

## Best Practices

# An Evidence-Informed Approach to Spinal Radiography in Vertebral Subluxation Centered Chiropractic Practice

Christopher Kent, D.C., J.D.<sup>1</sup>

1. *President, Foundation for Vertebral Subluxation, Kennesaw, GA & Professor and Director of Evidence Informed Curriculum and Practice, Sherman College of Chiropractic, Spartanburg, SC*

### Abstract

An evidence-informed approach to the use of radiography in the assessment of vertebral subluxation is described. Doctors of chiropractic are responsible for determining the safety and appropriateness of chiropractic care. This responsibility includes the detection and characterization of vertebral subluxations, congenital and developmental anomalies which may affect the selection of chiropractic techniques, and conditions which may contraindicate certain chiropractic adjusting methods. Furthermore, radiography may disclose conditions requiring referral to another type of health care provider. Indications for the use of spinal radiography in chiropractic practice are presented.

**Key Words:** *Vertebral subluxation, radiographs, x-ray, practice guidelines, best practices, standard of care*

### Rationale for Radiography in Chiropractic Practice

Doctors of chiropractic are responsible for determining the safety and appropriateness of chiropractic care.<sup>1</sup> This responsibility includes the detection and characterization of vertebral subluxations, congenital and developmental anomalies which may affect the selection of chiropractic techniques, and conditions which may contraindicate certain chiropractic adjusting methods. Radiography represents a useful tool to assist the chiropractor in making such determinations. Furthermore, radiography may disclose conditions requiring referral to another type of health care provider.

### Principles of Radiation Protection

X-ray examinations should only be conducted when clinically indicated. The decision to x-ray a patient is based upon the case history, examination findings, the best available external evidence, the judgement of the chiropractor, and the unique features of the individual. Radiation exposure should be as low as reasonably achievable (ALARA), and image quality as high as reasonably achievable (AHARA).

Several approaches to estimating the risks of clinical x-ray exposure have been proposed. These include the linear, non-threshold (LNT) hypothesis, the BEIR VII report (Biological Effects of Ionizing Radiation) and the radiation hormesis model.<sup>2</sup> Attempts to extrapolate risks of low doses of radiation have been criticized.

Tubiana et al<sup>3</sup> state that "Among humans, there is no evidence of a carcinogenic effect for acute irradiation at doses less than 100 mSv and for protracted irradiation at doses less than 500 mSv...The fears associated with the concept of LNT and the idea that any dose, even the smallest, is carcinogenic lack scientific justification."

The American Association of Medical Physicists<sup>4</sup> states that "medical imaging procedures should be appropriate and conducted at the lowest radiation dose consistent with acquisition of the desired information," while noting that "Risks of medical imaging at patient doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent."

According to Scott<sup>5-6</sup> "With the hormetic relative risk (HRR) model, low doses can stimulate the body's natural defenses (e.g., anti-cancer immunity), which can prevent cancers caused by other agents (e.g., lung cancer from cigarette smoke carcinogens), rather than causing harm. Unlike with the LNT model, hormetic effects (cancer incidence reduction) have been demonstrated to be scientifically credible using only low-dose data." Scott further notes that avoiding diagnostic imaging, not low-dose radiation, is a health risk."

Hendee and O'Connor<sup>7</sup> acknowledge that despite the scientific shortcomings of radiation safety models, "The authors believe

in three principles: to keep radiation doses as low as reasonably achievable (or ALARA), to keep medical procedures as safe as reasonably achievable (or ASARA), and to keep medical benefits as high as reasonably achievable (or AHARA).<sup>7</sup> They further acknowledge that anxiety concerning the speculative risks of x-ray examinations may cause harm by causing patients to forego or defer imaging examinations. "The negative health consequences of deferred imaging examinations undoubtedly far outweigh any risks of having the procedures performed."

X-ray examinations should be based on a benefit versus risk determination in an evidence-informed model, in the context of the individual needs and unique circumstances of the patient.

#### Classification of Patients

Patients may be classified according to how radiographic findings affect clinical management:

**Category 1.** There is good bone integrity and high velocity, low amplitude adjusting techniques may be applied if otherwise indicated.

**Category 2.** Congenital or developmental variants are present which need to be considered by the chiropractor when selecting an adjusting procedure.

**Category 3.** Patients in this category have conditions that weaken or soften bone. Gentle, judiciously applied adjustments may be employed.

**Category 4.** These patients have conditions that contraindicate high velocity, low amplitude adjustments to the involved area, and may need medical attention. Examples include fractures, infections, and malignancies.<sup>8</sup>

#### Clinically Significant Radiographic Findings in Chiropractic College Teaching Clinics

Pryor and McCoy<sup>9</sup> reviewed 500 files from a chiropractic college teaching clinic. 413 of these cases had cervical spine x-rays, 403 had thoracic spine x-rays, and 402 had lumbar spine x-rays taken. The authors reported that pathologies, abnormalities, and anomalies that might alter the management of the patient were found in 91% of the cervical spine radiographs, 70% of the x-rays of the thoracic spine, and 79% of x-rays of the lumbar spine. They listed reasons for spinal radiography in chiropractic practice. These include: to determine the existence of pathology and anomalies, to determine contraindications to the application of forces into the spine, to determine the extent of misalignment, to determine specific vectors to be applied in correction of subluxation, and to further assess a region when faced with "red flags." The study concluded, "A large percentage of patients in this study had pathologies, abnormalities, and/or anomalies that might alter the management of the patient."

Beck et al<sup>10</sup> reviewed 847 full spine radiographs from the outpatient health center of a chiropractic college. The authors reported that anomalies were found in 68% of the patients who had radiographs taken. "The 5 most frequently occurring

anomalies in descending order were degenerative joint disease (23.8%), posterior ponticle (13.6%), soft tissue abnormalities (13.5%), transitional segments (9.8%), and spondylolisthesis (7.8%)." Other noteworthy findings include fracture (6.8%), malignant tumor (0.8-3.1%). Abdominal aortic aneurysm (0.8%), and atlantoaxial instability (0.6%).

The authors concluded, "A large percentage of patients presenting for chiropractic care in New Zealand have anomalies present on spinal radiographs." It is suggested that research is needed that includes "the reliability and benefit of using plain films to provide biomechanical information that may be directly applicable to the analysis of subluxation in the form of spinal listings."

Jenkins et al<sup>11</sup> reviewed 3519 plain-film spinal x-ray reports with the chiropractic outpatient clinics of the Macquarie University chiropractic program. The authors reported, "The results of this study show a 30% chance in the cervical spine and a 22.5% chance in the lumbar spine of finding a clinically significant or contraindicating anomaly on spinal x-ray." The authors suggest that routine radiography may be appropriate before introducing a force into the spine of a patient. Furthermore, they note that because of limitations of the study, additional considerations need to be taken into account before any determinations can be reached.

#### Appropriateness of Radiography for Analysis of Vertebral Subluxation

The Palmer School of Chiropractic introduced the use of x-ray in chiropractic practice in 1910.<sup>12</sup> The objective for doing so was to "verify or deny palpation findings and to verify or deny proof of the existence of vertebral subluxations."<sup>13</sup> Canterbury and Krakos<sup>10</sup> noted that, "it soon became apparent that in addition to viewing biomechanical alterations, such as misaligned vertebra, x-ray would also be of enormous importance in the detection and diagnosis of pathological processes, fractures, and anomalies that would directly relate to the patient's health and prognosis, as well as the chiropractor's determination of what to do, or not do, to the patient."

A 2015 survey of full-time, practicing chiropractors from all 50 states and the District of Columbia was conducted by the National Board of Chiropractic Examiners.<sup>14</sup> The study reported that reviewing radiographic images to identify or rule out fracture, dislocation, and other pathology was rated as a professional function having "highest importance." Reviewing radiographic images to determine the possible presence of a spinal listing and/or subluxation was rated as a professional function having "significant importance."

The Council on Chiropractic Practice's guidelines<sup>15</sup> provide that "Plain film radiography is indicated: to provide information concerning the structural integrity of the spine, skull and pelvis; the misalignment component of the vertebral subluxation; the foraminal alteration component of the vertebral subluxation; and the postural status of the spinal column."



### Reliability and Validity of X-Ray Measurements

Reliability is a measure of the ability to reproduce a measurement. Validity is the extent to which a test measures what it is purported to measure.<sup>16</sup> A review and analysis of the reliability and validity of various methods of radiographic mensuration was undertaken by the Practicing Chiropractors' Committee for Radiology Protocols (PCCRP).<sup>17</sup> The preponderance of evidence supports the reliability, validity, and clinical utility of many widely used methods of x-ray analysis in chiropractic.

Since the publication of these guidelines, additional studies have been published which support the reliability and validity of certain x-ray measurement procedures. Examples include visual X-ray analysis of the cervical spine and pelvis,<sup>18</sup> reliability of the Blair protractoview method,<sup>19</sup> reliability of radiographic craniocervical posture of asymptomatic female subjects,<sup>20</sup> reliability of the craniocervical posture assessment,<sup>21</sup> reliability of cervical lordosis measurement techniques on long-cassette radiographs,<sup>22</sup> functional radiographic analysis of thoracic spine extension motion in asymptomatic men,<sup>23</sup> reliability analysis for radiographic measures of lumbar lordosis in adult scoliosis,<sup>24</sup> pelvic tilt measurements,<sup>25</sup> reliability of lumbar lordosis in ankylosing spondylitis,<sup>26</sup> reproducibility analysis of the Cobb angle and assessing sagittal plane,<sup>27</sup> measures of cervical sagittal rotation,<sup>28</sup> reliability and accuracy analysis of a new semiautomatic radiographic measurement software in adult scoliosis,<sup>29</sup> curvature measurement methods in early-onset scoliosis,<sup>30</sup> reliability of cervical lordosis and global sagittal spinal balance measurements in adolescent idiopathic scoliosis,<sup>31</sup> thoracolumbar sagittal spine alignment,<sup>32</sup> lumbar lordosis and sacral slope,<sup>33</sup> and intra- and inter-observer reliability of determining radiographic sagittal parameters of the spine and pelvis using a manual and a computer-assisted method.<sup>34</sup>

### Indications for Radiographic Examination

Specific indications for x-ray examination in chiropractic practice have been published in clinical practice guidelines and textbooks. These indications provide useful guidance to the chiropractor, but must be correlated with history, examination findings, and the proposed chiropractic technique.

#### From *Contemporary Chiropractic and Pediatric Chiropractic*:

1. History of trauma with clinical signs suggestive of fracture, dislocation, or subluxation
2. Clinical suspicion of infection or neoplasm
3. Clinical evidence of a congenital or developmental anomaly (e.g., Down's syndrome), which could alter the nature of the chiropractic care rendered, or which may itself require treatment
4. When clinical findings are equivocal, and the suspected condition can be detected or ruled out by plain film radiography
5. When other examination procedures do not disclose the complete nature of the condition, and the patient is not responding favorably to care.

6. To characterize the biomechanical component of the vertebral subluxation complex when such characterization would likely alter the chiropractic care (i.e., the directions and locations of adjustive intervention) and less hazardous or more accurate alternative examinations are not available
7. To evaluate patient response to chiropractic care when such evaluation would likely alter the nature of the care being rendered, and less hazardous or more accurate alternative examinations are not available.<sup>35,36</sup>

#### The Practicing Chiropractors' Committee on Radiology Protocols (PCCRP)

PCCRP has promulgated guidelines which include the following specific indications for spine radiography in children and adults<sup>37</sup>:

1. Abnormal posture,
2. Spinal Subluxation (defined in this document),
3. Spinal deformity (scoliosis, hyper-kyphosis, hypo-kyphosis, etc.),
4. Trauma, especially trauma to the spine,
5. Birth Trauma (forceps),
6. Restricted or abnormal motion,
7. Abnormal gait,
8. Axial pain,
9. Radiating pain (upper extremity, intercostal, lower extremity),
10. Headache,
11. Suspected short leg,
12. Suspected spinal instability,
13. Follow-up for previous deformity, previous abnormal posture, previous spinal subluxation displacement, previous spinal instability,
14. Suspected osteoporosis,
15. Facial pain,
16. Systemic health problems (skin diseases, asthma, autoimmune diseases, organ dysfunction),
17. Neurological conditions,
18. Delayed developmental conditions,
19. Eye and vision problems other than corrective lenses,
20. Hearing disorders (vertigo, tinnitus, etc.),
21. Spasm, inflammation, or tenderness,
22. Suspected abnormal pelvic morphology,
23. Post surgical evaluation,
24. Suspected spinal degeneration,
25. Suspected congenital anomaly,
26. Pain upon spinal movement,
27. Any "Red Flag Conditions" covered in previous guidelines.

These indications have been incorporated into the Best Practices and Practice Guidelines of the International Chiropractors Association.<sup>38</sup>

According to the National Emergency X-Radiography Utilization Study (NEXUS), cervical spine imaging is recommended for patients with trauma unless they meet all of the following criteria:

- Absence of posterior midline cervical-spine tenderness,
- No evidence of intoxication,

- A normal level of alertness and consciousness (baseline mental status),
- Absence of focal neurological deficit,
- Absence of any distracting injuries.

Midline posterior bony cervical-spine tenderness is present if the patient reports pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient expresses pain with direct palpation of any cervical spinous process.<sup>39</sup>

#### Summary

1. An evidence-informed approach to the use of spinal radiography acknowledges that x-ray examinations should only be conducted when clinically indicated. The decision to x-ray a patient is based upon the case history, examination findings, the best available external evidence, the judgement of the chiropractor, and the unique features of the individual.
2. Doctors of chiropractic are responsible for determining safety and appropriateness of chiropractic care. This responsibility includes the detection and characterization of vertebral subluxations, congenital and developmental anomalies which may affect the selection of chiropractic techniques, and conditions which may contraindicate certain chiropractic adjusting methods. Furthermore, radiography may disclose conditions requiring referral to another type of health care provider.
3. The preponderance of evidence supports the reliability, validity, and clinical utility of many widely used methods of x-ray analysis in chiropractic.

#### References

1. Clinical Practice Guideline: Vertebral Subluxation in Chiropractic Practice. Third Edition. Council on Chiropractic Practice. 2008. P. 29.
2. Harrison DE, Harrison DD, Kent C, Betz J: Practicing Chiropractors' Committee on Radiology Protocols (PCCRP) for Biomechanical Assessment of Spinal Subluxation in Chiropractic Clinical Practice. Practicing Chiropractors' Committee on Radiology Protocols 2009. P. 102-119.
3. Tubiana M, Feinendegen LE, Yang C, Kaminski JM: The linear no-threshold relationship is inconsistent with radiation biologic and experimental data. *Radiology*. 2009 Apr;251(1):13-22.
4. American Association of Physicists in Medicine. Position statement of the American Association of Physicists in Medicine. Radiation risks from medical imaging procedures. December 2011.
5. Scott B: Avoiding Diagnostic Imaging, Not Low-Dose Radiation, Is the Real Health Risk. *Journal of American Physicians and Surgeons* 2016;21(3):74-80.
6. Scott BR. Radiation-hormesis phenotypes, the related mechanisms and implications for disease prevention and therapy. *J Cell Commun Signal* 2014;8:341-352.
7. Hendee WR, O'Connor MK: Radiation risks of medical imaging: separating fact from fantasy. *Radiology*. 2012 Aug;264(2):312-21.
8. Kent C: Diagnostic Imaging. In Redwood D (ed): *Contemporary Chiropractic*. New York. Churchill Livingstone. 1997. P. 93.
9. Pryor M, McCoy M. Radiographic findings that may alter treatment identified on radiographs of patients receiving chiropractic care in a teaching clinic. *J Chiropractic Education* 2006;20(1):93-94.
10. Beck RW, Holt KR, Fox MA, Hurtgen-Grace KL. Radiographic Anomalies That May Alter Chiropractic Intervention Strategies Found in a New Zealand Population. *J of Manipulative and Physiol Ther* 2004; 27(9):554-559.
11. Jenkins H, Zheng X, Bull P: Prevalence of Congenital Anomalies Contraindicating Spinal Manipulative Therapy within a Chiropractic Patient Population. *Chiropr J Aust* 2010;40:69-76.
12. Canterbury R, Krakos G: Thirteen Years after Roentgen: The Origins of Chiropractic Radiology. *Chiropr Hist*. 1986;6:25-9.
13. Palmer BJ. *The Bigness of the Fellow Within*. Davenport, IA. The Palmer School of Chiropractic. 1949. P. 196-197.
14. Practice Analysis of Chiropractic 2015. Greeley, Colorado. National Board of Chiropractic Examiners. Table 6.6, page 68 and Table 6.7, page 115.
15. Clinical Practice Guideline: Vertebral Subluxation in Chiropractic Practice. Third Edition. Council on Chiropractic Practice. 2008. P. 29.
16. Patrick DL, Deyo RA. Generic and disease-specific measures in assessing health status and quality of life. *Med Care* 1989; 27(3 Suppl):S217-32.
17. Description, Reliability, Validity & Efficacy of Chiropractic Radiographic Views. Chapter X. In: Harrison DE, Harrison DD, Kent C, Betz J: *Practicing Chiropractors' Committee on Radiology Protocols (PCCRP) for Biomechanical Assessment of Spinal Subluxation in Chiropractic Clinical Practice*. Practicing Chiropractors' Committee on Radiology Protocols 2009. P. 158-334.
18. Slusher R, Shook B, Hazjan J, et al: The reliability of visual X-ray analysis of the cervical spine and pelvis: A preliminary study. *J Vert Sublux Res*. 2010 ;Mar (25):Online access only pp. 1-7.
19. Hubbard TA, Vowles BM, Forest T: Inter- and intraexaminer reliability of the Blair protractoview method: examination of a chiropractic radiographic technique. *J Chiropr Med*. 2010 Jun; 9(2): 60-68.
20. Gadotti IC, Magee D: Assessment of intrasubject reliability of radiographic craniocervical posture of asymptomatic female subjects. *J Manipulative Physiol Ther*. 2013 Jan;36(1):27-32.
21. Gadotti IC, Armijo-Olivo S, Silveira A, Magee D: Reliability of the craniocervical posture assessment: visual and angular measurements using photographs and radiographs. *J Manipulative Physiol Ther*. 2013 Nov-Dec;36(9):619-25.
22. Janusz P, Tyrakowski M, Yu H, Siemionow K: Reliability of cervical lordosis measurement techniques on long-cassette radiographs. *Eur Spine J*. 2015 Dec 26. [Epub ahead of print].
23. Edmondston SJ, Christensen MM, Keller S, Steigen LB, Barclay L: Functional radiographic analysis of thoracic spine extension motion in asymptomatic men. *J Manipulative Physiol Ther*. 2012 Mar-Apr;35(3):203-8.



24. Hong JY, Suh SW, Modi HN, Hur CY, Song HR, Park JH: Reliability analysis for radiographic measures of lumbar lordosis in adult scoliosis: a case-control study comparing 6 methods. *Eur Spine J.* 2010 Sep;19(9):1551-7.
25. Tyrakowski M, Yu H, Siemionow K: Pelvic incidence and pelvic tilt measurements using femoral heads or acetabular domes to identify centers of the hips: comparison of two methods. *Eur Spine J.* 2015 Jun;24(6):1259-64.
26. Lee JS1, Goh TS, Park SH, Lee HS, Suh KT: Radiographic measurement reliability of lumbar lordosis in ankylosing spondylitis. *Eur Spine J.* 2013 Apr;22(4):813-8.
27. Wu W, Liang J, Du Y, Tan X, Xiang X, Wang W, Ru N, Le J: Reliability and reproducibility analysis of the Cobb angle and assessing sagittal plane by computer-assisted and manual measurement tools. *BMC Musculoskelet Disord.* 2014 Feb 6;15:33.
28. Jiang SD, Chen JW, Yang YH, Chen XD, Jiang LS: Intraobserver and interobserver reliability of measures of cervical sagittal rotation. *BMC Musculoskelet Disord.* 2014 Oct 4;15:332.
29. Aubin CE, Bellefleur C, Joncas J, de Lanauze D, Kadoury S, Blanke K, Parent S, Labelle H: Reliability and accuracy analysis of a new semiautomatic radiographic measurement software in adult scoliosis. *Spine (Phila Pa 1976).* 2011 May 20;36(12):E780-90.
30. Hwang JH, Hong JY, Suh SW, Yang JH, Lee JM: A comparative analysis of 4 curvature measurement methods in early-onset scoliosis. *Spine (Phila Pa 1976).* 2012 Sep 15;37(20):E1273-81.
31. Vidal C, Ilharreborde B, Azoulay R, Sebag G, Mazda K: Reliability of cervical lordosis and global sagittal spinal balance measurements in adolescent idiopathic scoliosis. *Eur Spine J.* 2013 Jun;22(6):1362-7.
32. Abdel MP, Bodemer WS, Anderson PA: Supine thoracolumbar sagittal spine alignment: comparing computerized tomography and plain radiographs. *Spine (Phila Pa 1976).* 2012 Feb 15;37(4):340-5.
33. Bredow J, Oppermann J, Scheyerer MJ, Gundlfinger K, Neiss WF, Budde S, Floerkemeier T, Eysel P, Beyer F: Lumbar lordosis and sacral slope in lumbar spinal stenosis: standard values and measurement accuracy. *Arch Orthop Trauma Surg.* 2015 May;135(5):607-12.
34. Dimar JR 2nd1, Carreon LY, Labelle H, Djurasovic M, Weidenbaum M, Brown C, Roussooly P: Intra- and interobserver reliability of determining radiographic sagittal parameters of the spine and pelvis using a manual and a computer-assisted methods. *Eur Spine J.* 2008 Oct;17(10):1373-9.
35. Kent C: Diagnostic Imaging. In Redwood D (ed): *Contemporary Chiropractic.* New York. Churchill Livingstone. 1997. P. 92.
36. Kent C, Plaughner G, Borges D, Borges KM, Steiner DM, Cichy DC: Diagnostic Imaging. In Anrig CA, Plaughner G: *Pediatric Chiropractic.* 2nd Edition. Philadelphia. Wolters Kluwer. Lippincott, Williams & Wilkins. 2013. P. 54.
37. Harrison DE, Harrison DD, Kent C, Betz J: *Practicing Chiropractors' Committee on Radiology Protocols (PCCRP) for Biomechanical Assessment of Spinal Subluxation in Chiropractic Clinical Practice.* Practicing Chiropractors' Committee on Radiology Protocols 2009. P. 7.
38. Chapter 6. Routine Plain Film Radiography is the Standard of Practice for Chiropractic. In: *ICA Best Practices and Practice Guidelines.* Washington, DC. International Chiropractors Association. 2013. P. 57.
39. Hoffman JR, Wolfson AB, Todd K, Mower WR: Selective cervical spine radiography in blunt trauma: methodology of the National Emergency X-Radiography Utilization Study (NEXUS). *Annals of Emergency Medicine* 1998; 32, 461-9.