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An investigation into the chiropractic practice and communication of routine repetitive radiographic imaging for the location of postural misalignments

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ABSTRACT

Many clinicians use radiological imaging in efforts to locate and diagnose the cause of their patient's pain, relying on X-rays as a leading tool in clinical evaluation. This is fundamentally flawed because an X-ray represents a "snapshot" of the structural appearance of the spine and gives no indication of the current function of the spine. The health and well-being of a system, including the spinal motion segments, depend on the inter-relationship between structure and function. Pain, tissue damage, and injury are not always directly correlated. Due to such a high incidence of abnormalities found in asymptomatic patients, the diagnostic validity of X-rays can be questioned, especially when used in isolation of history and/or proper clinical assessment. The utility of routine X-rays is, therefore, questionable. Others may posit that their application promotes overdiagnosis, and unvalidated treatment of X-ray findings (such as changes in postural curvature), which may mislead patients into believing these changes are directly responsible for their pain. A substantial amount of research has shown that there is no association between pain and reversed cervical curves. Accuracy can also be questioned, as X-ray measurements can vary based on the patient's standing position, which research shows is influenced by an overwhelming number of factors, such as patient positioning, patient physical and morphological changes over time, doctor interreliability, stress, pain, the patient's previous night's sleep or physical activity, hydration, and/or emotional state. Furthermore, research has concluded that strong evidence links various potential harms with routine, repeated X-rays, such as altered treatment procedures, overdiagnosis, radiation exposure, and unnecessary costs. Over the past two decades, medical boards and health associations worldwide have made a substantial effort to communicate better "when" imaging is required, with most education around reducing radiographic imaging. In this review, we describe concerns relating to the high-frequency, routine use of spinal X-rays in the primary care setting for spine-related pain in the absence of red-flag clinical signs.

Keywords: Radiographic imaging, X-ray, Chiropractic, Subluxation

INTRODUCTION

The use of radiology is integral to modern medicine and health care. However, certain fractions of the chiropractic health-care profession have been known to use them routinely and repetitively to locate postural syndromes and "subluxation" misalignments.[1] The use of X-rays for postural purposes or subluxation misalignments is concerning, considering the large amount of current research and literature on this issue. In addition, there is apprehension about the strong language chiropractic physicians choose to use and the methods that may be employed when presenting postural lines.

Many chiropractors utilize postural lines with the intention of providing an analysis of overall spinal alignment and posture.[2-4] In the traditional Gonstead technique, postural line analysis is deemed extremely important in locating "vertebral subluxations" within the spine.[2,3] A common aspect of postural line analysis includes placing extended lines across the inferior vertebral endplates of the lateral cervical, thoracic, and lumbosacral radiographic images.[3-5] These specific lines are obtained to compare the segment above with the one below to determine the "posteriority" of a segment, which is conclusive when the extended lines converge posteriorly.[3] Furthermore, they are commonly drawn to communicate the patient's overall spinal curvature and increased weight-bearing that may be occurring at specific structures, for example, anterior head carriage and reversal of the cervical lordotic curve.[3,5,6]

Postural analysis of the lumbopelvic region is also commonly used to validate treatment approaches and communicate a patient's spinal health.[3,7] The ilium analysis is constructed based on points placed at various anatomical positions on the ilium and sacrum, which give particular measurements to draw conclusions.[3] It is not unheard of for patients to report that their previous chiropractor informed them their pelvis is "misaligned" or "rotated." Various factors can influence this extremely dogmatic approach to a patient's assessment, including alteration of patient positioning, variation in an individual's anatomy, inter-examiner reliability, and overall image quality.[8-12]

These postural lines are believed to be important in validating specific vertebral segments to manipulate; however, they also provide an unethical framework to communicate an individual's spinal health through radiographic imaging.[13-15] This can lead to an exaggeration of the severity of an individual's health, leaving the individual pressured into beginning or continuing care. The diagnostic validity, accuracy, ethics, and safety are questioned in this review.

DIAGNOSTIC VALIDITY

Many clinicians use radiographic imaging to locate and diagnose the cause of their patient's pain. Research shows pain, tissue damage, and injury are not always directly correlated. It remains non-conjectural that many pain-free individuals have identical structural changes on X-rays that are also observed in patients with pain. A cause-and-effect relationship clearly does not exist. Due to such a high incidence of abnormalities found in asymptomatic patients, the diagnostic validity of X-rays can be questioned when used in isolation of history and proper clinical assessment. Kiuru *et al.* (2005) reported out of 75 detected bone injuries on scans, only 30 were symptomatic.[16] Furthermore, Horga *et al.* (2020) found that when scanning 115 uninjured, asymptomatic adults, 97% presented with some type of abnormal knee findings, such as a tear, rupture, tendonitis, or cartilage lesions. Furthermore, things become progressively concerning when we look at back pain.[17] In fact, a 2015 systematic literature review consisting of 3110 asymptomatic individuals reported shocking results.[18] About 37–96% had disc degeneration, 30–84% had a disc bulge, 4–83% had facet degeneration, and 3–50% had a spondylolisthesis – all asymptomatic, pain-free individuals. Guidelines from the United States and Europe all discourage routine X-ray scans for low back pain (LBP) without red flags.[19] Furthermore, various studies have found that serious pathology is present in 0.2–3.1% of people with LBP, with fractures accounting for 0.2–6.6%.[20-23] Finally, research shows that using X-rays prematurely in cases where there are no red flags can have negative health outcomes, such as increased radiation, more doctor follow-ups, poorer self-test health status, more pain, and overall dissatisfaction.[19] There is no evidence to suggest that X-rays should be used to diagnose benign radiographic findings. In addition, there is no evidence to support the idea that specific asymptomatic radiographic findings, such as spondylolisthesis, transitional segments, or degeneration, should alter how these conditions are treated in a clinical setting if they have already been identified through a thorough history or physical examination.[1]

A study by Beck *et al.* (2001) investigated radiographic anomalies that may affect patient outcomes through chiropractic intervention.[21] The five most common anomalies that were reported radiographically were degenerative changes (23.8%), posterior ponticle (13.6%), soft-tissue anomalies (13.5%), transitional segments (9.8%), and spondylolisthesis (7.8%).[21] Many of these anomalies may or may not alter patient outcomes over a period of chiropractic intervention, so it is important that a thorough history and physical examination are taken to gain full information. Of the radiographs that were investigated from the individuals, only 11.6% were symptomatic, and 69.4% showed some sort of anomaly.[21] So, is this enough evidence to routinely image a patient for the purpose of biomechanical alterations and certain anomalies? Is it worth the unnecessary costs and radiation exposure when other interventions could be used instead of manipulation?

POSTURE AND PAIN

Clinicians may use radiographic imaging to validate therapeutic interventions for their patients. One technique is presenting postural changes on an X-ray (such as reversed curves) and convincing the patient that this is directly responsible for their pain. This presents an ethical dilemma, and the practice is not backed by research.[24] A substantial amount of research shows that there is no association between pain and reversed cervical curves.[25] A 2012 study compared radiographic imaging of injured and non-injured participants. However, when they tried to draw a correlation between spinal injury and poor postural curvatures, they

could not - there was no significant difference between both groups.[26] In addition, a 2008 systematic critical review found there to be no association between postural curvatures and overall health.[27] Moreover, Murrie *et al*. (2003) reported no link between a reversed lumbar lordosis and pain either.[28] In 2014, Kumagai *et al*. studied 762 volunteers. When trying to link sagittal cervical alignment and neck symptoms, once again, they could not – concluding that there is no association present.[29] Moreover, Matsumoto *et al*. (1998) prospectively studied almost 1000 cervical X-rays (495: Asymptomatic; 488: Acute whiplash). His overwhelmingly conclusive results showed no significant differences in cervical lordosis between the two groups, concluding that reversed postural curves are likely a normal variant and NOT pathological.[30]

It must be addressed that over the years, there have been some contradictory studies by one very active group, the Harrisons. The Harrisons own and promote the "Denneroll," a pillow device that they claim "improves cervical lordosis, reduces forward head position, improves breathing, reduces muscle tension and improves blood flow to the brain." The Harrisons have been challenged multiple times by many leading chiropractors, claiming the method was "physiologically flawed" and the studies extremely "vulnerable to false-positive diagnoses."[30] In fact, two 2006 reviews concluded that "we must reclassify their studies as seriously flawed controlled clinical trials" and "inconclusive evidence that may be viewed as professionally irresponsible by the scientific and academic community".[31,32]

The overwhelming amount of non-biased literature supports that cervical lordosis or reversed postural curves are NOT associated with pathology or pain.[33]

ACCURACY

Accuracy can also be questioned, as X-ray measurements can vary based on an overwhelming number of factors, such as patient positioning, patient physical and morphological changes over time, doctor/user reliability, stress, pain, the patient's previous night's sleep or physical activity, hydration, and/or emotional state.[8-12] In fact, Beauchamp *et al*. (1993) found a 5° difference in Cobb's angle in participants with scoliosis who were radiographed at 8 am compared to 8 pm.[34] If orthopedic surgeons misinterpret such gross angles, how confident can we be when certain professions claim to accurately locate extremely small spinal misalignments or "vertebral subluxations"? Furthermore, Triano *et al*., in 2013, concluded that the use of spinal X-rays had been found to be a poor method of detecting specific areas of spinal manipulation.[35]

SUBLUXATION

Vertebral subluxation is a term and condition created by chiropractors that refers to misalignment of the vertebra, a bone out of place, causing pressure on the spinal nerve and interference with mental impulses. Subluxation is a legitimate medical condition; however, this completely differs from the condition used by chiropractors. Over the years, there have been numerous definitions and takes on what "vertebral subluxation" is – even though the term and concept date back to 1902, it is still commonly used in the chiropractic community.[36] It has been described that the misalignment of the vertebra causes occlusion of where the spinal nerve travels, thus causing nerve pressure and disrupting the "mental impulse," which is part "intelligence" (a synonym for "spirit" and part of the "mental realm," and part neural impulse; which is part of the physical realm. Many chiropractors believe that when bones press on nerves, the corresponding organ on the other end of the nerve will suffer disease.[37] At this point, it appears more like religion; however, it is crucial that we include this as many clinicians use this "condition" as grounds to order unnecessary radiographic imaging. Extensive medical research has shown that bones do not slip out of place, squishing nerves causing various and different pathologies – and there is certainly no way to scientifically prove the interference of a "spirit" or life force.[38-40] Nonetheless, none of this is grounds for ordering an X-ray and does not qualify as any type of "red flag," raising concern about how and when chiropractors are using radiographic imaging.

The Rubicon Group is a collaboration of chiropractic educational institutions that combine traditional chiropractic principles, vitalistic philosophy, and a neurophysiological approach.[41] Their approach is to move away from the traditional pressure on nerve theory and become more research and evidence-based. They currently define a "vertebral subluxation" as "a self-perpetuating, central segmental motor control problem that involves a joint, such as a vertebral motion segment, that is not moving appropriately, resulting in ongoing maladaptive neural plastic changes that interfere with the central nervous system's ability to self-regulate, self-organize, adapt, repair, and heal" (The Rubicon Group. Policies: Definition and Position Statement on the Chiropractic Subluxation).[41]

SAFETY CONSIDERATIONS

The overuse of radiographs is increasing. The possible risks must be considered and assessed within the context of the utility. Corso *et al*. (2020) reported that apart from red flags, there was no evidence showing repeated radiographs were necessary for the assessment of spinal structures, nor did they provide any clinical value or patient benefit given the inherent risk of radiation.[42] Furthermore, research has concluded that there is strong evidence linking various potential harms with routine, repeated X-rays, such as altered treatment procedures, overdiagnosis, radiation exposure, and unnecessary costs.[1] A real concern also exists relating to

undiagnosed soft-tissue pathology in the presence of pain and clinical red flags when X-rays are relied upon. The potential for missed diagnosis is attributed to the poor sensitivity and false-negative rate of X-ray investigations compared with the exquisite resolution capability of magnetic resonance imaging (MRI) and computed tomography (CT) scanning. Both clinician and patient may develop a false sense of security by the "normal" appearing X-ray. This may contribute to the delayed diagnosis of soft-tissue pathology when more advanced imaging is prudently ordered in the case of persistent symptoms. If clinical concerns arise, hesitation to obtain high-resolution imaging with CT (or MRI) scans should not be a factor based on radiation dose (or cost). Further, supporting this is the now widely available helical multi-slice low-dose CT protocols that preserve image quality.

UNETHICAL COMMUNICATION

Spinal X-rays can lead to the detection of radiographic findings that can be used as an overdiagnosis for the patient, even though they may be asymptomatic. These include spinal anomalies, osteophytes, reduced disc heights, low-grade spondylolisthesis, transitional segments, and spina bifida occulta. The chiropractor can use all radiographic findings as "scare tactics" or "fear-mongering" to retain a patient under a specific frequency of care, thus creating unnecessary concern for the patient. Multiple studies have concluded that radiographic findings do not always correlate with a patient's symptomatology.[18,43,44] Brinjikji *et al*. (2015) concluded that disc degeneration was present in asymptomatic individuals, ranging from 37% in 20 year olds to 96% in 80 year olds.

Many chiropractors use "phases of degeneration" as a method of communication in order for patients to adhere to excessive treatment plans.[13] It is unnecessary and unethical to scare patients to obtain compliance with chiropractic care.[13] These "scare tactics" can negatively influence patients' behavior, especially those who already experience reduced levels of self-efficacy.[14,15] This unnecessary use of communication can cause negative thoughts, leading to fear of avoidance of physical activity and management advice as there is a concern for further damage.[45] In addition, the likelihood that a patient will experience chronic pain may arise due to the belief that they won't get better until the radiographic findings are resolved.[46]

CURRENT GUIDELINES

Over the past two decades, medical boards and health associations worldwide have made a substantial effort to communicate better "when" imaging is required, with most education around the reduction of X-rays/CTs/MRIs in medical cases that do not present any red flags.[47] In fact, the American Board of Internal Medicine's worldwide initiative "Choosing Wisely" (which advocates for better dialogue around unnecessary medical tests and procedures) has openly stated they recommend against initial imaging unless red flags are present.[48] This notion is supported widely in the literature, with many medical journals suggesting conservative care and no imaging is preferred for up to 6 weeks with conditions referred to as "Non-Specific Low Back Pain" (NSLBP).[49] In addition, Australian guidelines have advised against diagnostic imaging for routine assessment of patients with NSLBP, with research showing there is no evidence to indicate imaging in the absence of red flags produces any improved clinical or patient outcomes while practicing outside these guidelines does yield possible negatives, such as unnecessary health system and patient cost and radiation exposure to the patient.[47] Major concerns around the possible inappropriate or unethical use of imaging (specifically around NSLBP) have caused the issuance of various practical and clinical guidelines around the usage of X-rays/CTs/MRIs worldwide. The American Academy of Family Physicians recommends withholding imaging for LBP within the first 6 weeks of symptom onset unless clinical "red flags" present. The American Association of Neurological Surgeons and Congress of Neurological Surgeons recommend withholding all imaging of the spine in patients with nonspecific acute LBP and without "red flags."[50]

Furthermore, the "Canadian C-spine Rule" and others like it utilize strict objective criteria to determine whether radiographic imaging is required for patients following trauma.[51] Criteria such as age >65, high-risk mechanisms of injury, midline tenderness, altered conscious state, neurological deficits, other distracting injuries, or known pre-existing spinal disease all mandate imaging and afford a satisfactorily high sensitivity and negative predictive for significant cervical spine injury.[51,52]

RED FLAGS

X-rays and imaging are integral to the development of modern medicine, with millions of lives saved worldwide – including the location and prevention of life-threatening illnesses, diseases, and cancers. It is necessary to use imaging; however, appropriate education is paramount for the therapist or clinician to understand the valid utility of imaging, including plain X-rays. As described in this review, the use of repeated imaging for postural or spinal misalignments is not advised by worldwide governing health authorities and is not supported in most current guidelines. Red flags when screening for LBP are as follows: history of cancer with new onset of LBP, unexplained weight loss, failure to improve after 1 month, age >50 years, night pain, fever, intravenous drug use, recent severe bacterial infection, immunocompromised state, fecal incontinence, saddle anesthesia, lower limb weakness or numbness, history of osteoporosis, prolonged use of corticosteroids, older age, history of fall, or other trauma.[53] In these circumstances, consideration should be

given to high-resolution MRI imaging given that a normal X-ray and even CT scan still necessitate the superior soft-tissue resolution provided by MRI.

CONCLUSION

The importance of medical imaging cannot be overstated. Medical professionals, on the other hand, must adhere to ethical and responsible standards. These guidelines may be ambiguous in some situations, professions, and countries, resulting in many gray areas of practice. As discussed in this review, the ongoing justification many use to justify the excessive, repetitive, and ongoing use of X-rays for reasons that research does not support is highly concerning. This article highlights potential unvalidated practices within the chiropractic field relating to poor utility imaging.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent is is not required as there are no patients in this study.

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Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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