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# Best Practices

## Radiogenic Cancer Risks from Chiropractic X-rays are Zero: 10 Reasons to Take Routine Radiographs in Clinical Practice

Paul A. Oakley D.C.<sup>1</sup>  
Deed E. Harrison, D.C.<sup>2</sup>

1. *Private Practice of Chiropractic, Newmarket, ON, Canada*
2. *President, CBP Non-Profit, Eagle, ID*

### Abstract

**Background:** Extremely restrictive radiology guidelines have recently been adopted within the chiropractic profession that pose a public health threat. Risk assessment from exposure to radiation from diagnostic x-rays are based on the linear no-threshold (LNT) model/hypothesis that has been disproved for use in risk estimates in the low-dose range, i.e. less than 100mGy (10,000mrem).

**Discussion:** We discuss ten reasons why routine radiography should be the standard in chiropractic practice including: it offers zero harm to the patient; contemporary evidence-based methods require it, these methods lead to better outcomes; incidental findings are important; it increases patient satisfaction; it completes a thorough exam; it satisfies practitioner medico-legal liability concerns; its costs are minimal; alternative methods (i.e. MRI) are not practical for daily practice and are typically performed in the nonphysiologic recumbent position and do not convey appropriate biomechanical information; finally, it may enhance patient health by hormesis.

**Conclusion:** As opposed to current x-ray reduction efforts and traditional beliefs, the weight of the current evidence substantiates two facts: 1. X-rays are not harmful to patients; 2. X-rays should be a routine part of the comprehensive spinal assessment in order to deliver optimal and contemporary chiropractic care.

**Key words:** *Radiation, x-rays, hormesis, spinal radiographs, chiropractic, cancer, clinical practice, risk assessment, biomechanics, vertebral subluxation, spinal adjustment, spinal manipulation*

### Introduction

The issue of radiation risk from diagnostic x-rays taken by chiropractors has become a hotly debated topic.<sup>1-3</sup> There are recent trends within the chiropractic profession to avoid initial radiography (i.e. for acute low back pain) except for use in diagnosing ‘red-flags’ (i.e. cauda equina syndrome, fracture, infection, inflammatory disorders, and malignancies). This troubling trend is an attempt to mirror the allopathic medical model of low back pain management in regards to consideration of radiography for spinal disorders where the patient is to be treated by pharmaceuticals or referral – not the traditional chiropractic approach of introducing force vectors directly into a patient’s spine.

Many chiropractic techniques require specific spinal listings and biomechanical data only obtainable by radiography for a priori treatment considerations that are unique to chiropractic and have nothing to do with ruling out ‘red flags.’ Although there are current chiropractic radiography and practice protocol guidelines that do reflect the unique use of radiology in chiropractic practice,<sup>4-6</sup> there are others (i.e. Bussieres et al.<sup>7,8</sup>) that simply mimic allopathic guidelines.

The Bussieres et al.<sup>7,8</sup> radiology guidelines are likened to refurbished medical guidelines and have been criticised for not reflecting the uniqueness of the chiropractic profession.<sup>9</sup> Further, the American Chiropractic Association (ACA) has recently joined the ‘Choosing Wisely®’ campaign, where two of five points aimed at the public dissuades the use of radiology:<sup>10</sup>

- ‘In the absence of red flags, do not obtain spinal imaging (X-rays) for patients with acute low-back pain during the six weeks after the onset of pain.’
- ‘Do not perform repeat spinal imaging to monitor patients’ progress.’

The Aug. 15, 2017, ACA release of these recommendations have drawn a lot of criticism from chiropractors,<sup>11</sup> chiropractic associations,<sup>12</sup> and chiropractic colleges.<sup>13</sup> For example, Dr. Dennis Marchiori, chancellor of the Palmer colleges states in a letter to alumni: “Palmer college does not support the narrow scope of plain-film use by the ACA...”<sup>13</sup>

The irony surrounding the anti-x-ray movement in chiropractic is that it is immoral, misleading, fear-mongering, and completely unnecessary. Herein we discuss ten main points supporting the use of radiography as a routine clinical assessment procedure for contemporary chiropractic practice.

### **1. No Harm to Patient (No Data Exist Supporting X-rays Induce Cancers)**

Radiation risk from radiography is assessed using a linear model, the 'linear no-threshold' model (LNTM).<sup>14</sup> This is an assumption or hypothesis that all radiation is harmful regardless of dose level. The LNTM assumes that high-dose radiation exposure data from the Nagasaki/Hiroshima atomic bomb survivors (Life Span Study<sup>15</sup>) represents a linear extrapolation down to zero-dose (See Figure 1). Thus, LNTM theoretically assumes all radiation is harmful, no matter the exposure level, even for plain radiography - being several orders of magnitude less than high-dose atomic bomb data.

The ultimate health risk from radiation exposures (other than death) is cancer. Traditionally, atomic bomb exposure data has been used to theoretically calculate supposed radiogenic cancer risks from low-doses from radiography (plain film or CT scans) – all these estimates use the LNTM<sup>16-21</sup> Shockingly, there is no data that supports the LNTM for low-dose radiation (LDR) risk assessment for exposures from radiography.<sup>22-24</sup> This is because no cancer risk model is justified to estimate radiogenic health risks from radiation doses less than 100mSv (10,000mrem):<sup>25</sup> "The Health Physics Society recommends that assessments of radiogenic health risks be limited to dose estimates near and above 100 mSv. Below this level, only dose is credible and statements of associated risks are more speculative than credible." In fact, even the International Commission on Radiological Protection (ICRP) admits use of the LNTM for low-doses (<100mSv) is "speculative, unproven, undetectable, and 'phantom'."<sup>26</sup>

The atomic bomb data is the most important support for the LNTM, however, a 2012 analysis by Ozasa et al.<sup>27</sup> demonstrated that the atomic bomb data no longer supports the LNTM as these data better fit a linear-quadratic model.<sup>28-30</sup> As Doss states: "a resolution of the controversy regarding the carcinogenicity of LDR appears to be imminent, with the rejection of the LNT model and acceptance of radiation hormesis;"<sup>30</sup> hormesis referring to a J-shaped dose-response curve (See Figure 1).

Calabrese, a world expert on hormesis in toxicology<sup>31</sup> has carefully documented the historical timeline of events surrounding the first application of the LNTM for radiation protection purposes and has come to the shocking conclusion that the research was flawed.<sup>32-35</sup> Due to the flawed LNTM underpinnings and thus its invalidity, there are immense pressures for the termination of the LNTM as used in radiation protection standards for LDR – for example, as given by x-ray and CT scans.<sup>36-39</sup> Since the ALARA radiation safety principle ('As Low As Reasonably Achievable') is borne from the LNTM, it too is invalid and serves only to create and propagate public and physician fear of phantom and zero risks. The scientific community also demands the abandonment of the ALARA concept.<sup>28,29,40-42</sup>

### **2. Contemporary Spine Care Methods Necessitate It**

Chiropractic techniques such as Chiropractic Biophysics technique (CBP) have validated methods to improve spinal structure/posture,<sup>43-56</sup> upper cervical techniques have been proven to reduce spinal misalignment,<sup>57-59</sup> and contemporary scoliosis treatment approaches have been proven to reduce spinal curvature.<sup>60-66</sup> All these evidence-based methods necessitate radiological imaging to assess posture spinal alignment and to characterize vertebral subluxation prior to rendering care and for repeat imaging to monitor progress.

CBP methods have at length substantiated a valid spinal model as a goal of care,<sup>67-73</sup> upper cervical care aim to restore symmetry to the skull and upper cervical segments, and scoliosis management aims to reduce spinal curvature toward the AP/PA vertical axis. The x-ray line drawing methods for these analyses are repeatable and reliable,<sup>74-85</sup> and represent aspects of evidence-based ethical practice in contemporary chiropractic practice.

### **3. Radiographic Information Leads to Better Patient Outcomes**

CBP technique, upper cervical techniques, and modern scoliosis management methods all have some level of scientific evidence demonstrating these methods offer greater benefits to patients versus traditional or conventional approaches.

CBP for example, utilizes unique protocols as a part of its management programs aimed at correcting subluxations, posture and spine alignment. Specifically regarding the restoration of the cervical and lumbar lordoses, several randomized clinical trials<sup>43-50</sup> have determined that patients with either cervical or lumbar hypolordosis having associated cervicogenic (i.e. neck pain, headache, etc.) or lumbosacral symptoms (i.e. low back pain, sciatica, etc.) receive only temporary, short-term relief from 'conventional' physiotherapy treatment programs (i.e. stretching exercises; infrared radiation; manipulation; myofascial release; TENS therapy; mobilization) versus when the patient also gets extension traction methods which improve spinal alignment (i.e theorized to be the 'root cause' of the problem<sup>43</sup>). Patients receiving the conventional treatments have a regression of symptom relief as quickly as 12-weeks later, where patients improving their spine alignment as managed with CBP methods stay well long-term and remain statistically significantly healthier up to a year later.<sup>43-50</sup>

Atlas orthogonal (AO) upper cervical chiropractic technique has demonstrated to provide greater improvement in children by reducing scores on the Autism Treatment Evaluation Checklist as scored by parents versus full-spine chiropractic treatment.<sup>57</sup> It should be noted that in this clinical trial, both groups improved under chiropractic care; the AO treated children demonstrated a 32% decrease and the full-spine treated group had an 8% decrease in scores.

In management of scoliosis, clinical trials by Noh et al.<sup>60</sup> and Monticone et al.,<sup>61</sup> have demonstrated that treatment programs are more effective when tailored specifically to the patient's spinal deformity rather than employing 'cookie-cutter'

conventional approaches.<sup>60,61</sup> Noh et al. found that although a patient group had reduction in Cobb angle after completing a 'conventional exercise program' (focusing on core stabilization), better results were obtained by the comparison group completing the 'corrective spinal technique' (CST) featuring patient-specific Schroth methods.<sup>60</sup> The CST group achieved greater improvements in Cobb angle, vertebral rotation, as well as total score, treatment satisfaction, and self-image subscale scores on the scoliosis research society questionnaire (SRS-22). Monticone et al.<sup>61</sup> demonstrated that traditional spinal exercises performed by patients with mild scoliosis achieved a maintenance of health status (Cobb angle and health-related quality of life-HRQL), however, a comparison group of similar patients receiving a customized patient-specific program (active self-correction, task-oriented spinal exercises and education) achieved better improvements in both reduced Cobb angle and increased HRQL.<sup>61</sup>

#### 4. Incidental Findings are Important

'Incidental findings' (IFs) or previously undiagnosed medical conditions that are discovered unintentionally during radiography alone may confer a favorable risk/benefit balance. In assessing children with CT after blunt head trauma, for example, Rogers et al.<sup>87</sup> found the incidence of IF to be 4% and importantly 1% "warranted immediate intervention or outpatient follow-up." Regarding chiropractic, the few studies that have evaluated IFs on radiographs have all determined that a significant patient percentage many have various pathologies, abnormalities and/or anomalies that may directly affect and alter management of the patient and treatment considerations.

Upon reviewing 847 full-spine radiographs, Beck et al.<sup>88</sup> determined that the incidence of serious IFs deemed as 'absolute contraindications' for manual therapy were common and included an incidence rate of 6.6% for fracture (1 in 15), 0.8-3.1% for malignant tumor (1 in 32 to 1 in 125), 0.8% for abdominal aortic aneurysm (1 in 125) and 0.6% for atlantoaxial instability (1 in 167). Bull<sup>89</sup> concluded that 33% of patients had relative contraindications and 14% had absolute contraindications to certain types of adjusting procedures.

In reviewing 3519 patient radiology reports from the years 2000-2005 from the Macquarie University chiropractic outpatient clinics, Jenkins et al.<sup>90</sup> found the percentage of IFs consisting of developmental and congenital anomalies to be 28.5%, 0.7%, and 18.3% for the cervical, thoracic, and lumbar spinal regions. In a sample of 500 patient radiographs, Pryor and McCoy<sup>91</sup> determined that 91%, 70%, and 79% of patients may have radiographic-verified anomalies and pathologies that would alter treatment for the cervical, thoracic, and lumbar spinal areas.

#### 5. Increased Patient Satisfaction

It must be pointed out that patients who go to get spine care expect a thorough examination that includes radiographic imaging.<sup>92-94</sup> The classic Deyo study found that 73% of patients expect to get x-rays in the diagnosis for their spinal problem.<sup>93</sup> More recently, Jenkins et al.<sup>94</sup> determined that about half of all patients seeking care for low back pain

consider imaging to be necessary. A part of satisfying a patient seeking care is to fulfill their expectations; in brief, patients are typically more satisfied with chiropractic care,<sup>95</sup> and are particularly satisfied when their beliefs are met by receiving radiographic imaging for their spinal problems.<sup>96-98</sup>

#### 6. Completes a Thorough Examination

Among all assessment procedures, including consultation, pain and disability questionnaires, examination including palpation, orthopedic tests, range of motion (ROM), neurologic testing, reflexes, etc., radiology provides substantial information not attainable from other procedures. ROM, for example, can provide global end-range values, however, only neutral and stress film analysis can pinpoint spinal coupling patterns that may correlate with mechanisms of spinal dysfunction. Neutral spine alignment dictates spinal flexibility.<sup>99-104</sup>

As discussed, radiological imaging is essential in the diagnosis of patient-specific spine and posture alignment and disorders (subluxation patterns) and are the underpinning of providing superior patient care versus 'cookie-cutter' conventional treatment.<sup>43-50,57,60,61</sup> When considering scoliosis or hyperkyphosis correction programs for instance, it is essential to know if there are structural vertebral deformities such as a wedged vertebra or compression fracture that may completely change treatment approach and expectation for reduction. This information can only be obtained in clinical practice by x-ray imaging.

#### 7. Satisfies Practitioner Medico-legal Liability Concerns

As discussed IFs are very common, and identifying potential contraindications to imparting forces into the spine are important.<sup>88-91</sup> Blanket 'red flag only' guidelines (i.e. don't x-ray acute LBP) are based on the low odds of finding serious pathology. As mentioned, this does not consider the unique discipline of chiropractic. Regardless, basing guidelines on unlikely odds does not apply to the individual patient who actually has a serious pathology and/or absolute contraindication to chiropractic care.

It is often argued that the incidence of finding serious pathology in patients presenting with acute LBP is small, for example Henschke et al.<sup>105</sup> found a 1% incidence in 1172 consecutive patients. However, in this same study, 80% of the patients demonstrated 'red flags,' and alarmingly, 50% of those with serious pathology would have been missed without further imaging – it was impossible to differentiate during the initial consultation which of the 80% (985/1172) of the sample having 'red flags' actually had the serious pathologies.<sup>105</sup>

Even though the incidence of serious IFs may be low, they do exist. Consider malignant tumors for instance, Beck found an incidence of up to 3.1% or 1 in 32 patient radiographs.<sup>87</sup> Since cancer rates are continuing to rise,<sup>106</sup> malignant tumors as IFs are becoming more commonplace. This raises medico-legal and liability concerns over potentially misdiagnosing a serious IF. As stated by Underwood: "Malignancy is a diagnosis that practitioners would not wish to miss."<sup>107</sup> It cannot be overstated that a chiropractor should always perform a comprehensive assessment including radiography, as goes the

old adage 'no x-rays, no defense.'<sup>108</sup>

## 8. Costs are Minimal

Costs for plain film x-ray is minimal compared to costs for either CT or MRI. The average MRI scan costs \$2611 and facilities can charge whatever they want; this fee includes the scan, the actual procedure, a radiology report, and contrast dyes if necessary.<sup>109</sup> Compared to plain x-ray, the average cost of a CT scan is also steep ranging on average from \$410 - \$1224 depending on the body area.<sup>110</sup> The cost of an x-ray is usually less than \$100, with a chest x-ray being \$59.<sup>110</sup> The first author of this paper charges \$47-\$100 CDN for new patient full-spine x-rays, and most often waives the fee for follow-up x-rays.

The current allopathic financial healthcare crises have led to imaging cost analyses to be performed. Klein<sup>111</sup> suggested that the US healthcare system could save between 1.2 to 3.4 billion dollars if previously taken abdominal CT scans were reviewed for the assessment of subsequent lumbar spine disorders, thus avoiding unnecessary MRI studies. Kim et al.,<sup>112</sup> demonstrated that in the assessment of degenerative spinal disorders, it is much more cost-effective to rely on plain film x-ray and spine-focused clinical assessments rather than over-relying on CT and MRI imaging – ironically, this is what the chiropractic profession already does.

Within chiropractic, some have criticised the costs associated with radiography (i.e. Bussieres et al.<sup>2</sup>) however, medical papers are referenced as evidence. This is a classic flaw in the argument that anti-x-ray, 'red-flag only' x-ray guideline supporters make – to apply medical studies on MDs costs of radiology imaging for LBP patients (who get prescribed meds, referred for further imaging, or referred to an orthopaedist, neurologist, or physiotherapist) to the chiropractic profession. As shown, plain film radiography is at the bottom of the ladder in terms of costs associated with spinal imaging, and chiropractic care is already more cost-effective compared to typical medical care.<sup>113,114</sup>

## 9. Alternative Methods Do Not Convey Appropriate Biomechanical Information

Standing radiography as of yet cannot be replaced by alternate methods. CT scans and MRIs are performed in the recumbent position (new standing MRI units are now available but are rare, very costly and inaccessible for daily chiropractic practice) and postural data such as sagittal balance and spinal curve measurements are not physiologic. The measurement of lumbar lordosis, for example, differs between neutral standing and laying supine<sup>115</sup> and thus not physiologic and not useful for the chiropractor when measured from a recumbent position.<sup>116</sup>

Other methods to measure spine alignment are not valid. Skin surface contouring devices, for example, may have good or fair reliability but do not give a valid reflection of the internal sagittal spine alignment.<sup>117-119</sup> Upper cervical techniques that require initial listings cannot be determined through non-radiographic methods.<sup>120</sup>

## 10. Possible Patient Health Enhancement via Hormesis

As discussed, radiation hormesis is a real phenomenon that is beneficial to health as long as the exposures are in the hormetic zone. This occurs as LDR does cause damage to the organism, however this stimulates the bodies adaptive protection systems to repair the damage caused.<sup>121-123</sup> Further, it has been proven that when the body's adaptive protection systems are engaged from a non-lethal radiation dose, the body is demonstrated to produce a modest 'overcompensation,' or it repairs more damage than was initially caused.<sup>124</sup>

Lobrich et al.<sup>124</sup> determined that DNA double-strand breaks (DSBs) occur in humans after receiving a CT scan. The DSBs were seen to be self-repaired between 5-24 hours after the scan where incredibly, innate repair mechanisms repaired more than the initial damage cause by the scan resulting in a final DNA DSB count that was less than the initial count prior to the scan. The ultimate application of LDR on health is the observed increased lifespan, for example, recently Lemon et al. has documented increased lifespan in mice after exposure to either a single CT scan<sup>125</sup> or multiple CT scans.<sup>126</sup>

LDR therapy can be applied to treat many human diseases and conditions as it improves the health status of the organism by stimulating the innate protection repair systems, thus improving the health status of the organism – regardless of disease. This illustrated in the treatment of cancer where LDR therapy and has been shown to achieve better survival rates versus today's standard treatment approaches.<sup>127</sup> Recently, Cuttler et al.<sup>127,128</sup> have demonstrated the successful treatment of both Alzheimer's and Parkinson's disease with LDR by standard CT scans.

It should be well noted that a CT scan typically employs an order of magnitude greater radiation exposure than plain x-rays, therefore LDR as received by patients during plain radiograph assessment by a chiropractor attempting to gain valuable biomechanical information cannot be harmful if it is not even enough exposure to be healthful by hormesis as in the LDR treatment of cancer, Alzheimer's, and Parkinson's disease. As Siegel et al. state "evidence of a beneficial (hormetic) effect of low-dose ionizing radiation... argues against radiogenic causation of either solid cancers or leukemias in children or adults."<sup>39</sup>

## Conclusion

As opposed to current x-ray reduction efforts and traditional beliefs, the weight of the current evidence substantiates two facts: 1. X-rays are not harmful to patients; 2. X-rays should be a routine part of the comprehensive spinal assessment in order to deliver optimal and contemporary chiropractic care.

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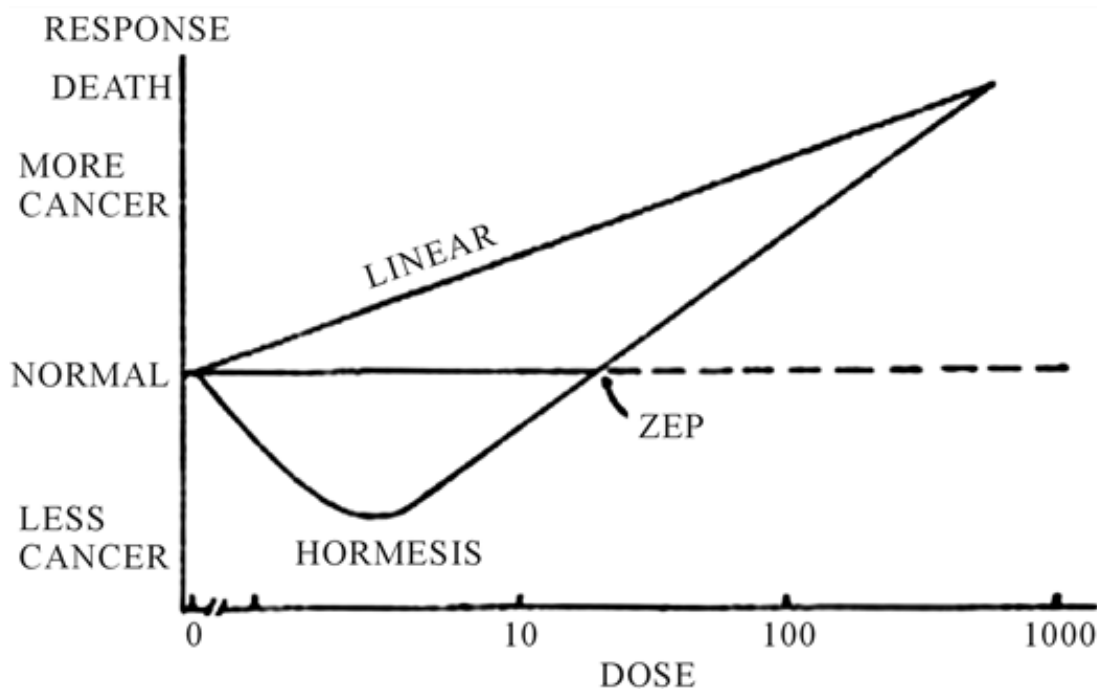
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**Figure 1.** Linear no-threshold model (LNTM) vs. hormesis model. LNT is a linear extrapolation from high-dose atomic bomb data down to zero-dose; hormesis model reflects the observations that low-dose radiation lowers cancer incidence prior to inducing it beyond the zero-equivalent point (ZEP), the level demonstrating actual harm at the threshold of high-dose exposures (Adapted from Luckey<sup>14</sup>).