-year-old female with atrial fibrillation and hypertension. After four visits, her heart rate variability readings showed signs of improvement and blood pressure returned to normal upon which her MD discontinued her hypertensive medication.¹¹⁸

A case series of forty-two subjects in an AO private practice looked at hypotension and hypertension. The primary outcome measure was arterial blood pressure measured before and after an AO adjustment. Arterial blood pressure increased in the hypotensive subjects and decreased in the hypertensive, both resulting from the same UC procedure.¹¹⁹ The same practitioner conducted a placebo-control, computer randomized, prospective longitudinal cohort clinical trial.¹²⁰ Forty subjects were randomized into equal control and therapeutic groups where arterial blood pressure was measured at baseline, one week, two weeks, four weeks, and six weeks after AO intervention. No adverse events were recorded. The control group showed no significant change in blood

pressure. The therapeutic group demonstrated significant lowering of both systolic and diastolic measurements during the six-week study period.

Another Knee Chest case of a 25-year-old woman with medically diagnosed hypertension and migraine headaches occurring twice weekly, reports a significant decrease in blood pressure frequency and severity of migraine headache symptoms after twelve weeks of care.¹²¹ In a NUCCA case, a male with sciatica and hypertension reported a stabilization of blood pressure and minimal sciatica symptoms after 16 visits.¹²² A Knee Chest study of a 55-year-old male with a 25-year history of resistant hypertension responded with normal blood pressure after seven months of care.¹²³ In this patient's distant medical history, a traumatic side blow cervical spine injury occurred 25-30 years prior.

Miscellaneous

A Blair case from the indexed literature describes a seven-year-old girl with a history of cyclic vomiting episodes over the past four and one-half years.¹²⁴ After receiving a chiropractic spinal manipulation to her upper cervical spine, there was improvement in her symptoms within an hour. Vomiting returned after a direct trauma to her neck, resolving immediately after a repeat intervention.

One recurring incident in many of these cases is concomitant head and neck injury somewhere in the patient's past medical history. *In the Downside of Upright Posture*, Flanagan presents a hypothesis that head injury or whiplash predisposes patients to neurodegenerative disorders.¹²⁵ Flanagan outlines potential mechanisms in previous works involving CSF outflow.^{126,127} Recent investigations previously cited have reported alterations in CSF outflow following correction of the upper cervical misalignment.²¹⁻²³ From these case reports one conclusion of overreaching speculation, would suggest a possible relationship in head and neck trauma to the patient reported pathophysiologies and an upper cervical misalignment. These cases were not 'cherry-picked' to make this point. While these conclusions describing UC chiropractic care may appear to be overreaching, they clearly warrant additional structured investigation to determine if an association is present.

Limitations

This paper is a narrative review describing upper cervical procedures and is not an exacting or structured review

of the literature. Information contained herein is limited by the quality of literature used in support of statements made. As there is little high quality research citable from PubMed indexed journals, many papers used were of lesser quality, but included non-indexed or non-peer reviewed sources. Reference search criteria followed this strategy; highest priority, current (within last seven years) indexed literature in PubMed, then less current PubMed references, followed by MANTIS, Index to Chiropractic Literature (ICL) and CINAHL indexed peer reviewed sources, then non-indexed peer reviewed journals. Non-indexed, non-peer reviewed papers were used as a last resort to show statements had some investigation albeit poor for substantiation. The majority of works cited in this paper have at least undergone peer review to support of much of the upper cervical work as it has evolved from empirical observation into its present form. Much thought has gone into this foundational literature, and while it does not meet current scientific standards, it is not based on conjecture. As UC procedures mature to conduct sound quality research, another paper in ten years could report an understanding based on high quality investigations describing this evolution of UCT.

Conclusion

Using a variety of resources, this narrative review provides the reader with insight into the history, evolution, and current status of upper cervical or craniocervical chiropractic procedures participating in the International Chiropractors Association's (ICA) Council on Upper Cervical Care. UCT utilize empirical time-tested protocols, now under scientific investigation, for delivering upper cervical chiropractic care. Those truly desiring to explore UCT should pay close attention "to the relative abundance of clinical research on the effects of upper cervical care"¹²⁸.

Acknowledgements

Authors would like to thank contributions by:

- Ms. Joscelyne Smith, in providing administrative support in preparation of this manuscript,
- Dr. Phillip Schalow, in allowing use of his data to prepare table one,
- Ms. Brittany Rochester, Ms. Kira Scholten and Dr. Jordan Landholm for their reviews.

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