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EXPLANATION OF THE BASIS FOR SPECIFIC CHIROPRACTIC X-RAYS

Lodged by Patrons of Chiropractic Science Inc. (PCS)

Introduction:

PCS wishes to provide explanations and examples for the primary purpose of chiropractic radiographs to the Australian Commission on Safety and Quality in Health Care (ACSQHC) in relation to its National Safety & Quality Medical Imaging (NSQMI) standards review, so that current and future guidelines and regulations are better able to consider and possibly accommodate some of the special clinical requirements for both the X-ray acquisition procedures and also the interpretation of these films by the chiropractic profession.

Ruling out situations where X-rays may not be utilised, such as pregnancy, age or soft tissue injury, obviously, a major element of X-ray screening relates to the identification of any pathology, fractures or abnormalities (malformations, calcification-growths-spurs), particularly in the regions of the body where a clinical decision to treat a specific area may be negatively impacted by such identification. This is especially relevant to the chiropractor as many treatment modes involve the application of a measured force or corrective thrust into that anatomical region. Further, identification of such pathology, fractures or abnormalities may trigger and warrant immediate referral to a medical specialist. There are many instances where standard examination screening by general practitioners failed to identify such issues, until the patient subsequently attends a chiropractor, who then X-rayed the patient and immediately identified what could be regarded as a red flag area of concern.

However, the more relevant matter that encouraged PCS to make this submission is a concern that one of the major purposes for chiropractic X-rays may be either misunderstood or ill-considered by the ACSQHC and its NSQMI regulators or its advisors, which may then impact the very standards and regulations aimed to protect the public from harm and improve the quality of imaging delivered for this specific health care profession.

X-ray examination forms a fundamental component of chiropractic clinical practice and the benefits to the patient for both safety and clinical outcome aspects far exceed any potential impacts of the minor radiation doses such X-ray acquisition may cause, where the radiation doses employed for the limited number of plain view radiographs usually required are very low, estimated at 100 times below the threshold dose for harmful effects (1). The newer direct radiology (DR) acquisition systems further reduce radiation doses.

This submission will focus on explanations for the specific acquisition requirements and the interpretation of these radiographs by the chiropractic profession.

Background:

The reasons chiropractors require X-rays has been concisely summarised by Jenkins et al (2); diagnosis of pathology or trauma leading to detection of contraindications to care (as noted above); spinal biomechanical analysis; determination of treatment options; patient reassurance; and medicolegal reasons.

This last point, medicolegal reasons, generally relates to screening leading to detection of pathology, trauma or abnormalities that assist in the detection of contraindications. Such screening may also confirm a pre-existing injury, anatomical anomaly, fracture or congenital condition that might otherwise be attributed to subsequent chiropractic care. For example, in 2013 a chiropractor was charged with fracturing a child's C2 vertebra following a complaint by a paediatrician, but this condition was later proven to be a pre-existing congenital non-ossification of the vertebra, and not an induced injury or fracture as the paediatrician contended (the child's father also actually suffered from the same inherited deformity).

However, every anomalous detection may not always lead to a referral, it may simply alter the clinical assessment for the type or anatomical region of chiropractic treatment that may still be offered to help the patient's presenting health issue improve or recover.

X-rays also help the chiropractor to visually explain to the patient what treatment is to be recommended and the areas of the spine or body to be targeted, and this certainly educates and reassures the patient assisting in the appropriate levels of understanding when seeking informed consent. Additionally, it ultimately improves compliance to various suggestions and guidelines the chiropractor may recommend enhancing recovery and healing of the particular clinical presentation. Such patient reassurance is also common in the medical branches, where scans or radiographs are often displayed to a patient to demonstrate the area of concern and assist in the explanation of a proposed treatment.

Ultimately, the most important and applicable aspect of X-ray utilisation for the chiropractor relates to the spinal biomechanical analysis. Such analysis may incorporate a series of accurate, oriented grid lines, originating from certain specific anatomical landmarks to quantify structural dimensions, misalignment, undertake scoliosis, postural, primary and secondary spinal curve assessments, and assist in the identification of malformation. The lateral X-ray is critically important to assess intervertebral disc (IVD) shape, which accurately correlates to compromised spinal motor units or zones of compensatory changes.

However, biomechanical analysis is not only utilised by chiropractors. The USA American Medical Association (AMA) Guides to the Evaluation of Permanent Impairment, uses X-ray and measurement of spinal displacements to determine alterations of motion segment integrity and percentage of permanent partial disability (PPD) to be awarded. These guidelines also contemplate loss of motion segment integrity, which can be assessed by various means, including flexion/extension radiographs also commonly utilised by chiropractors. The AMA Guidelines note that "Motion Segment Alteration" causes abnormal spinal joint function, which may trigger various neurological insults and symptoms. (3,4)

While certain medical analysis touches on spinal biomechanical assessment, notably with spinal scoliosis, fracture displacement, IVF stenosis or osteophytic development, post surgical and IVD assessments (5), the most advanced and detailed spinal biomechanical analysis is actually undertaken by the chiropractic profession. Such analysis forms a critical part of the clinical decisions ultimately taken by the chiropractor to confirm the primary and most compromised structure, ascertain and quantify structural juxtapositioning, clearly required prior to the delivery of a specific adjusting corrective thrust to return the segment back towards optimal alignment and within its normal physiological range of movement.

The leading, well established chiropractic practise techniques that rely on such biomechanical analysis include Meric, Gonstead, Thompson, Cox Flexion/Distraction, Diversified, CBP (Chiropractic BioPhysics), Pettibon, Logan Basic, Pierce/Stillwagon, Spinal Stressology, Applied Spinal Biomechanical Engineering (ASBE), Upper Cervical (NUCCA), Grostic,

Orthospinology and Atlas Orthogonal (6, 13). Figure 1 presents a genealogical depiction of the origins and relationships of these various chiropractic X-ray analytical procedures.

Most of these analytical approaches both share and have also developed their own unique X-ray acquisition procedures, that provide specific images and views that are based on constant patient alignment and acquisition factors to facilitate critical biomechanical analysis, and validate any subsequent post-treatment re-analysis comparisons (7,8,9,10,11,12,13).

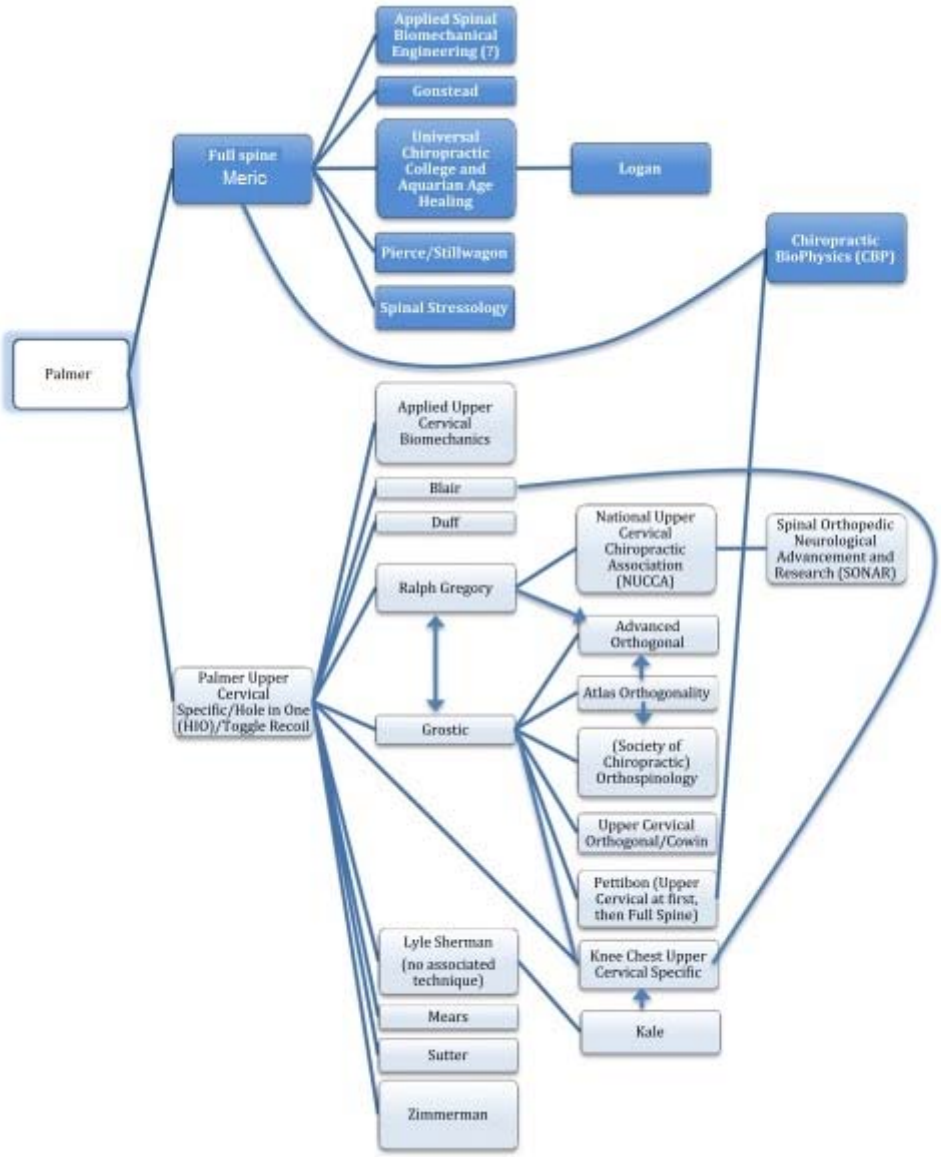


Figure 1: *Family tree of technique systems that use radiography for chiropractic subluxation analysis (13).*

Brief Explanation of chiropractic acquisition procedures:

Many of the noted chiropractic techniques require the patient to stand in a neutral, erect, weight bearing posture, where any anatomical radiation shielding is located without impacting the neutral positioning (such as the avoidance of compression locating bands or straps) (7, 8). Some of these techniques require specific, neutral, patient positioning with stabilisation aids during exposure by the use of structural clamps, as shown in Figure 4 below.

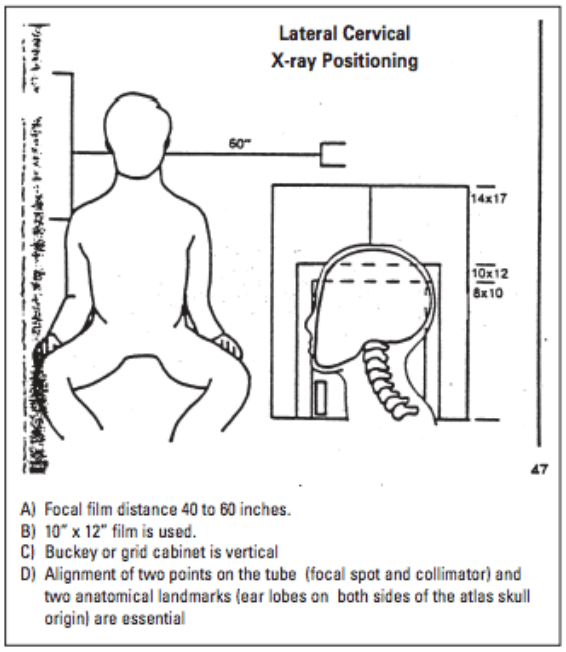
The fundamental requirements for most of the chiropractic acquisition procedures is the application of constant postural factors and guidelines that are designed to limit image distortion, optimally depict either postural, structural or weight bearing realities, facilitate analytical repeatability if a post X-ray is required, and minimise radiation exposure.

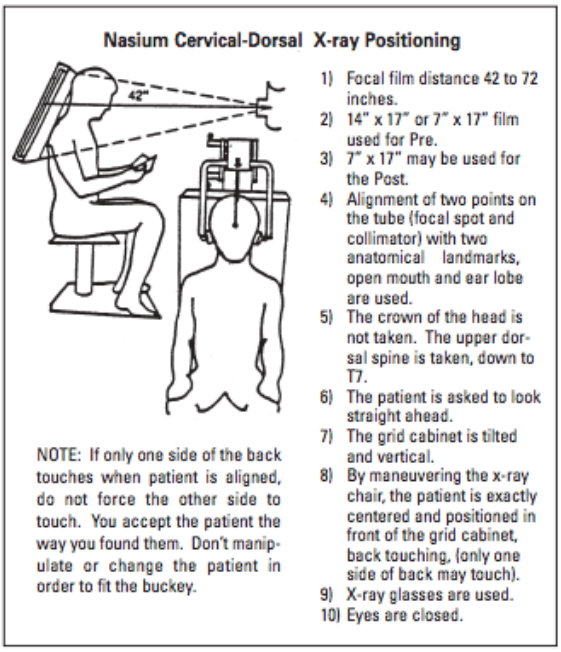
For example, the standard Gonstead full spine radiographs are taken in 3 exposures (A-P single exposure full spine, lateral two exposures) at 200 cm film focal distances and also utilising additional aluminium step filters (Bauer or Nolan filters, specifically developed by chiropractors) at the tube collimator to minimise secondary radiation. Thyroid, ocular and gonad lead shielding are added as required, without alteration to the natural weight bearing posture. For the A-P exposure, the patient is positioned in a natural erect posture, with heels parallel to the X-ray film plane without altering natural foot flare, open mouth, to capture the upper cervical spine (see Figure 2). The lateral exposures require natural posture and head carriage with the patient focussing sight at their own eye level. Where a patient appears unsteady, gentle bilateral support may be utilised that is carefully applied as to not alter the natural postural depiction on the X-ray image.

***Figure 2**: Patient positioning for Gonstead A-P erect posture X-ray (7)*

On the other hand, the Pettibon, Grostic/Orthospinology and Palmer Upper Cervical techniques focus on the upper cervical spine and incorporate stabilising clamps and alignment aids to ensure accurate positioning both for the accuracy of the initial and repeatability for any subsequent post-treatment film analysis. Established radiographic analytical procedures determine the presence of an upper cervical misalignment. Once visualized and measured, the analysed images guide the direction of the adjustment. The analysis of the radiographs may delineate cervical adjusting technique as either articular or orthogonal.

***Figure 3**: Pettibon cervical X-ray positioning and stabilisation descriptions (12, 14)*





Orthogonal procedures use an orthogonal radiographic series consisting of the lateral cervical, nasium and vertex views, and may also include the anterior-posterior open mouth view. Further biomechanical analysis reveals in three dimensions the anatomical orientation and degree of misalignment. Measurements quantify the misalignment in degrees for establishing a calculated vector in directing a corrective force, which is used to realign the atlas and the lower cervical spine. Grostic Procedures, NUCCA, Orthospinology, and Advanced Orthogonal use this orthogonal radiographic acquisition and analysis model. (11, 14, 15)

***Figure 4**: Pettibon cervical X-ray positioning and stabilisation example (12, 14)*

The various consistent acquisition factors provide the constant base line for the preferred biomechanical X-ray analytical methodology chosen by the practitioner. Further, with such a constant underlying acquisition basis, it is possible to ascertain if an observed structural measurement deviation or difference, particularly when comparing one anatomical component to its opposing or paired structure, relates to an actual biomechanical displacement or anatomical structural anomaly or deformity. Critically, very few medical radiological facilities are able to consistently meet the specific patient positioning requirements for such chiropractic analysis, which is why many chiropractors continue to insist upon operating their own X-ray acquisition units, requiring considerable personal investment.

Brief Explanation of chiropractic X-ray analytical procedures:

As noted, the required acquisition procedures provide a consistent basis for the chiropractor to undertake accurate and reliable biomechanical analysis. In some instances, the analytical markings not only highlight the potential compromised segment, they also provide a more general overview of the impact to any presenting postural and structural variations compared to the normal, healthy presentation of a spine.

For example, Figures 5, 6 and 7 below demonstrate Gonstead lateral cervical analysis for the normal, healthy, cervical vertebral alignment (Fig.5), compared to abnormal presentations, where posterior-inferior displacement of a lower cervical vertebra (Figs. 6 & 7) has significantly altered the anatomical relationships, resulting in a noticeable loss of the normal lateral cervical curve, leading to the development of cervical kyphosis. Further, the specific vertebral misalignment contributing to the kyphosis is readily identified by the convergence of the A-P cervical plane lines at C7 (Fig. 6) and C6 (Fig. 7) respectively.

Such an accurate assessment and visual depiction could not be reliably ascertained by simple visualisation or palpation of the patient in the absence of the X-ray.

Figure 5: Normal alignment

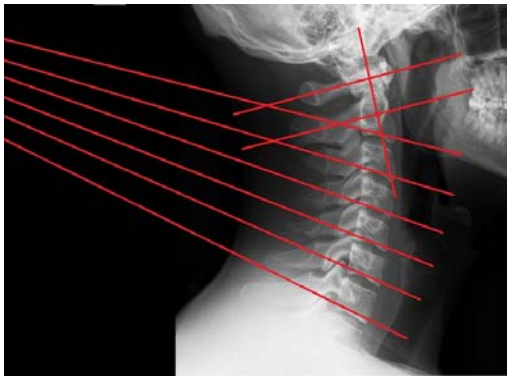


Figure 6: Posterior-inferior C7

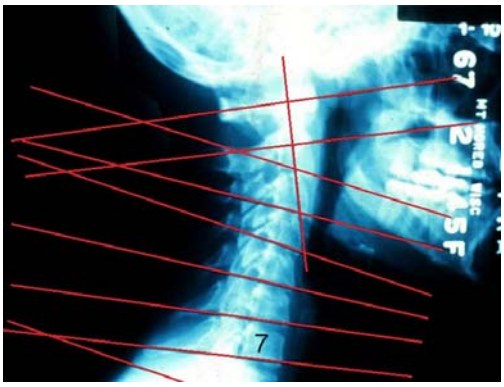
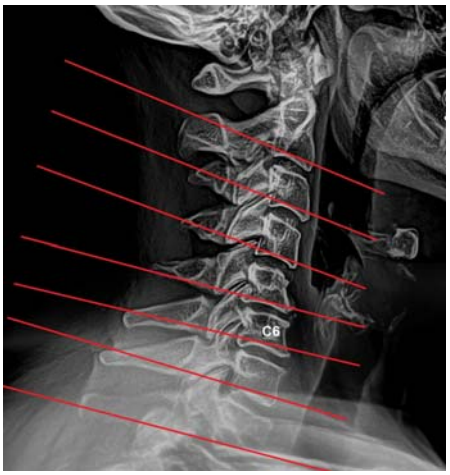


Figure 7: Posterior-inferior C6



The value of the lateral X-ray is not only derived from the analytical lines. The X-ray film can also confirm the shape and relative size of the IVD space. It is well accepted with both chiropractic and medical interpretation that comparison of a normal IVD (both in shape and thickness that should be similar to those vertebrae surrounding the segment of interest), to the staged degenerative IVD appearance changes, further confirms the most likely compromised segment. (16, 17, 21) Such degenerative changes in the IVD space relate to the progressive loss of function and segmental mobility, which then interferes with normal IVD metabolism, both through impacts of loading, inflammatory processes and loss of nutrient exchanges via reduced imbibition. Generally, the segments displaying the greatest misalignment are in fact mobile, compensating segments, as is the case in Figs 6 & 7, where you can see the mid cervical vertebrae are significantly out of normal alignment within a reversed lateral curve.

Medical and chiropractic radiology experts describe between 4 and 6 stages of IVD degenerative stages. (18, 19, 20, 21) For example, Gonstead technique describes 6 disc listing stages of IVD degeneration from normal to severe, which are graphically depicted at L5 in Figures 8 to 14 below. These degenerative changes, progressive retrolisthesis and altered primary and secondary spinal curves, can only be accurately observed with weight bearing, lateral view X-rays, and this data provides one of the strongest visual indicators for a compromised segment.

It should be noted, that the normal spine, at the three joint complex of the vertebral articulation with its founding vertebra below, the articular facets do not assume any significant loading in the neutral position, but when the IVD reaches Stage 4 degeneration (Figs.12 & 15), the facets are then shown to assume up to 70% of the intervertebral loading. This explains why facet degeneration, associated facet joint syndrome and facet arthropathy develops, and again such changes can only be accurately observed by X-ray (21).

Figure 8: *Normal*

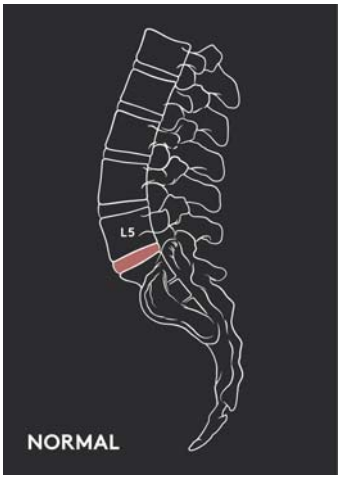


Figure 9: *Stage D1(acute-swollen)*

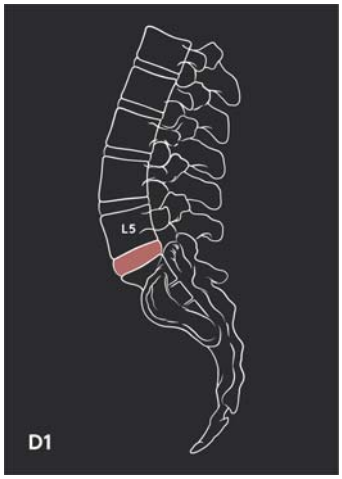


Figure 10: *Stage D2*

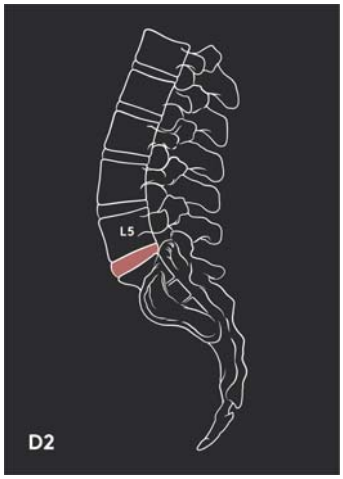


Figure 11: *Stage D3*

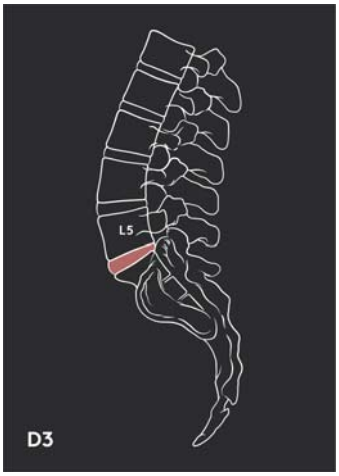


Figure 12: *Stage D4*

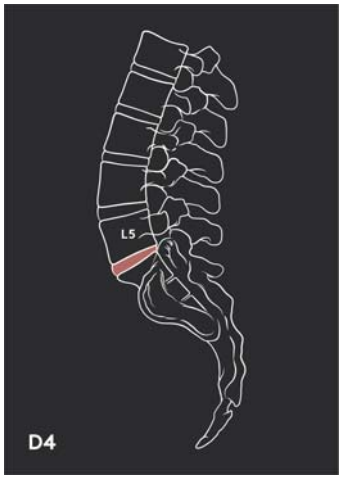


Figure 13: *Stage D5*

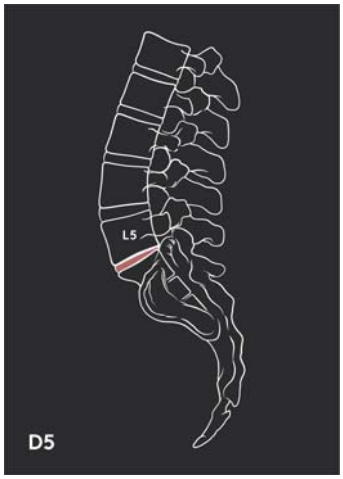


Figure 14: *Stage D6*

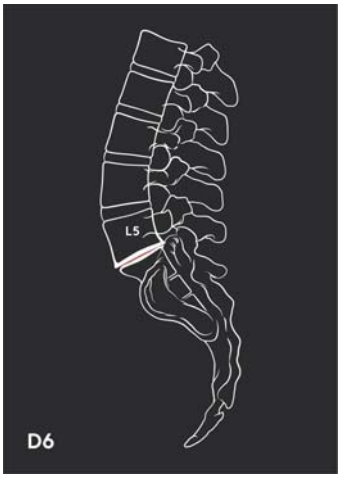


Figure 15: *Actual Stage D4*

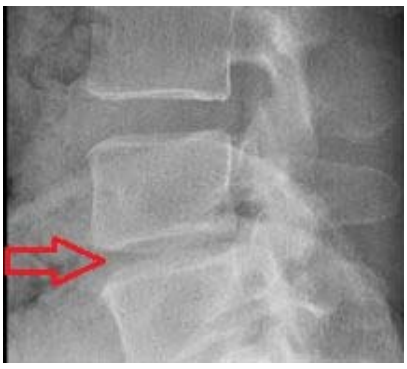
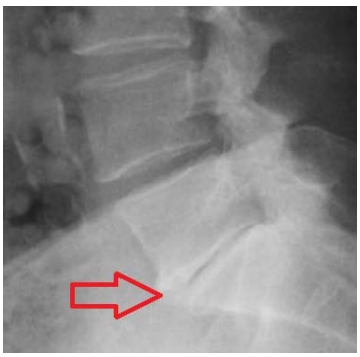


Figure 16: *Actual Stage D6*



The Pettibon, Grostic/Orthospinology and Upper Cervical techniques, that focus on the upper cervical spine, have additional, specific biomechanical analytical techniques to mark and quantify altered alignment states in the standard A-P and lateral views, but also may include further non-standard radiographs such as the nasium, vertex, base-posterior and at times the C-1 protractiview, that each contribute to a highly accurate quantification of the relative location of C1 to the occipital condyles and C2.

Figure 17: *nasium view*

5b. Nasium

Figure 18: *vertex view*

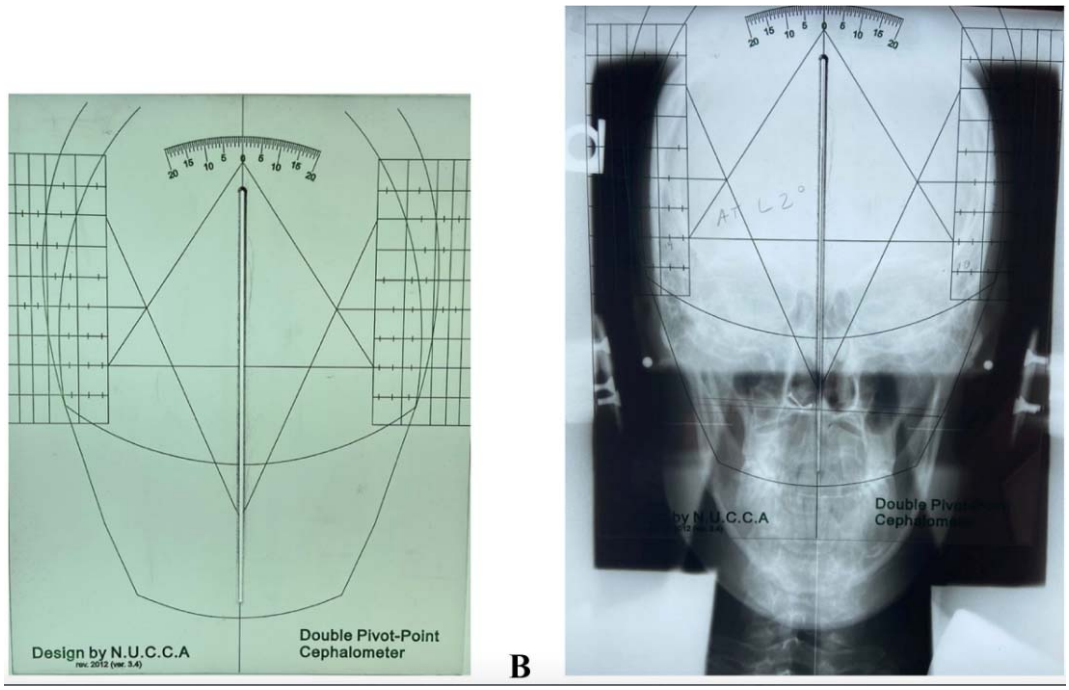
5c. Vertex

Figure 19: *base-post view*

6b. Base Posterior (BP)

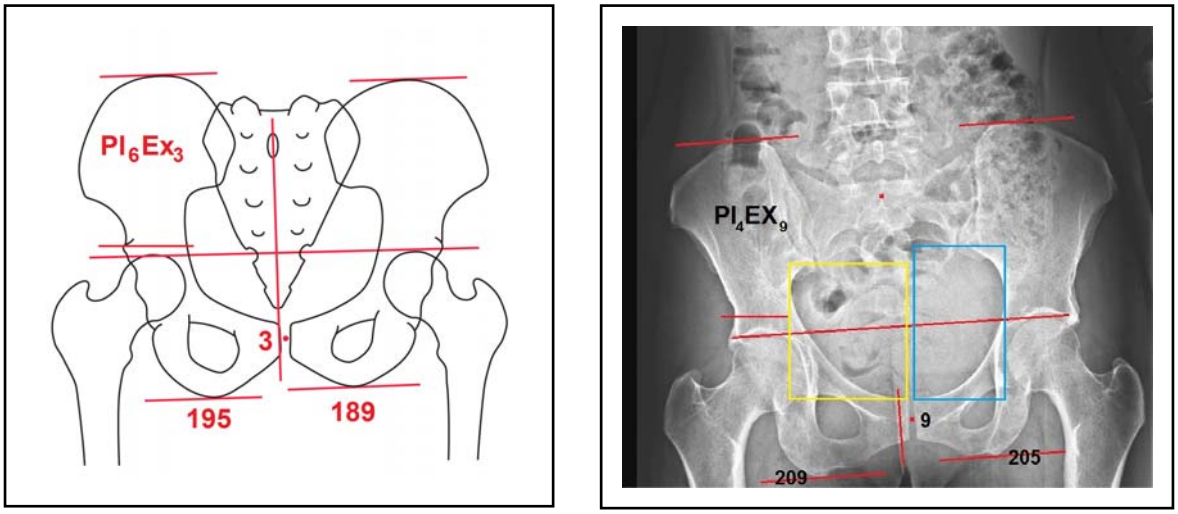
Each of these X-rays have their own unique analytical approaches, where the data confirms the precise relative position, including rotation and tilt of the atlas C-1 vertebra. The inter-examiner agreement of these analytical approaches for the upper cervical assessment is shown to be strong. (1, 9, 12, 15, 21, 21, 23, 24, 25, 26)

Figure 20: *NUCCA plexiglass cephalometer to analyse the nasum X-ray*



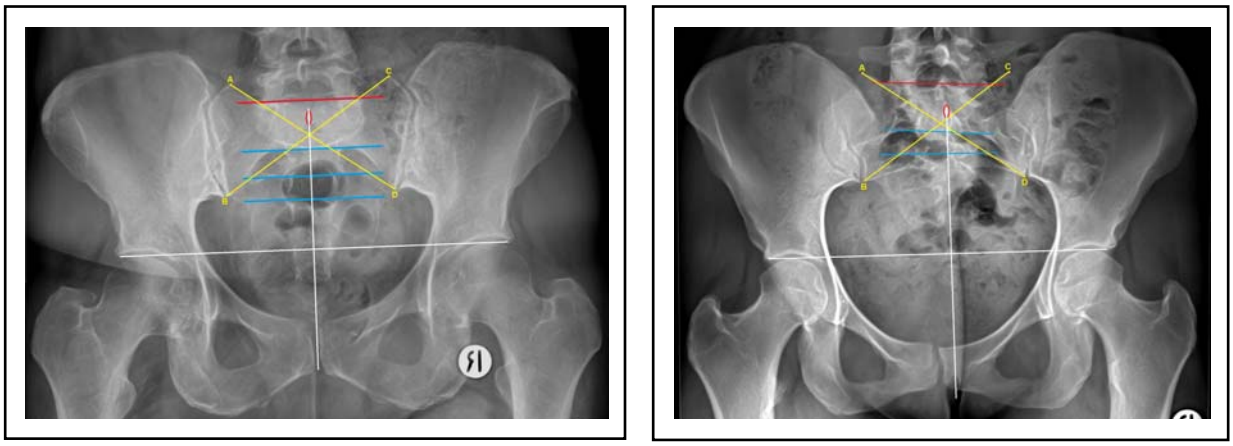
Similar standards and accuracy occur with full spine analysis. For example, Gonstead technique analysis of the pelvic girdle is base on a constant acquisition standard, and assumes an anatomically uniform pelvis. Fig. 21 below shows a graphic depiction and X-ray of the standard analysis of the erect, weight bearing A-P lumbo-pelvic X-ray, which in this instance demonstrates a potential misalignment listing for the left innominate of PIEx (posterior-inferior plus external rotation of the PSIS as compared to the right). A potential anatomical left leg deficiency is also depicted. Gonstead technique places significant importance to the pelvic girdle as ultimately, it is the foundation of the erect spine, and can influence the function of every vertebral segment above. The reliability of the Gonstead biomechanical analysis is widely accepted and utilised by many in the profession. (27, 28, 29, 30)

Figure 21: *graphic and X-ray depiction of the standard Gonstead technique A-P pelvic analysis (31)*



Each of the X-ray analytical methods must also accommodate the possibility of malformation in any structure. For example, the Gonstead A-P pelvic analysis shown on the Fig. 21 X-ray also includes a yellow and blue pelvic brim containment box, which is drawn to specific landmarks. The shape/dimensions of these boxes must also agree with the standard measurements and listing, otherwise further malformation investigation is required. Other malformation checks accompany the containment boxes, including obturator foramen shape (an extremely reliable check to confirm any innominate misalignment as these foramen are rarely malformed), ICFH (iliac crest to femur head), FHIT (femur head to ischial tuberosity) and OLM (oblique ischial measurments). In addition to these specific innominate malformation checks are various sacral malformation checks, as depicted in Fig. 22 below.

Figure 22: *X-ray depiction of the Gonstead technique A-P sacral malformation analysis, with image on the left showing a normal sacrum and the analytical lines to demonstrate a malformed sacrum (and therefore contributing to a compromised founding base for the lumbar spine above) (32)*



Conclusion:

The purpose of this brief explanation of the value, acquisition and analytical methods for specific chiropractic radiographs is to impress upon the ACSQHC and the NSQMI Standards review the unique approaches that the chiropractic profession has developed over the past 115 years in relation to X-ray technology, that in many instances do not appear to be analogous to those required by the medical profession.

It is interesting to note that X-ray imaging technology was discovered in 1895, the same year that chiropractic as an individual healing art focussing on the spine was also "discovered" by DD Palmer, (34) Many other healing arts and their leading exponents have also recognised the impact of a compromised spine, some for 1000's of years, including Hippocrates, the father of modern medicine. Early in the 1900's, Palmer began to investigate the value of this new imaging technology, and in 1910, the Palmers purchased the first X-ray machine for the Palmer School of Chiropractic, theorising that since this new technology allowed the visualisation of bones within the body, subluxations (misalignments) within the spine could now be 'proved', thereby helping to legitimise the core theory of chiropractic. (35)

Hippocrates also described the nature and importance of normal curves of the spine in a most articulate manner, and noted a spine consisting of many small parts would be more flexible, but the unavoidable consequence of this flexibility would have been its vulnerability. Hippocrates stated a physician must "get knowledge of the spine, for it is the requisite for many diseases". (36) This view also remains a fundamental tenet of chiropractic.

While there are many recognised chiropractic techniques, the vast majority of these approaches both require and diagnostically benefit from the specific type of radiographs that these techniques recommend. Fig. 23 below lists the major chiropractic techniques and the degree that each is utilised by the profession. Of the 15 major techniques listed, 13 require X-rays of the areas of the spine that may impact its overall structural and functional integrity.

Figure 22: *major chiropractic technique listed by percentage of use (35)*

Technique/Procedure	% of DC Use
1. Diversified	95.9%
2. Extremity manipulating/adjusting	95.5%
3. Activator Methods	62.8%
4. Gonstead	58.5%
5. Cox Flexion/Distraction	58.0%
6. Thompson Technique	55.9%
7. Sacro Occipital Technique	41.3%
8. Applied Kinesiology	43.2%
9. NIMMO/Receptor Tonus	40.0%
10. Cranial	37.3%
11. Adjustive Instruments	34.5%
12. Palmer Upper Cervical	28.8%
13. Logan Basic	28.7%
14. Meric	19.9%
15. Pierce-Stillwagon	17.1%

This submission deals with one of the most critical and important diagnostic tools available to the modern chiropractor, that not only ensures the safety and efficacy of treatment for the patient, but also the accuracy for both the identification of the compromised segment or structure and the specific, optimal vector for its correction. While X-ray analysis does not form an absolute diagnosis, it remains a significant contributor. Importantly, the X-ray findings can then be accurately related to the physical examination findings indicating a compromised structure.

One of the primary clinical teaching textbooks by Souza, utilised by the government regulated and the Tertiary Education Quality and Standards Agency (TEQSA) approved Australian chiropractic colleges, states patients with apparent multilevel neurological involvement should first undergo radiographic evaluation. Further, Souza clarifies that if pain appears mechanical, while delay for the use of radiographs for three to four weeks could be considered, if information gained from a radiographic evaluation is likely to change the treatment approach to the patient with regard to a specific technique or management approach, radiographs have value as an initial evaluation tool. (38)

The International Chiropractic Association (ICA) clarifies the importance of X-ray as an initial diagnostic tool for the modern chiropractor, notes that five projections comprise a complete spinal analysis for effective clinical practise:

1. AP full spine
2. Lateral full spine
3. Femoral head view
4. Sacral base view
5. Upper cervical view,

The ICA adds that nasium, base posterior and vertex X-ray views may be required for the specific upper cervical techniques. (39)

The ICA's documentation states chiropractors utilize plain film radiography to detect and measure subluxations (misalignments). The ICA's PCCRP X-ray Guidelines, an extensive document, is the supporting evidence for this conclusion. Any attempts in suggesting changes to these x-rays guidelines must prove that new proposed guidelines result in better patient outcomes than those documented in Section X of PCCRP. To date, this has never been achieved by any party. (39)

Naturally, chiropractors keep pace with all relevant emerging X-ray acquisition technologies that ultimately reduce patient radiation and improve image quality. Chiropractic clinics have shifted to high frequency generators that use less power and emit less radiation. Additionally, there has been a rapid shift to computer radiology (CR) systems, and more recently direct radiology (DR) systems that further reduce radiation exposure to the patient (up to 20%, largely due to the reduction in retakes) and allow for exceptional image enhancement, manipulation and transfer for third party analysis or remote viewing. (40)

The underlying basis of chiropractic health care benefit, and how correction of a misaligned and functionally compromised spinal segment or structure can facilitate improvements in health, both in relation to general musculo-skeletal presentations, but also the concomitant resolution of many other general health issues is a complex subject and certainly not one that PCS would attempt to include in this brief submission specifically dealing with chiropractic radiographs.

We trust this summary helps inform ACSQHC and the NSQMI Standards review of some of the unique acquisition requirements and analytical approaches of chiropractic radiology, and the significant value of X-rays to the practising chiropractor, and ultimately their patients.

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