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Chiropractic techniques and technologies

Dr. Brian Gleberzon, DC, MHSc*



Dr. Brian Gleberzon DC, MHSc
Guest Editor

Welcome to the June 2015 issue of the JCCA. It is my privilege to be the *Guest Editor* of this Special Issue that has as its focus “Techniques and Technologies”. This issue consists of ten original research-based articles from an international group of authors; some of the articles published here represent the first time a particular topic has ever been investigated.

At first glance, the ten articles may seem more like a collage of unrelated topics rather than a thematic issue of the JCCA, but further inspection belies that apparent randomness. This is because, due to the explosion of knowledge in all health care disciplines, any thematic journal must by necessity explore the topics of Techniques and Technologies through the lens of multiple perspectives.

Specifically, investigations into “Techniques” can no longer begin and end with a description of a particular technique system by its developer or its disciples, nor is it sufficient to simply populate a journal with a series of

the case reports that champion the effectiveness of this or that preferred method of cure. Likewise, investigations into “Technologies” have to cover the gamut of simple physical assessment procedures (i.e. palpation) all the way to the use of complex equipment now embedded into chiropractic education.

Toward that end, this issue of the JCCA includes a wide variety of articles including: a detailed description of a technique system (craniocervical techniques); case reports (management of a patient with occipital neuralgia; management of a patient with rheumatoid arthritis); narrative review (effectiveness of chiropractic care for patients with gastrointestinal disorders); investigations into diagnostic methods (validity of palpation C1 transverse process; the ‘inter-examiner reliability of paraspinal thermography used in pattern analysis; changes in resting pulse rate) and refining the advanced technology used to enhance the acquisition of psychomotor skills by students (in this case, the Force Sensing Table). It is important to note that this Special Issue contains articles that not only investigate the use of Diversified chiropractic technique for patient care but also Sacro Occipital Technique, Upper Cervical Technique, acupuncture and nutraceuticals.

That said, one article – an investigation of the incidence of sexual harassment among female chiropractors – is admittedly off-theme, but its inclusion here is relevant nevertheless since it is applicable to all chiropractors regardless of their approach to patient care. To the best of our knowledge, it is the first investigation into this unfortunately prevalent issue.

The Editorial Staff, Peer-Reviewers, Authors and I are sure you, dear reader, will find the articles housed in this Special Issue interesting to read, will help you on the proverbial Monday morning in your practice, will lead to further discussions and investigations and, as importantly, will favorably add to the evidence-base of the profession.

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Validity of palpation of the C1 transverse process: comparison with a radiographic reference standard

Robert Cooperstein, MA, DC^{a,b}
Morgan Young, DC^{a,b}
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Objectives: *Primary goal: to determine the validity of C1 transverse process (TVP) palpation compared to an imaging reference standard.*

Methods: *Radiopaque markers were affixed to the skin at the putative location of the C1 TVPs in 21 participants receiving APOM radiographs. The radiographic vertical distances from the marker to the C1 TVP, mastoid process, and C2 TVP were evaluated to determine palpatory accuracy.*

Results: *Interexaminer agreement for radiometric analysis was "excellent." Stringent accuracy (marker placed ± 4 mm from the most lateral projection of the C1 TVP) = 57.1%; expansive accuracy (marker placed closer to contiguous structures) = 90.5%. Mean Absolute*

Objectifs : *But principal : Déterminer la validité de la palpation de l'apophyse transverse C1 par rapport à une référence d'imagerie normale.*

Méthodologie : *On a posé des marqueurs radio-opaques sur la peau à l'emplacement supposé de l'apophyse transverse C1 chez 21 participants recevant une radiographie APOM (bouche ouverte en incidence antéro-postérieure). Les distances verticales radiographiques entre le marqueur de l'apophyse transverse C1, l'apophyse mastoïde et l'apophyse transverse C2 ont été évaluées afin de déterminer la précision de la palpation.*

Résultats : *Les examinateurs se sont accordés pour dire que l'analyse radiométrique était « excellente ». Précision rigoureuse (marqueur placé à ± 4 mm de la projection la plus latérale de l'apophyse transverse C1) = 57,1 %; précision expansive (marqueur placé plus près des structures contiguës) = 90,5 %. Écart*

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None of the authors has any commercial interest in the results of this study or belongs to any organizations that may benefit from the publication.

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Deviation (MAD) = 4.34 (3.65, 5.03) mm; root-mean-squared error = 5.40mm.

Conclusions: Manual palpation of the C1 TVP can be very accurate and likely to direct a manual therapist or other health professional to the intended diagnostic or therapeutic target. This work is relevant to manual therapists, anesthetists, surgeons, and other health professionals.

(JCCA 2015; 59(2):91-100)

KEY WORDS: palpation, C1 TVP, radiograph, validity, chiropractic

Introduction

Manual therapists often assess bony landmarks for asymmetry and for misalignment as part of their assessment of the musculoskeletal system.^{1,2} A spinal motion segment that is found both fixated and misaligned is generally considered a potential site of care, especially if symptomatic.³ To be considered clinically useful, the examination methods used to identify symmetry or misalignment must be found both reproducible and accurate. The accuracy of spinal static palpation has been addressed by validity studies that compared its results with an imaging reference standard. In each of these studies, palpators placed a radiopaque marker, either lead or fish oil, on the putative location of a spinal landmark, which was subsequently measured in relation to the actual location of the landmark as established by an imaging procedure: plain radiography^{4,10}, ultrasound imaging¹¹, fluoroscopy¹⁰, or magnetic resonance imaging^{12,13}.

The accuracy of palpating lumbar spinous processes (SPs) was addressed by Broadbent et al¹², Furness et al¹¹, Harlick et al⁴, Ebraheim et al⁵, Merz et al⁶, Robinson et al⁷, and Snider et al⁸. The accuracy in the thoracic spine was studied by Cooperstein et al⁹ and Holmaas et al¹³; and in the cervical spine by Robinson et al⁷ and Shin et al¹⁰. Apparently, only 1 study, that of Jende et al¹⁴, addressed palpation of spinal TVPs rather than SPs. These latter investigators studied whether examiners could accurately identify lateral translation of C1 in the frontal plane. The present authors are unaware of any studies that addressed

absolu moyen (EAM) = 4,34 (3,65, 5,03) mm; valeur quadratique moyenne d'erreur = 5,40 mm.

Conclusions : La palpation manuelle de l'apophyse transverse C1 peut être très précise et présente de fortes chances de guider un thérapeute manuel ou un autre professionnel de la santé vers le diagnostic ou la cible thérapeutique souhaités. Ce travail concerne les thérapeutes manuels, anesthésistes, chirurgiens et autres professionnels de la santé.

(JCCA 2015; 59(2):91-100)

MOTS CLÉS : palpation, apophyse transverse C1, radiographie, validité, chiropratique

the accuracy of C1 TVP palpation in relation to its contiguous structures, the mastoid process and the transverse process (TVP) of C2.

This study sought to determine if static palpation of the C1 TVPs were accurate compared with radiographic analysis. If so, more credence would be afforded to manual therapy interventions putatively directed at C1. On the other hand, lacking demonstration of such palpatory specificity, mechanical diagnoses and claims made for interventions directed at C1 would seem over-reaching. The results of this study would clarify whether an intervention directed at C1, with its unique anatomy, may result in different clinical outcomes from those of other cervical interventions, as some have claimed.¹⁵

There are several threats to the accuracy of upper cervical palpation inherent to the special anatomy of this spinal region. Although cervical SPs only rarely overlap, as in Bastrup's disease^{16,17}, there is some evidence that the mastoid process occasionally overlaps the C1 as seen on an anterior-to-posterior open mouth (APOM) radiograph¹⁸. This would almost certainly complicate distinguishing the adjacent structures. As another potentially confounding issue, craniocervical anomalies are found in 1-4% of the population. Possible anomalies include elongated mastoid processes, lateral ponticles, and ossification of the stylohyoid ligament.¹⁹⁻²² Dysplasia of the upper cervical spine has been well documented.²³⁻²⁷ Since the present study was conducted within the venue of a chiropractic college, it may be relevant that congenital anom-

alies among chiropractic students have been reported to be higher than in the general population.^{28,29}

The primary purpose of the present study was to determine the accuracy of static palpation of the C1 TVP, in order to secondarily establish the feasibility of directing interventions specific to the C1 vertebra, in both clinical and research settings.

Methods

The investigators recruited a convenience sample of 21 chiropractic students who were scheduled to receive radiographic examination at the chiropractic college clinic. Their x-ray examinations had been ordered prior to and independently of the goals of the research project. Since the authors were performing a secondary analysis of radiographs taken for a different purpose, no participant was exposed to additional radiation as a result of their having been involved in this project. The Institutional Review Board of the chiropractic college approved the study, and each participant was provided with an explanation of the procedures and an opportunity to ask questions before providing signed informed consent.

The only deviation from the usual radiographic procedure was that prior to exposure, a palpator putatively identified the C1 TVP bilaterally, and affixed to the participant's skin a 2mm in diameter radiopaque lead marker mounted on a self-adhesive pad ("nipple artifacts markers", AliMed.com). Following that, APOM and sagittal plane radiographs were obtained as part of the college clinic's typical full spine series, utilizing proper filtration and collimation as per its standard protocols.

Of the 21 subjects seen in this study, 19 were palpated by the Principal Investigator (PI), a chiropractor with 8 years of experience, and two by another chiropractor with over 2 years experience. The participant was seated in a neutral posture. The palpator stood behind the seated patient and used the tip of the index finger to locate the C1 TVP by finding the angle of the mandible, sliding slightly superior and posterior to the mandibular ramus while remaining anterior and inferior to the mastoid process. The distance from the mandibular ramus to the mastoid process is typically about one finger's breadth and the C1 TVP is judged to be the bony prominence that lies between these two bony landmarks.³⁰⁻³⁵ An effort was made to remain perpendicular to the surface of the participant's skin, irrespective of any postural asymmetry. Having con-



Figure 1. Radiometric method

True horizontal lines A, B, C, and D demarcate the inferior mastoid, C1 TVP, marker, and C2 TVP, respectively. The red vertical lines pass through the markers. Line B-C is examiner error for C1 TVP palpation, line A-C is maker-mastoid distance, and line D-C is C2 TVP-marker distance. In this exemplar radiograph, the right mastoid process and the upper surface of the left C1 TVP are difficult to visualize.

tacted the skin lateral to the projection of the C1 TVP, the palpator placed the radiopaque marker directly overlying the most lateral projection of the C1 TVP, avoiding as much as possible soft tissue slippage during the process.

All patient information was removed from the digital image that was provided to 2 of the investigators for the purpose of radiometric analysis. They analyzed the radiographs well after data collection was complete (several months in one case and more than a year in the case of the other). The radiographs were analyzed digitally (Figure 1) using the GIMP 2.8 software product (<http://www.gimp.org/>). This software measures the vertical, horizontal, and direct distances in pixels between any 2 points identified on a graphic image. Measurements were obtained on the left and right for each of 21 partici-

pants (thus 42 measurements in all) for the vertical distance of the marker from the most lateral portion of the C1 TVP, the inferior aspect of the mastoid process, and the most lateral aspect of the C2 TVP. The left and right horizontal distances from the skin to the marker were also measured in a randomly selected subset of 10 participants. To convert the pixel measurements to millimeters (mm), the average width in pixels was considered equivalent to the average width of a C1 vertebra (as measured between the most lateral aspects of the TVPs), which has been established to be 73.5mm.^{36,37} This conversion protocol was double-checked for accuracy by determining how many pixels corresponded to the known 2mm diameter of the radiopaque markers that were used. The radiometric method is illustrated in Figure 1.

Statistical analyses were performed in SPSS v.19 (<http://www-01.ibm.com/software/analytics/spss/>). Intraclass correlation coefficients (2,1) were calculated for the 2 investigators who measured the distances from the markers to the osseous landmarks. Both the MAD (Mean Absolute Deviation), the average of the absolute values of examiner errors for the vertical marker-TVP measurement, and the RMSE, root mean squared error (another measure of examiner accuracy) were calculated. A Pearson product-moment correlation coefficient was obtained to determine if there were correlation between examiner errors on the left and right.

Accuracy was calculated according to both stringent and expansive definitions of accuracy. To calculate accuracy stringently, the center of the marker was considered in relation to the *field* of the C1 TVP, the interval between the superior and inferior surfaces of the C1 TVP. Since these surfaces could not be consistently visualized, and in some cases displayed considerably irregular contours, the investigators found it more feasible to identify and measure from the most lateral projection of the TVP. Since this most lateral projection of the TVP was approximately centered between the superior and inferior surfaces of the TVPs, this method was mathematically equivalent to having measured from the midpoint of the field of the TVP. Knowing from previous studies that the average frontal plane width of the C1 TVP is approximately 8mm¹⁸, the marker center was stringently considered to lie within the field of the TVP when it was ± 4 mm from most lateral projection of the TVP. To calculate accuracy *expansively*, the palpator was judged to have been accurate when the

Table 1.
Accuracy as measured by MAD

	Mean absolute difference	MAD 95% confidence interval (CI)		Standard error of mean	σ_c , root mean squared error
		lower	upper		
	MAD, mm			SEM	RMSE, mm
left	4.76	3.03	6.49	0.88	6.21
right	3.92	3.00	4.83	0.47	4.45
grand	4.34	3.65	5.03	0.35	5.40

Table 2.
Accuracy as measured by % agreement

	Left		Right		Grand
	Mastoid	C2 TVP	Mastoid	C2 TVP	
Stringent accuracy	54.7%		59.5%		57.1%
Expansive accuracy	100%	92.9%	97.6%	100%	90.5%

center of the marker was placed closer to the most lateral aspect of the C1 TVP than to either the inferior aspect of the mastoid process or the most lateral aspect of the C2 TVP.

Results

Twenty-one minimally symptomatic participants were recruited (60 percent male, mean age 26) and palpated bilaterally, resulting in a total of 42 measurements of the vertical distance between the centers of the radiopaque marker and the most lateral aspect of the C1 TVP. The intraclass correlations (ICCs) for the 2 investigators marking the radiographs were 0.92 for the C1 TVP distance-to-marker, 0.82 for the mastoid distance-to-marker, and 0.84 for the C2 TVP distance-to marker. All of these ICC values were judged “excellent” according to the Landis & Koch interpretive scale.³⁸

Tables 1 and 2 summarize accuracy in this study in terms of both MAD and % agreement, respectively. MAD, the mean absolute value for examiner marker-TVP errors, was 4.76, 95% CI [3.03, 6.49] mm on the left; and 3.92, 95% CI [(3.00-4.83)] mm on the right, resulting in a grand MAD of 4.34 (3.65, 5.03) mm. The square root of mean squared error (MSE) yields root-mean-square-error (RMSE), yet another measure of examiner accuracy. In this study, left RMSE was 6.21mm, and right RMSE

4.45mm, resulting in a grand RMSE of 5.40mm. RMSE will always be larger or equal to the MAD. The greater the variance in examiner errors, the greater the difference between them. In fact, when RMSE=MAD, all the errors are of the same magnitude. Since grand RMSE exceeded grand MAD by only 1.06mm, examiner errors were confirmed to be relatively small. The average distance of the marker to the mastoid process was 8.70mm, and to the C2 TVP midpoint was 13.77mm.

Stringent accuracy, defined as when the marker center was ± 4 mm from the average center of the TVP field, was achieved in 24 of 42 (57.1%) measurements, 54.7% on the left and 59.5% on the right. Expansive accuracy, when the marker was closer to the C1 TVP than to either of the contiguous structures, occurred in 38/42 (90.5%) cases; the marker was closer to the left C2 TVP in 3 cases (by an average of 2.99mm), and to the right mastoid in 1 case (by 3.39mm). There were no significant differences in accuracy when the data were stratified by gender.

To determine if the palpator errors on the left and right were correlated, the authors obtained their Pearson's product moment correlation value for their signed values: $r = 0.63$ (two tailed $p = .001$). On average, the left marker was positioned 1.07mm inferior to the C1 TVP, and the right marker 0.57mm inferior, for a mean inferiority (representing systematic bias) of 0.82mm. A set of 10 cases was randomly selected to determine if the depth of the C1 TVP as measured to the marker were related to the accuracy of C1 TVP palpation. There were no clinically or statistically significant relationships.

Discussion

A 2003 review article³⁹ stated there had been relatively few studies of the validity of spinal palpation examination procedures but the number has been growing. Lack of consistency in the use of indexing terms may have complicated the process of retrieving relevant literature.⁴⁰ Authors investigating the validity of spinal landmark palpation as compared with an imaging reference standard have used varying definitions of accuracy, some including both strict and more liberal, clinically relevant definitions; comparable to the "stringent" and "expansive" definitions in the present study. As a general rule, prior studies have defined a posteriorward projection of a SP or an intervertebral interspace to be its "field," and then scored the radiopaque marker as being strictly within or more

permissively overlapping this field. This strict definition of accuracy may be anatomically accurate, but may not be clinically relevant. The vertebra in question articulates with segments above and below, so that diagnostic procedures and therapeutic interventions necessarily involve to some degree at least 2 motion segments involving 3 contiguous structures. Taking this into account, placing the radiopaque marker somewhat outside the field of the SP would not likely undermine the purpose of the diagnostic or therapeutic procedure, so long as it were closer to the target than to adjacent structures. Recognizing this point of view, some of the prior studies defined a more liberal concept of accuracy. In some cases the marker was judged accurately placed when closer to the target than adjacent structures^{13,41,42}, and in others by defining the field of accuracy to include ± 1 level^{4,11}. The following brief review of the published literature is organized by the profession of origin: manual therapy, anesthesiology, or surgery.

Manual therapy studies

Like the present authors, Jende et al¹⁴, studied the accuracy of C1 TVP palpation, but with a very different study goal: to determine the accuracy in identifying frontal plane lateral deviation. Accuracy was poor. Robinson et al⁷ determined the accuracy of numerating the C7 and L5 SPs using methods commonly used by physiotherapists. The mean expanded accuracy for 2 manual therapists was 64% for C7 and 42% for L5. Merz et al⁶ studied whether the addition of visual cues as to the location of anatomical landmarks in the pelvis would increase the accuracy of motion palpation in identifying the location of the SP of L5. The accuracy increased from 45% to 83%. In Snider et al⁸, a number of examiners attempt to identify the SP of L1-4 using a number of spinopelvic landmarks as reference points. Using a posteroanterior radiograph reference standard, rather than the more typical sagittal plane radiography, the accuracy was 69%. Cooperstein et al⁴² had a palpator place radiopaque markers on the thoracic SPs palpated to correspond with the inferior tip of the scapula, and also the 2 SPs judged to be 3 spinal levels inferior and superior. Expanded accuracy, in which the marked level was closer to the intended level than to contiguous structures, was 76.5%. Harlick et al⁴ allowed physiotherapists to use whatever technique they preferred to identify the SPs of L1, L3, and L5. Accuracy, defined as any degree

of overlap between a radiopaque marker and the field of the SP, was 47%; whereas expanded accuracy, including 1 spinal level above or below, was 88%. Using relatively large 7.5mm in diameter radiopaque markers resulted in a relatively permissive definition of accuracy, since this increased the likelihood of a marker overlapping the field of the intended SP. Three studies⁴³⁻⁴⁵ investigated whether the PSISs and an intercrestal line could reliably identify a lumbar level as confirmed by a radiopaque marker, but since the examiners did not actually palpate the spine, their work will not be reviewing herein.

Anesthesiology studies

Anesthetists share the need with manual therapists to accurately identify the correct intervertebral interspaces, using palpation to identify a suitable vertebral level for epidural and spinal anesthesia. Broadbent et al¹² studied the accuracy of placing a fish oil marker at any of the lumbar vertebral interspaces. Their accuracy rate was 29% as established by magnetic resonance imaging. Furness et al used similar methods to determine the accuracy of identifying the L2-3, L3-4, and L4-5 interspaces. Accuracy, defined as marker placement within the field of the interspace was 30%, compared to the 71% accuracy achieved using ultrasound imaging. Holmaas et al¹³, using a magnetic resonance imaging reference standard, determined the accuracy of numerating vertebral levels from the T7-8 to the T11-12 interspace by counting either cephalad from the putative L3-4 level at Tuffier's line (drawn across the iliac crests), or caudally from the putative C7 level (thought to be the vertebra prominens). Palpation was judged accurate when a fish oil capsule marker was either placed the correct intervertebral space, in 26.7% of cases; or more expansively when it overlaid an adjacent SP, in 36.7% of cases. Shin et al¹⁰ compared the accuracy of two assessment procedures for identify the C7 SP: considering C7 to be have the most prominent cervical SP, and using motion palpation into extension. Using fluoroscopy as a reference standard, the motion palpation method was 77.1% accurate, compared with 47.9% using the most prominent SP method.

Surgical studies

The surgical community is also confronted with the same necessity to accurately identify the location of C1, which serves as an anatomical landmark for surgeries and treat-

ing various otolaryngeal conditions, including injuries to the spinal accessory nerve.⁴⁶⁻⁴⁸ In a study by Sheen et al⁴⁷, although there was some clinical disagreement on numerating the vertebra, a CT scan and computer modeling determined the most prominent TVP identified by manual palpation was in fact the C1 TVP. In a lumbosacral study involving surgical protocols⁵, surgeons placed a radiopaque marker directly on the TVP cephalad to a spinal segment that was to be surgically fused. A sagittal plane radiograph then determined if the desired fusion level was in fact the spinal level that had been fused. The accuracy rate was 76/80 (95%), deemed unacceptable, with 4 patients in the study having had the wrong surgical level fused.

Operational definition of accuracy in the present study

In the present study, accuracy was calculated in both a stringent and a more permissive manner. According to the strict definition, a palpator would place a soft-tissue marker within the 8mm wide field of the C1 TVP; whereas according to the more clinically relevant expansive definition, the palpator would place the marker closer to the C1 TVP than to either the mastoid process above or the C2 TVP below. Unlike all but one of the spinal landmark validity studies reviewed, our study involved TVP rather than SP palpation. The only other study to have done so was Jende et al¹⁴, who found palpation to have been inaccurate. Due to factors related to image interpretation, it would have been difficult to define a field of marker accuracy by projecting lines from the inferior and superior aspects of TVPs, analogous to what investigators had done in the reviewed SP studies. As an alternative method, the authors identified the most lateral projection of the C1 TVP on the radiograph, which moreover would have presumably been the most likely aspect of the vertebra with which the palpator had "made contact" through the soft tissue.

Our method of calculating expanded accuracy, wherein the marker was closer to the target than to contiguous structures, necessarily differed in method from some of the SP validity studies that also included a concept of liberal accuracy.^{4,11,13,41,42} In these other studies the contiguous structures were equally distant from the targeted structure; whereas in the present study, the mastoid-C1 TVP distance did not equal to the C1 to C2 TVP distance. Since the average distance of marker to mastoid was

8.70mm, and to C2 TVP midpoint 13.77mm, there was no way to define a *constant magnitude* of examiner error that would be regarded as expansively accurate. Therefore, the authors defined expanded accuracy in a purely clinical sense as having placed the center of the radiopaque marker closer to either of the contiguous structures (mastoid process and C2 TVP).

The other studies on the accuracy of SP palpation used markers ranging in size from the 2mm lead markers similar to those used in our study to 8-10mm fish oil capsules^{12,13}; some studies did not specify the dimensions. If the definition of accuracy includes overlap of a spinal landmark with a radiopaque marker, then the accuracy rate will be directly proportional to the size of the marker. Since the present study used relatively small markers, the results would have understated its accuracy compared with studies using larger markers that defined agreement as *any degree of overlap* with the spinal structure, (e.g.,⁴). As an alternative, the present study defined stringent accuracy as a marker's center having been ± 4 mm from the center of the C1 TVP, given its average height of 8mm.¹⁸ Although the calculated MAD values do represent examiner error in this study, the term "error" could be misleading. In fact, 57.1% of these "errors" actually overlapped the TVP; that is, they were not errors at all in the normal sense of the term, when used outside the context of statistical analysis. Only when the palpator error exceeded 4.0mm (42.9% of cases) could it be inferred there had been *any* palpatory error, since the C1 TVP is a surface with a vertical height rather than constituting a point.

In this study the mean of signed examiner errors was 0.82mm, signifying a slight bias toward identifying the TVP inferior to its actual location. This may have been due to the fact that the palpatory method involved making contact with the putative C1 TVP from an inferiorward direction. This very small distance is unlikely to be clinically relevant. The very rationale for calculating the MAD statistic lies in the fact that a simple average of positive and negative examiner errors converges toward zero when bias is small, since positive and negative values tend to offset. Failure to appreciate this can and has led some authors to report exaggerated agreement for examination methods or examiners. To obtain a more clinically relevant measure of average examiner errors, it is more instructive to look at the mean of the *absolute values* of the errors, the Mean Average Deviation (MAD). MAD

is a robust measure of the measurement errors, defined as such because it is more resilient to outliers in a data-set than calculations of standard deviation, which square measurement errors. In this study, the MAD and MSE were greater on the left, suggesting more palpatory accuracy on the right. MAD equals RMSE when all the errors are of the same magnitude. With increasing variance in the errors, RMSE increases in relation to MAD, and thus becomes a more useful (certainly more conservative) estimate of accuracy. The significant correlation of examiner errors on the left and right suggests there were symmetric anatomic features of the C1 vertebra that predisposed toward the direction and magnitude of examiner error.

Triano *et al* performed the most comprehensive study of its kind on the reliability and validity of the various methods used by manual therapists to target the site of care.³ The evidentiary support for the use of static palpation to determine a spinal site of care was judged to be "unclear." (Some^{4,14} but not all of the studies reviewed in the current article were included in the site of care article.) Several studies have called into question a manual therapist's ability to deliver forces to their intended targets.⁴⁹⁻⁵⁶ It is not known to what extent diagnostic and/or adjustive imprecision in the manual therapy professions leads to suboptimal clinical consequences. There is some evidence suggesting that under certain circumstances the information provided by cervical motion palpation for the specific site of care may not change the outcome of care.⁵⁷

In the practice of manual therapy, misdiagnosing the level of a misaligned or dysfunctional segment may or may not result in an altered clinical outcome. For example, an intervention might nonetheless be directed at an appropriate level, even though the clinician may have misidentified it. Although this misidentification need not directly lead to a clinical problem, issues may arise if or when another or the same clinician attempts to intervene on the incorrectly charted level on another day. Level misidentification may also be problematic in attempting to track clinical changes over time. Accurate palpation is crucial when the practitioner is attempting to correlate physical examination findings with the results of an imaging study, in order to decide upon the clinical relevance of manual examination findings. In addition to the context of static spinal palpation, accuracy in identifying spinal levels has also manifested as an issue in the context of motion palpation, where sometimes the palpators have agreed on the

locations of dysfunction, but disagreed on numerating the level.⁵⁸⁻⁶¹ Comparable to the expanded definitions of accuracy utilized in some of the SP validity studies, some of the motion palpation studies have also expanded the field of examiner agreement to include nominated segments that were within one level of each other.^{62,63}

Limitations of the study

It was deemed challenging to place the radiopaque markers where intended. Despite attempts to limit skin movement, the confined space behind the ear required the palpator to remove the finger from the suspected C1 TVP position to place the radiopaque marker, and then re-palpate through the radiopaque marker to ensure accurate placement. Lateral tilting of the head in relation to the floor might have altered marker positioning relative to the C1 TVPs; on the other hand this would have confounded the results of this study only if had participants assumed a different degree of lateral titling during the radiological examination. Since 1 of the palpators also performed radiometric analysis, it might have been possible for him to identify or recall specific palpatory findings that might have biased subsequent analysis of the radiographs. That stated, he felt that so much time had elapsed between obtaining and analyzing the radiographs that this was virtually impossible. Although the study results showed stringent accuracy of 57.1% and expansive accuracy of 90.5% in palpating the C1 TVP, it did not address the interexaminer reliability of the procedure. Even if demonstrably valid, without demonstrated interexaminer reliability the described palpatory procedure would not be judged clinically useful. The evidence is sparse that a specific adjustment of C1, or any vertebral site of care for that matter, achieves a clinical outcome that is different or better than what might have been achieved by adjusting a different level.^{3,57,64} The participants in the study were almost all young adults, all either asymptomatic or minimally symptomatic (pain <3 on a 0-10 pain scale). This homogeneous participant group differs from patients that would be drawn from the general population, thus requiring caution in projecting these results to more heterogeneous patient populations.

Conclusions

The primary purpose of the present study was to determine the accuracy of static palpation of the C1 TVP, in

order to secondarily establish the feasibility of directing interventions specific to the C1 vertebra, in both clinical and research settings. The results suggest examiners can to some degree accurately identify the C1 TVP on a patient. Although ideally speaking this determination should best be made for all spinal levels, it might be considered especially important for the C1 level given the abundance of claims made for its unique clinical importance.¹⁵

The authors were fortunate in being able to harvest information from radiographs being taken for clinical reasons unrelated to the study goals, thus not requiring participants to be exposed to additional ionizing radiation. Other investigators interested in pursuing similar research goals, but not having a similar capability of harvesting such information, might consider using ultrasonography, as did Furness et al¹¹ or magnetic resonance imaging, as did Broadbent et al¹² and Holmaas et al¹³.

This finding should be of interest not only to manual therapists, but also a variety of other health professionals, including nurses, surgeons, anesthesiologists, and acupuncturists. This study does not by itself establish the clinical utility of this procedure, but does establish a methodological foundation for devising clinical outcome studies that could in principle do so. Future studies on the hypothetical importance of optimizing a specific site of care ultimately will require more studies such as the present one.

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Improvement in clinical outcomes after dry needling in a patient with occipital neuralgia

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The primary purpose of this case report is to outline the diagnosis, intervention and clinical outcome of a patient presenting with occipital neuralgia. Upon initial presentation, the patient described a four-year history of stabbing neck pain and headaches. After providing informed consent, the patient underwent a total of four dry needling (DN) sessions over a two-week duration. During each of the treatment sessions, needles were inserted into the trapezius and suboccipital muscles. Post-intervention, the patient reported a 32-point change in her neck disability index score along with a 28-point change in her headache disability index score. Thus, it appears that subsequent four sessions of DN over two weeks, our patient experienced meaningful improvement in her neck pain and headaches. To the best of our knowledge, this is the first case report describing DN

L'objectif principal de cet exposé de cas est de souligner le diagnostic, l'intervention et le résultat clinique d'un patient souffrant de névralgie cervico-occipitale. Lors de la présentation initiale, la patiente a décrit des antécédents de douleur aiguë dans le cou et de céphalées pendant quatre ans. Après avoir fourni le consentement éclairé, la patiente a subi un total de quatre séances de piqûres sèches sur une période de deux semaines. Au cours de chaque séance de traitement, des aiguilles lui ont été insérées dans le trapèze et les muscles sous-occipitaux. Après l'intervention, la patiente a signalé un changement de 32 points à l'index d'incapacité cervicale avec un changement de 28 points à l'index d'incapacité liée aux céphalées. Par conséquent, il semble qu'à la suite des quatre séances de piqûres sèches réparties sur deux semaines, notre patiente a connu une amélioration remarquable concernant ses douleurs cervicales et ses céphalées. À notre connaissance, il s'agit du premier exposé de cas décrivant des piqûres sèches qui améliorent avec succès les résultats cliniques chez un

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to successfully improve clinical outcomes in a patient diagnosed with occipital neuralgia.

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KEY WORDS: dry needling, intramuscular stimulation, occipital neuralgia, headache, neck pain, chiropractic

Introduction

Occipital neuralgia is defined according to guidelines provided by the International Headache Society (IHS). Briefly, the IHS diagnostic criteria include sharp, paroxysmal, severe pain in the occipital region along with associated tenderness and sensory disturbances.¹ Occipital neuralgia may be the result of pathology in the greater, lesser or third occipital nerves (Figure 1).² Previous evidence indicates that occipital neuralgia affects the greater occipital nerve in 90% of cases, lesser occipital nerve in 10% of cases, and both occipital nerves in 9% of cases.³ However, the specific incidence and prevalence rates for occipital neuralgia remain unknown along with an elusive pathophysiology including the precise etiology.^{2,4} Differential diagnoses for occipital neuralgia include cervicogenic, migraine, cluster and tension-type headaches. Treatment for occipital neuralgia may comprise interventions such as pharmacology, conservative care, interventional therapies and/or surgery.^{2,5-8}

Dry needling (DN) or intramuscular stimulation is defined as a therapeutic procedure that involves inserting a dry needle, without medication, into a myofascial trigger point with the goal of inactivating a trigger point and mitigating pain.^{9,10} In 1979, Karel Lewit became one of the first persons to distinguish between the effects of inserting a *dry* needle into a myofascial trigger point and injection of a medicinal substance into a myofascial trigger point.¹¹ Since that publication, there has been accumulating evidence supporting the use of DN in the management of myofascial pain along with basic science research attempting to establish therapeutic mechanisms.¹²⁻¹⁴

The primary purpose of this case report is to outline the diagnosis, intervention and clinical outcome of a 26-year-old female with occipital neuralgia. As part of this discussion, our article includes information outlining the

patient ayant reçu un diagnostic de névralgie cervico-occipitale.

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MOTS CLÉS : piqûres sèches, stimulation intramusculaire, névralgie cervico-occipitale, céphalée, douleur cervicale, chiropratique

anatomy, pathophysiology, clinical presentation, differential diagnosis and management of occipital neuralgia. In addition, this paper briefly reviews evidence supporting the use of DN in managing myofascial pain.

Case Report

Upon arrival, a 26-year-old female described a four-year history of neck pain and headaches. The patient related

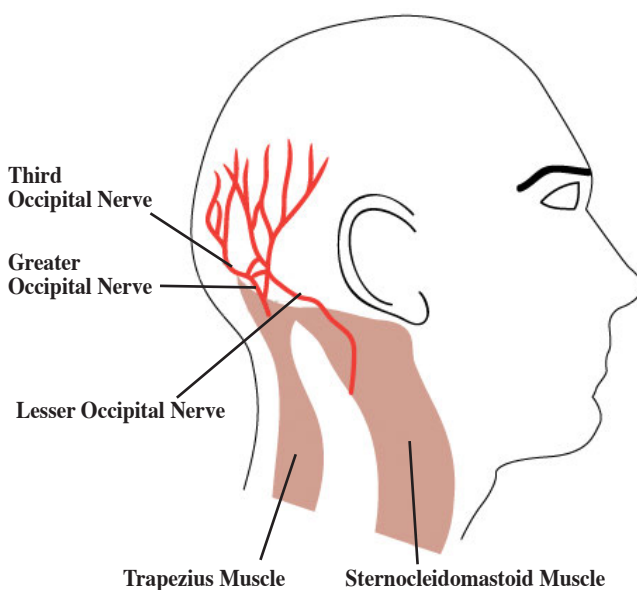


Figure 1:
Distribution of the greater, lesser, and third occipital nerves.

Adapted from: Kemp III WJ, Tubbs RS, Cohen-Gadol AA. The innervation of the scalp: a comprehensive review including anatomy, pathology, and neurosurgical correlates. *Surg Neurol Int.* 2011;2:178.⁴⁹

the onset of these symptoms secondary to a traumatic event four years prior to presentation. While walking a dog in damp conditions, she reported falling backwards and striking her head on the ground with a transient loss of consciousness. The day after striking her head, she proceeded to the hospital complaining of right-sided neck pain and headache in the occipital region. After an examination including x-rays, the patient described a diagnosis of “concussion” from the hospital physician. Also, she described “swelling” in her anterior neck region for approximately four weeks post-trauma, but the swelling abated with time and use of over-the-counter medications. However, her neck pain and headache continued beyond dissipation of the edema, transitioning to a persistent condition.

During the initial consultation, the patient described her right-sided neck pain and occipital headache as “knife-like” and stabbing. When asked to point to the painful region, she touched the right occipital region between the midline and the sternocleidomastoid muscle. Also, she recounted that the pain occasionally radiates into her right fronto-orbital region. She described a paroxysmal pattern to the stabbing pain, without ever experiencing complete resolution of symptoms. She indicated experiencing a severe headache in her right occipital region approximately one to two times a month with each occurrence lasting for about one week, including two to three days of high intensity pain with each episode. She denied vomiting, aura, prodrome or neurological indicators such as nystagmus, numbness, nausea, dizziness, dysarthria, dysphagia, diplopia, drop attacks and ataxia. The patient rated the average daily pain as 2/10 on a verbal pain rating scale, with exacerbations or paroxysms rated as 9/10. She denied any triggers or aggravating factors related to the paroxysms, but these changes in pain seem random or unpredictable. However, the patient described several factors that afford pain relief, albeit temporary.

Factors that yielded provisional and limited relief of pain included spinal manipulation, transcutaneous electrical nerve stimulation (TENS), physical therapy, needling, and an orthodontic appliance. Previous physical therapy interventions included neck strengthening and relaxation exercises, while the orthodontist provided an oral appliance to reduce nocturnal “clenching” of the jaw. In addition, her family physician prescribed Maxalt (sublingual and oral) for treatment of headaches with a vari-

Table 1:
Pre-intervention Cervical Spine Active Range of Motion

Trial	RR (°)	LR (°)	RLF (°)	LLF (°)	F (°)	E (°)
1	78	74	38	42	60	40
2	82	78	44	42	54	39
3	76	78	45	51	59	41
Mean±SD	78.7±3.1	76.7±2.3	42.3±3.8	45.0±5.2	57.7±3.2	40.0±1.0

RR = right rotation; LR = left rotation; RLF = right lateral flexion; LLF = left lateral flexion; F = flexion; E = extension; SD = standard deviation

able clinical response including limited relief or no effect. Finally, she recounted that “rubbing” or pressing the right temporal region above her eye reduces the severe pain associated with headaches, but this stimulation creates lacrimation and nausea. However, none of the remedies or interventions described above brought complete or lasting resolution of her pain.

She conveyed no previous specific diagnoses for her neck pain and headache. However, her past medical history included diagnoses related to low back pain, anxiety/depression, attention deficit disorder (ADD), acne, and pre-diabetic. She reported ongoing use of medications for managing her anxiety/depression (Cymbalta), ADD (Adderall), acne (Spironolactone), and pre-diabetes (Metformin). Her past medical history also included knee reconstruction approximately ten years prior. Her social and occupational history included limited alcohol (one unit per week) and caffeine (two drinks per day) consumption along with moderate exercise (three to four days per week for 30-45 minutes per session). The patient denied tobacco use or any other diagnoses.

Examination procedures included neurological screening/testing, range of motion/mobility, palpation, and orthopedic testing. Neurological testing included cranial nerve function along with muscle/strength testing, deep tendon reflexes, and sensation. Based upon examination, cranial nerve and upper quarter neurological function appeared within normal limits. Cervical spine active range of motion (AROM) consisted of three trials of motion in each direction measured with a single inclinometer. Based upon normative comparison values¹⁵, the patient’s AROM emerged WNL, except for limited extension (Table 1). Also, the patient denied painful sensations during performance of cervical AROM.

Palpation of the cervical spine revealed elevated muscle tone in bilateral upper trapezii muscles. Using a soft tissue tenderness grading scheme¹⁶, palpation uncovered grade I tenderness in bilateral levator scapula muscles along the superomedial border of the scapula, bilateral interscapular muscles (rhomboids, middle trapezii, lower trapezii), and right posterior cuff muscles (teres minor, teres major). In addition, palpation elicited grade II tenderness in the right upper trapezius and occipital regions. For an additional description of this soft tissue tenderness grading scheme, please see Hubbard and Berkoff.¹⁶ Palpation revealed myofascial trigger points in bilateral upper trapezii muscles along with the right suboccipital muscles.

Orthopedic testing consisted of regional examination related to the complaint of cervical spine pain. The upper limb tension test A (ULTTA) and shoulder depression tests revealed negative results bilaterally.^{17,18} However, the cervical compression test elicited localized right-sided neck pain in the upper cervical region; left cervical compression produced negative results.^{17,18} Also, Spurling's tests yielded localized right-sided pain in the upper cervical region and localized left-sided pain in the mid-cervical region.^{17,18} Cervical distraction test reduced the right-sided pain in the upper cervical region.^{17,18}

Other outcomes measures for this case report included the neck disability index (NDI), and headache disability index (HDI). The patient completed each of these questionnaires on two occasions: pre-intervention at baseline and post-intervention at three week follow-up. Table 2 lists the NDI, and HDI scores pre and post-intervention.

The patient presentation and examination findings

suggested a probable diagnosis of occipital neuralgia. Differential diagnoses included cervicogenic headache, migraine headache, and tension-type headache. After the patient read and signed the appropriate informed consent forms, the clinician initiated an intervention consisting of dry needling (DN). The patient underwent a total of four DN sessions over a two-week duration.

The first treatment session involved placing needles into myofascial trigger points located in bilateral upper trapezii muscles (see video demonstration) and bilateral cervical multifidi muscles between the C5-T1 regions. Following the first DN session, the patient reported "stiffness" in the right upper trapezius muscle that lasted approximately one hour. Also, she rated her right-sided neck pain and headache as 1/10 using the verbal pain rating scale. Orthopedic testing reproduced her neck pain and palpation elicited grade I tenderness in bilateral upper trapezii muscles and interscapular muscles, along with the right posterior cuff and suboccipital muscles. The second treatment session consisted of DN myofascial trigger points in the same anatomical regions as the first visit. A week later during the third visit, the patient reported sleeping on a "different pillow" which seemed to aggravate her condition. The patient stated that she seemed "on the verge" of an exacerbation in symptoms. During this third treatment session, needles were inserted into one additional anatomical region. On this occasion, needles were placed into bilateral upper trapezii muscles, bilateral cervical multifidi muscles, and the proximal attachment of bilateral suboccipital muscles along the nuchal line. Two days later, upon presentation for the fourth visit, the patient reported complete resolution of her neck pain and headache. Also, she felt that the last DN session had "aborted" her imminent exacerbation. Orthopedic testing demonstrated negative tests bilaterally for cervical compression and Spurling's. Again, needles were placed into myofascial trigger points in bilateral upper trapezii, cervical multifidi and suboccipital muscles. During each of the four treatment sessions, insertion of needles into the described muscles elicited palpable and/or visible local twitch responses (LTRs). Three weeks following the final treatment session, the patient completed the post-intervention neck disability index, and headache disability index questionnaires. Finally, as a result of her favorable clinical outcome, the patient was discharged from care (Figure 2).

Table 2:
*Pre-intervention and Post-intervention
Neck Disability Index (NDI), and
Headache Disability Index (HDI) Scores*

Outcome Measure	Pre-Intervention	Post-Intervention
NDI	42/100	10/100
HDI	62/100	34/100

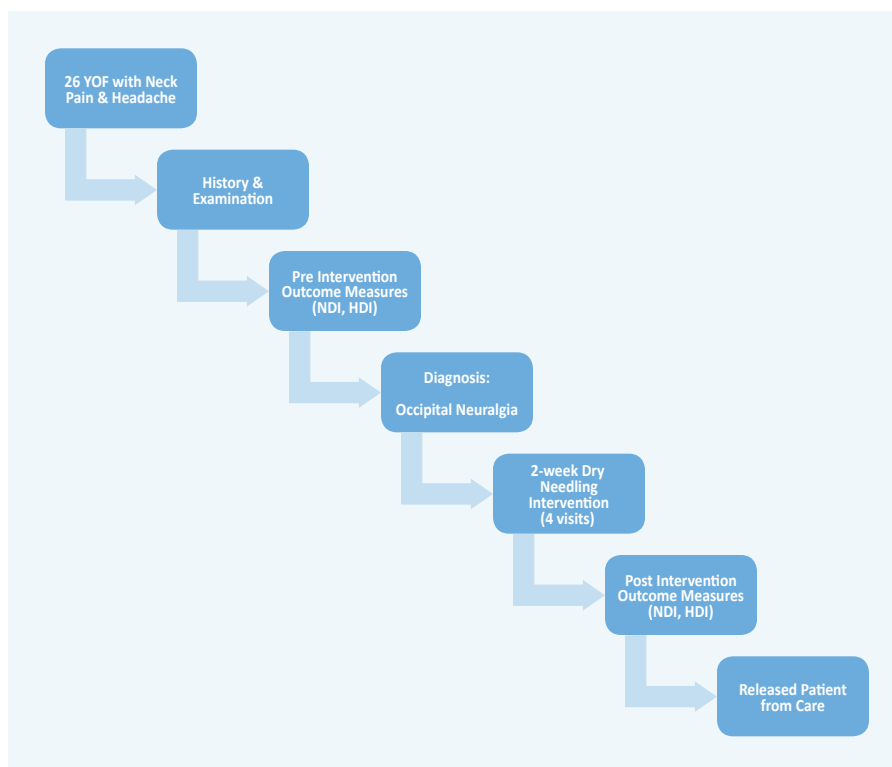


Figure 2:

Patient flow diagram outlining course of care and collection of outcome measures.

Discussion

A. Occipital Neuralgia

Anatomy

As previously discussed, occipital neuralgia may involve the greater occipital nerve, lesser occipital nerve, third occipital nerve or a combination of these neural structures (Figure 1).¹⁻³ The greater occipital nerve derives from the medial branch of dorsal ramus of C2 while the lesser occipital nerve arises from branches of C2 and C3 in the cervical plexus.¹⁹ Lastly, the third occipital nerve originates from the medial branch of C3.¹⁹ Sensory innervation of greater occipital nerve consists of the cutaneous region on the posterior scalp between the external occipital protuberance and the vertex.¹⁹ The lesser occipital nerve provides cutaneous innervation to the lateral region of the scalp posterior to the ear whereas the third occipital nerve

innervates the upper cervical spine and inferior occipital regions.¹⁹

Pathophysiology

Presently, the precise etiology of occipital neuralgia remains unclear with most cases presenting as idiopathic. However, proposed mechanisms of onset for occipital neuralgia include trauma, muscular entrapment, structural lesions or secondary diseases such as multiple sclerosis and myelitis.²⁰⁻²⁴ Based upon the potential presence of structural or organic etiologies associated with occipital neuralgia, neuroimaging modalities such as magnetic resonance imaging (MRI) may be indicated to rule out serious pathology.²

Clinical Presentation

The clinical presentation for occipital neuralgia has been described by the International Headache Society (IHS)

Table 3:

IHS Diagnostic Criteria for Occipital Neuralgia¹

Reproduced from: *International Classification of Headache Disorders, 3rd edition. Cephalalgia: An International J Headache. 2013;33(9):629-808. With permission: SAGE Publications.*

A.	Unilateral or bilateral pain fulfilling criteria B-E
B.	Pain is located in the distribution of the greater, lesser and/or third occipital nerves
C.	Pain has two of the following three characteristics: 1. recurring in paroxysmal attacks lasting from a few seconds to minutes 2. severe intensity 3. shooting, stabbing or sharp in quality
D.	Pain is associated with both of the following: 1. dysaesthesia and/or allodynia apparent during innocuous stimulation of the scalp and/or hair 2. either or both of the following: a. tenderness over the affected nerve branches b. trigger points at the emergence of the greater occipital nerve or in the area of distribution of C2
E.	Pain is eased temporarily by local anaesthetic block of the affected nerve
F.	Not better accounted for by another ICHD-3 diagnosis.

including specific diagnostic criteria (Table 3). Also, according to the IHS, the pain associated with occipital neuralgia may extend to the fronto-orbital area via trigeminocervical interneuronal networks in the trigeminal spinal nuclei.¹ In addition to the IHS criteria, patients may demonstrate a positive Tinel’s sign with repeated tapping over the occipital condyle producing numbness and/or tingling.²

Differential Diagnosis

As previously stated, differential diagnoses for occipital neuralgia include cervicogenic, migraine, cluster and tension-type headaches. These headache disorders closely resemble the clinical presentation associated with occipital neuralgia, particularly cervicogenic headache. For example, both occipital neuralgia and cervicogenic headache may present with pain the upper cervical and occipital regions. However, the pain associated with cervicogenic headache is often described as dull, while the pain description for occipital neuralgia is usually expressed as sharp, stabbing or shooting.² In light of the IHS diagnostic criteria for cervicogenic headache (Table 4), it becomes

apparent that the clinical presentations for cervicogenic headache and occipital neuralgia overlap, thus creating a diagnostic challenge.¹ The diagnostic hallmarks of migraine headache (with or without aura) include unilateral location with *pulsating* quality of moderate or severe pain intensity and aggravated by or causing avoidance of routine physical activity, while cluster headaches present as brief, severe, unilateral headaches with associated lacrimation, rhinorrhea, facial sweating along with myosis and/or ptosis.¹ The clinical presentation for tension-type headache includes bilateral location with a pressing or tightening (*non-pulsating*) quality of mild or moderate intensity.¹ Thus, mindful clinical evaluation is needed to ensure the correct diagnosis for a particular headache presentation.

Management

As outlined earlier, management considerations for occipital neuralgia may include pharmacology, conservative care, interventional therapies and/or surgery. With regards to pharmacological approaches, previous literature describes using non-steroidal anti-inflammatory drugs (NSAIDs), muscle relaxers, tricyclic antidepressants, and

Table 4:

IHS Diagnostic Criteria for Cervicogenic Headache¹

Reproduced from: *International Classification of Headache Disorders, 3rd edition. Cephalalgia: An International J Headache. 2013;33(9):629-808. With permission: SAGE Publications.*

A.	Any headache fulfilling criterion C
B.	Clinical, laboratory and/or imaging evidence of a disorder or lesion within the cervical spine or soft tissues of the neck, known to be able to cause headache
C.	Evidence of causation demonstrated by at least two of the following: <ol style="list-style-type: none"> 1. headache has developed in temporal relation to the onset of the cervical disorder or appearance of the lesion 2. headache has significantly improved or resolved in parallel with improvement in or resolution of the cervical disorder or lesion 3. cervical range of motion is reduced and headache is made significantly worse by provocative maneuvers 4. headache is abolished following diagnostic blockade of a cervical structure or its nerve supply
D.	Not better accounted for by another ICHD-3 diagnosis.

antiepileptics to manage occipital neuralgia.^{2,7} Conservative or non-pharmacological interventions targeting abnormal muscle tone involve rest, cryotherapy or thermotherapy, soft-tissue massage, and physical therapy.⁷

Interventional therapies (ITs) for managing occipital neuralgia consist of injections, pulsed radiofrequency ablation, and occipital neurostimulation.^{2,6,7,25} Briefly expanding on these ITs, injection or infiltration of the greater occipital nerve or lesser occipital nerve with anaesthetic (i.e., lidocaine) is considered diagnostic for occipital neuralgia, but also therapeutic by providing transient pain relief.^{20,25} In addition, botulinum toxin type A is another infiltrate that has been reported as beneficial for managing occipital neuralgia.²⁶ According to Dougherty, pulsed radiofrequency (PRF) exposes afferent nerve endings to intermittent short duration, high-voltage radiofrequency signals creating a low-intensity electrical field around sensory nerves, thus modulating pain via ablation or degeneration.² Lastly, occipital neurostimulation involves implantation of electrodes in the occipital region that produce paresthesia with resultant pain modulation in the distribution of the occipital nerves.²⁷

Previous research indicates surgical excision of the greater occipital nerve may provide pain relief for occipital neuralgia.⁵ However, this surgical procedure should only be considered as a last resort in response to unsuccessful attempts to resolve pain via other interventions.⁵

B. Dry Needling

As previously mentioned, dry needling (DN) or intramuscular stimulation is defined as a therapeutic procedure that involves inserting a dry needle, without medication, into a myofascial trigger point with the goal of inactivating a trigger point and mitigating pain.^{9,10} By comparison, a fundamental premise of acupuncture is controlling and regulating energy flow and balance via needling of defined points.⁹ Also, acupuncture is founded on Eastern concepts, while DN is based on neurophysiological and biomechanical principles.^{9,28} However, according to scientific literature, acupuncture and DN employ the same therapeutic tool, namely a solid filament needle. For a more detailed discussion of DN and acupuncture, please review an article written by Dommerholt.⁹

By definition, a myofascial trigger point is described

as a hyperirritable point in a taut band of skeletal muscle fibers with resultant local ischemia and hypoxia along with peripheral and central sensitization.¹² A theoretical construct outlining the outcomes of DN proposes that needling of myofascial trigger points induces physiological effects that modulate muscle tension, local ischemia and hypoxia, along with peripheral and central sensitization.¹²

Previous literature describes that DN of myofascial trigger points elicits a local twitch response (LTR) thus changing muscle length and tension through regulation of spontaneous electrical activity.^{29,30} By definition, a LTR is a localized contraction within a muscle produced by an involuntary spinal reflex as a result of being stretched, injected or dry needled.¹² Also, previous research suggests that eliciting a LTR improves the clinical outcomes associated with DN.³¹ In addition to changing muscle length and tension, DN may stimulate a change in blood flow within the ischemic and hypoxic tissues of a myofascial trigger point.³² Lastly, research indicates that DN may modulate pain through peripheral and central pathways including segmental inhibition and biochemical cascades such as endogenous opioids, and serotonergic and adrenergic mediators.³³⁻³⁷

A recent systematic review and meta-analysis recommended DN for patients with upper-quarter myofascial pain syndrome, compared to sham or placebo, for reducing pain immediately following treatment and at four weeks post-intervention.³⁸ According to Vulfsons et al, DN performed by a competent clinician may be considered a safe intervention.¹³ However, mild adverse events have been reported including localized muscle soreness and hemorrhaging, or more seriously, spinal epidural hematoma.^{39,40} Evidence suggests that the incidence of severe adverse events associated with needling is very rare.⁴¹ Moreover, caution is advised while DN around potentially vulnerable anatomical structures such as those within the cervical and thorax regions.¹³

In the context of this case report, the patient presentation closely matched the International Headache Society (IHS) criteria for occipital neuralgia including unilateral, severe, stabbing, paroxysmal pain in the greater occipital nerve region with associated tenderness and myofascial trigger points. The patient presentation did not meet the IHS criteria of temporary pain relief provided by local anaesthetic block of the affected nerve. However, fol-

lowing the four sessions of myofascial trigger point dry needling in our case report, the patient reported a 32-point change on a 100-point scale in her neck disability index score along with a 28-point change on a 100-point scale in her headache disability index score. According to recent literature, the minimum detectable change (MDC) for the neck disability index is approximately 10/100 for uncomplicated neck pain and 20/100 for cervical radiculopathy.^{42,43} Also, the described clinically important difference (CID) for the neck disability index varies amongst reports ranging from 10/100 to 38/100.⁴³ In order to ascribe the effects of clinical improvement to an intervention, a patient must report a 29-point change in headache disability index scores from pre to post-intervention.⁴⁴ Thus, it appears that following four sessions of DN over two weeks, our patient experienced meaningful improvement in her neck pain and headaches.

Previous literature supports the theory that the therapeutic mechanism of pain relief following *anaesthetic* injection of myofascial trigger points might be the associated neuromechanical stimulation of the needle *itself*.^{9,11,14,31} For example, a recent study compared the effects of dry needling, lidocaine injections and botulinum toxin type A injections into myofascial trigger points of patients presenting with myofascial pain syndrome.⁴⁵ Using a *syringe* (not an acupuncture needle) for each of the three needling interventions, the researchers reported clinical outcomes such as pain pressure threshold and pain scores significantly improved in all three groups. When contrasting injection therapy with DN of myofascial trigger points, numerous investigators have proposed that “dry needling of the myofascial trigger point provides as much pain relief as injection of lidocaine but causes more post-injection soreness”.⁴⁶ Thus, using DN to manage the myofascial trigger points associated with occipital neuralgia may have implicitly met the IHS criteria of pain relief following anaesthetic block of the affected nerve.

Previous case reports using acupuncture to manage occipital neuralgia have described favorable clinical outcomes.^{8,47,48} However, to the best of our knowledge, this is the first case report describing dry needling to successfully improve clinical outcomes in a patient diagnosed with occipital neuralgia.

Limitations

As this paper describes a single case report involving oc-

occipital neuralgia and dry needling, there may be possible limitations. Although diagnosed with occipital neuralgia based upon the IHS criteria, the patient may have exhibited an alternative diagnosis or a more complex diagnosis with associated co-morbidities. Also, the clinical presentation might have mimicked another closely related condition such as cervicogenic headache. Also, it is not plausible to establish a causal relationship between DN and occipital neuralgia based upon a single case report. However, the information from this case report may stimulate critical thinking and appraisal leading to a more sophisticated experimental design examining the effects of DN in patients presenting with occipital neuralgia.

Consent

The patient provided written informed consent acknowledging permission for publication of this case report. A copy of the written consent is accessible for review from the Editor of this journal.

Authors' Contributions

BB provided patient care along with conducting the literature review and composing the manuscript. CK also assisted with the literature review and manuscript preparation. Both authors read and approved the final manuscript.

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Sexual harassment of female chiropractors by their patients: a pilot survey of faculty at the Canadian Memorial Chiropractic College

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Background: The purpose of this study was to survey a group of female chiropractors and inquire as to whether or not they had been sexually harassed by their patients.

Methods: An online questionnaire was emailed via Survey Monkey to 47 female faculty members at the Canadian Memorial Chiropractic College (CMCC). Respondents were asked if they had been sexual harassed and, if so, the characteristics of the incident(s), their response to it, how serious they perceived the problem to be and whether or not they felt prepared to deal with it.

Results: Nineteen of 47 questionnaires were completed and returned. Of these 19, eight respondents reported being sexually harassed by a patient (all male), most commonly within the first 5 years of practice and most commonly involving a 'new' patient. It was rarely anticipated. The nature of the harassment varied and respondents often ignored the incident. Most respondents perceive this to be a problem facing female chiropractors.

Discussion: Although this is the first survey of its kind, this is a significant problem facing other healthcare professionals.

Historique : L'objectif de cette étude était de sonder un groupe de chiropraticiennes afin de savoir si elles avaient été harcelées sexuellement par leurs patients.

Méthodologie : Un questionnaire en ligne a été envoyé par l'intermédiaire de Survey Monkey à 47 chiropraticiennes membres du corps professoral du Canadian Memorial Chiropractic College (CMCC). On a demandé aux personnes interrogées si elles avaient été harcelées sexuellement et, si oui, quelles étaient les caractéristiques de l'incident, leur réaction face à celui-ci, la gravité du problème selon elles et si elles se sentaient préparées à y faire face.

Résultats : Sur les 47 questionnaires, 19 ont été remplis et retournés. Parmi ces 19 questionnaires, huit personnes ont indiqué avoir été harcelées sexuellement par un patient (tous des hommes), la plupart du temps au cours de leurs cinq premières années de pratique et il s'agissait le plus souvent d'un « nouveau » patient. C'était rarement anticipé. La nature du harcèlement variait et les chiropraticiennes ont souvent ignoré l'incident. La plupart des personnes interrogées pensent que ce problème est propre aux chiropraticiennes.

Discussion : Bien qu'il s'agisse de la première étude de ce type, on a affaire à un problème important qui touche d'autres professionnels de la santé.

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Conclusions: *Among this group of respondents, sexual harassment by patients was a common occurrence. More training on how to handle it, during either a student's chiropractic education or offered as a continuing education program, may be warranted.*

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KEY WORDS: harassment, sexual, chiropractor, patient, chiropractic

Introduction

Chiropractic licensing bodies across Canada and the United States have enacted very stringent standards of practice with respect to boundary violations between chiropractors and their patients, and the penalties for this type of professional misconduct are among the most severe in the regulatory world.^{1,2} Boundary violations are referred to as sexual harassment, sexual misconduct, sexual impropriety, sexual violation or sexual abuse- depending on the jurisdiction and the nature of the transgression.² Actions deemed to be boundary violations run the gamut from idle chatter of a sexual nature, offensive jokes, suggestive or insulting sounds (whistling, 'wolf' or 'cat-calls'), improper gowning procedures, inappropriate comments about a patient's appearance or sexual orientation, inquiries into their sex life, sexual fantasies or preferences all the way to overtly sexual acts.² Inappropriate sexual acts can include kissing and hugging to penetrative sexual activities or masturbation of the doctor by the patient or of the patient by the doctor. If proven, penalties typically involve reprimands, suspension of a doctor's certificate of registration or, in the case of Ontario, Canada a mandatory revocation of licensure for five years. Repeat offenders face permanent revocation. Estimates vary, but a recent jurisdictional review by the Health Professions Regulatory Advisory Council² in Ontario reported a prevalence of between 4% and 10%, a rate of recidivism of up to 80% and the typical profile of an offender to be a Caucasian male between the ages of 45 and 55 years old.

But what if the patient initiates the boundary violation toward the doctor? Given that chiropractic care is, by its very nature, among the most intimate forms of health-

Conclusions : *Parmi ce groupe de personnes interrogées, le harcèlement sexuel provenant de patients est fréquent. Une meilleure formation sur la manière de gérer le problème peut être justifiée, que ce soit au cours d'une formation d'étudiants en chiropratique ou en tant que programme de formation continue.*

(JCCA 2015; 59(2):111-121)

MOTS CLÉS : harcèlement sexuel, chiropraticienne, patient, chiropratique

care since it involves direct physical contact between the doctor and patient, there is certainly the possibility that a patient may misconstrue the motivation of the doctor's actions. Although this area of health care is under-investigated (see discussion below) the data that does exist point to a common and often serious problem.

If a patient initiates a boundary violation of the doctor-patient relationship, this would constitute a form of sexual harassment. The Canadian Public Health Association (CPHA) defines sexual harassment as "*any unwanted or unwelcome behavior about sex or gender that interferes with a person's life and makes him/her uncomfortable, even if the harasser says he/she was only joking*".³ Table 1 lists the kinds of behaviors that would constitute sexual harassment according to the CPHA.

Table 1.
Examples of behaviors considered to be sexual harassment by the CPHA³

Rude jokes, sexual remarks, spreading rumors
Sexual put downs
Cat calls, rating appearance, whistling
Insults about sexual orientation
Bragging about sexual relations
Any forced sexual conduct (touching, patting, grabbing, kissing)

Twenty years ago a California federal appeals court ruled that a hostile work environment should be assessed not from the perspective of a 'reasonable person' but from the standpoint of a 'reasonable woman'.⁵ While both men and women are the targets of sexual harassment, the majority of complaints come from women⁴ and the majority of studies investigating the incidence of characteristics of patient-initiated sexual harassment involve female practitioners (see Discussion below).

The purpose of this study was to survey a group of female chiropractors employed by the Canadian Memorial Chiropractic College (CMCC) and ascertain whether or not they had been sexually harassed by their patients and, if they had been, what were the circumstances and characteristics surrounding the incident.

Methods

Study Approval

This study was approved by the Ethics Review Board of CMCC.

Inclusion Criteria

An online questionnaire was emailed via Survey Monkey to all female chiropractic faculty members ($n=47$) at CMCC, since this was a convenient and readily accessible survey sample. Inclusion criteria were being a woman, being employed at CMCC, being a chiropractor and being involved with, or having been involved in, direct patient care. Participants were selected from the faculty database at CMCC and were contacted via faculty email.

Study Design

A cover letter explaining the purpose of the survey as well as the definition of sexual harassment as defined by the CPHA was sent to all female chiropractic faculty. The questionnaire included both multiple choice and short answer questions with the option of a confidential interview following the survey. The survey was modeled after the survey administered to female medical physicians practicing in Ontario, Canada in the early 1990s.⁶

In addition to general demographic information (e.g. respondent's age, years in practice, type of practice) the survey inquired whether or not the clinician had experienced any form of sexual harassment while in a clinical setting (i.e. not during their private every-day lives) and,

if so, to provide details of the nature of the incident(s). Respondents were also asked to list the age of the doctor at the time of the incident(s), how many years the doctor had been in practice at the time, what length of time the 'harasser' had been a patient at the time of the incident, the patient's gender, what action (if any) was undertaken by the doctor, if the event was anticipated, and if the doctor felt adequately prepared to handle these types of situations. Respondents were also asked to rate how severe they believed this problem is among female chiropractors on a 4-point rating scale (with '0' being 'not a problem' and '4' being a severe problem). An 'additional comments' section was made available for each question. Respondents were asked if they would be willing to be interviewed by the investigators at a later day. If they opted to be interviewed, respondents were asked to self-identify themselves, thus permitting the investigators to contact them separately.

Beta testing of the Survey

The survey was not beta tested. Since it was virtually identical to the survey used by Schneider and Philips⁶ published in the *New England Journal of Medicine* we felt it was unnecessary to beta test our survey.

Confidentiality

The respondents were not asked to identify themselves in the questionnaire. A statement of consent and confidentiality agreement was included in the cover letter. The data was collected electronically, was password-protected and was only accessible by the researchers. No incentives were made to potential respondents to participate in the survey.

Study Distribution

The questionnaire was distributed electronically via CMCC's internal email. A reminder to complete the survey was issued via email to those who did not respond within the first 10 days. The survey was kept open for 30 days.

Results

Response rate

Of the 47 female chiropractors surveyed, 19 (40.4%) completed the questionnaire. None of the respondents added any 'additional comments' and none of the respondents chose to be interviewed.

Demographic Characteristics:

The respondents ranged in age from 27 to 63, with 11 (57.9%) of respondents under the age of 40. Sixteen respondents (84.2%) had been in practice for less than 20 years. Seventeen respondents (89.5%) were currently involved in clinical practice and direct patient care. [Authors' note: unlike some chiropractic colleges and universities, CMCC does not allow faculty members to have a private clinic on campus. This means faculty who are in clinical practice maintain it off-campus). The two respondents who were no longer in practice reported they have withdrawn from practice within the past 10 years. All 17 respondents who were in clinical practice reported they practiced in Toronto, Ontario. Only two respondents (10.5%) stated they were in solo practices; the other 15 respondents were in multi-doctor and often multi-discipline practices.

Harassment:

Eleven respondents (57.9%) reported being sexually harassed while in a clinical setting, and eight of these 11 respondents reported the sexually harassment was from a patient. The other three respondents stated they were sexually harassed by other chiropractors or by office staff. Table 2 describes the types of sexual harassment encountered.

Table 2:

Types of sexual harassment encountered by female chiropractors from patients (n=8)

Behavior	Number (%) of respondents
Suggestive looks	7 (36.8)
Sexual remarks	8 (47.1)
Suggestive physical gestures	4 (21.1)
Receiving inappropriate gifts	2 (10.1)
Pressure for romantic dates	5 (26.3)
Exposure of body part in a sexually suggestive way	2 (10.1)
Inappropriate brushing, touching, or grabbing	2 (10.1)
Unwanted contact	3 (15.8)
Unwanted communication	3 (15.8)
Other: compliments on make-up/hair	1 (5.3)

Age and Number of Years in Practice of Respondent when incident of Sexual Harassment took place

At the time of the incident, five respondents reported they were between the ages of 25 and 30 years old. Five respondents stated they were in clinical practice for less than five years when the sexual harassment occurred. One respondent commented that she has encountered sexual harassment at different times though out her entire career, which spanned over 30 years.

Length of time of Doctor-Patient Relationship

With respect to how long the doctor-patient relationship had been established, seven of the eight respondents who had experienced an incident of sexual harassment stated they had been treating the patient for less than six months at the time of the incident.

Response to Harassment

Three respondents stated they ignored the behavior and continued to provide care for the patient. Three other respondents stated they gave the patient a verbal warning to stop their actions and then proceeded to continue care. One respondent referred the patient to a male doctor. None of the doctors reported the incident to law enforcement (Table 3).

Table 3:

Practitioner response to harassment

Response	Number of respondents
Ignored and continued care	3
Verbal warning and continued care	3
Immediate dismissal	0
Delayed dismissal after attempted continued care	1
Legal action	0
Contacted malpractice carrier	0

Level of preparedness

When asked if the chiropractor anticipated the incident of harassment seven respondents reported they had *not* anticipated it. When asked, four of the respondents stated they felt adequately prepared to handle the incident. That said, 13 of the 19 respondents said that additional training via continuing education or during their undergraduate education at CMCC could have helped them anticipate or handle such an event better.

Perception of the Seriousness of Sexual Harassment of Chiropractor by their Patients

When asked to rate how serious a problem they believe sexual harassment by patients toward doctors is, using a 4-point rating scale with “4” being a serious problem and “0” being not a problem at all, all but one of the 19 respondents stated they perceived it to be a problem. Of the 18 respondents who thought this is a problem, 7 respondents rated the seriousness of the problem as 1/4, 7 as 2/4, 1 rated the problem 3/4 and 3 rated the seriousness of the problem as a 4/4.

Discussion

To the best of our knowledge, this is the first study that surveyed female chiropractors and inquired as to their experience with respect to being sexually harassed by their patients. A literature search did not uncover any studies such as ours; however, it did find a number of studies that investigated this issue among other healthcare providers.

In a national survey of American physical therapists, 86% reported unwelcome sexual behavior during the course of treatment, while 63% reported at least one incident of harassment towards them by the patient.⁷ A study by Pennington et al⁸ examining dental hygienists and the incidence of sexual harassment in a clinical setting found 54% of respondents reported experiencing sexual harassment. In that study, 99% of respondents who reported being sexually harassed were woman, and in 45% of cases the offender was a male patient. Another survey of 650 dental hygienists in Washington State revealed over 26% of them had personally experienced one or more forms of sexual harassment.⁹ In that study, the most frequent types of sexual harassment was ‘aesthetic appreciation’, ‘active mental groping’, ‘social touching’ and actual ‘sexual threats’. Fifty-four of respondents (all women) indicated the harasser was a male dentist/employer, and 37.1% stat-

ed the harasser was a male patient.⁹ Garbin et al⁴ reported 15% of students enrolled in a dental program in Brazil stated they had been sexually harassed by either patients or, far less frequently, by a professor (5.4% of all incidents). The study by Garbin et al⁴ was the only study to report that men were three times more likely to be sexually harassed than women.

A survey of 188 critical care nurses reported that 46% of respondents had been harassed in various ways, the most common being the recipient of offensive sexual remarks (56%), unwanted physical contact (53%), unwanted nonverbal attention (27%), requests for dates (16%) and sexual propositions (9%).¹⁰

Phillips and Schneider⁶ surveyed 1064 female family physicians in Ontario, Canada. Over 75% of respondents reported some type of sexual harassment by patients at some time during their career, usually in their own office by their own patients. A qualitative study by Schneider and Phillips¹¹ examining sexual harassment of female doctors by their patients found that in some instances “*the gender of the patient takes precedence over her occupational status and, this combined with the unique characteristics of the doctor/patient relationship, can make the practice of family medicine more conducive to sexual harassment than other professions*”.

McNamara et al¹² examined the extent of harassment toward emergency medical residents and found that 98% reported at least one occurrence of abuse or harassment, with patients being the most frequent source of these actions. Women were more likely than men to report unwanted sexual advances. Another study by Vukovich¹³ surveyed 1,802 female family physician residents in the United States. The response rate was just over 50% ($n=916$) and 32% of respondents reported being the recipient of unwanted sexual advances, 48% reported use of sexist teaching material, 66% reported favoritism based on gender, 36% reported poor evaluation based on gender, 37% reported malicious gossip, 5.3% reported punitive measures based on gender and 2.2% reported being sexually assaulted during their residency.¹³

Brogan and Schiffman¹⁴ reported that, among a group of American female physicians ($n=4,501$), 47.7% respondents reported experiencing gender-based harassment, and 36.9% experienced sexual harassment. Characteristics associated with an increase likelihood of being sexually harassed included: Being younger; born in the

United States; being divorced or separated and; having a history of depression or suicide attempts. Women who were Asian or who were currently working in a group or government setting were less likely to report being sexually harassed.¹⁴ Respondents in this study stated harassment was more common while they were in medical school. This finding was similar to a much earlier study by Komaromy et al.¹⁵

This problem is not unique to Canada or the United States. A 2013 study by Bratuskins et al.¹⁶ investigated the nature and extent of sexual harassment among female Australian general medical practitioners. A random sample of 600 female medical physicians was surveyed, using a questionnaire based on an early study by Philips and Schneider⁶; 178 completed surveys were returned. Fifty-four percent of respondents reported being sexually harassed by their patients. The most common behaviors reported were request for inappropriate examination (64.9%), inappropriate exposure of body parts (55.7%), gender-based remarks (43.3%), inappropriate gifts (42.3), sexual remarks (36.1%) and touching or grabbing (30.9%). Of those respondents who reported being sexually harassed by their patients, two-thirds (66%) reported making personal changes or changes to their consultation style. Examples of these changes include adoption of a more formal demeanor, alter or avoid performing certain examinations, keeping the personal details of their own lives more private, changing their style of dress and no longer working after hours or alone. Only 6.7% of respondents reported that they have received any form of training related to strategies to deal with sexual harassment by patients.¹⁶

Two recent commentaries^{17,18} discussed the perils to healthcare providers caused by the stalking behavior of some of their patients, and provided strategies to proactively prevent it. Preventive strategies include: being clear about the professional nature of the doctor-patient relationship; establishing clear boundaries; taking care to protect one's privacy; minimizing any personal self-disclosure; considering transferring patients whose inappropriate behavior persists; informing colleagues of any event and; considering legal action.^{17,18}

Although our pilot study had a very small number of respondents, the data collected was very consistent with the findings of previous studies reviewed above. In general, it is not uncommon for a healthcare provider to be the

target of a variety of different forms of sexual harassment. Most incidents of sexual harassment involved inappropriate remarks or comments; relatively few involved overt sexual contact and the target of this conduct was typically female practitioners.

In our study, the characteristics most commonly associated with being the target of sexual harassment were: being a more recent graduate; working with a male patient and; the likelihood of some kind of sexual harassment increased if the doctor-patient relationship was relatively new (i.e. less than 6 months). Most respondents did not anticipate the incident happening. Similar to other studies, no legal or police action was taken by any of the respondents. Unfortunately, when not penalized in any meaningful way, an abuser may feel emboldened to repeat the behavior with another healthcare provider. Almost all respondents consider the issue of sexual harassment in clinical practice to be a problem for female chiropractors.

Our study was accepted as a poster presentation at the 2014 Association of Chiropractic College and Research Agenda Conference (ACC-RAC) held in Orlando, Florida.¹⁹ Two of the reviews of our manuscript submission, along with several chiropractors (predominately women) who viewed our poster during the conference all commented that our study did not address the issue of the doctor's attire or appearance. Specifically, comments were raised that perhaps the doctor was dressed provocatively or inappropriately, or that the doctor in some way invited the harassing behavior upon herself. The law does not recognize this as a mitigating factor and instead focuses only on the behavior of the 'harasser'. One reviewer suggested that there ought to be a difference between a patient complimenting a doctor's appearance versus an overtly sexual remark; perhaps there should be, but the law does not make this distinction. More importantly, any inquiries into this topic area would undoubtedly itself be considered inappropriate and possibly misogynistic; it is for that reason we purposefully avoided making inquiries into the doctor's appearance or conduct.

Limitations

There were several limitations to our study. The small sample size as well as inclusion criteria restricted to female chiropractic faculty only within a single institution makes it unlikely our results are generalizable to the profession at large. There may also have been some confu-

sion with respect to our question structure. For example, a respondent may have experienced more than one incident of sexual harassment: When asked to describe the characteristics of any these incidents, the respondent may have been confused as to whether they should describe the most recent event or the most serious one. In any event, we erred in not providing more clear instructions or a better survey structure to enable respondents to describe more than one incident of sexual harassment.

In surveys such as these, respondents may suffer from recall bias or, as Wells⁵ suggests respondents may have interpreted an innocuous comment from a patient as a form of sexual harassment, depending on the respondent's cultural background. It is possible the data was skewed in that only respondents who were the target of sexual harassment were most likely to complete the survey. It is possible that a person chose not to respond to our survey since they were concerned (not without justification) that, given the small sample size, by describing their personal demographics they could be identified. Lastly no inference can be made toward male chiropractors, since they were not surveyed and, according to Brogan et al¹⁴ women may perceive certain actions as a sexual harassment whereas men would not.

Future Studies

Based on the results obtained from this study, we would redesign any future study to allow a respondent the ability to describe the characteristics of as many incidents of sexual harassment as they may have experienced. We would expand the study to include male chiropractic faculty and, ultimately, expand the study to a sample of chiropractors outside the college faculty.

Conclusions

In one chiropractic college, eight of 19 female practitioners who responded to our survey stated they had been sexually harassed by their patients while in clinical practice. All of the incidents were by male patients, most commonly occurred during the doctor's first five years in practice and if the patient was a relatively 'new' patient (less than six months). The doctors most often chose to either ignore the incident or provide a verbal warning; in only one instance was the patient referred to another (in this case male) chiropractor. In no cases was the patient dismissed from care outright. In all instances, the doctor had

no suspicion the incident was forthcoming. Respondents tended to report they perceived sexual harassment toward female chiropractors to be a problem. This may speak to a need for more training on this topic during either student undergraduate education or provided by continuing education programs. Future studies will involve both male and female chiropractors and will be better structured to allow a fulsome description of all incidents of sexual harassment experienced by respondents.

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Thank you for your participation in our survey. Please provide the following demographic information:

Age:
Gender:
Marital Status:
Years in practice:
Location of practice:
Total number of employees in clinic setting:

Please answer the following questions:

1a) Are you currently involved in active patient care as a significant part of your practice activities?

Y N

1b) If NO, when was the last time you were involved in providing active patient care as a significant part of your practice activities?

- a) within the past 5 years
- b) 10 years
- c) 15 years
- d) 20 years
- e) more than 20 years

2) Have you ever experienced any form of sexual harassment, in a clinical setting or otherwise?

Y N

3a) In accordance to the aforementioned definition of "sexual harassment", have you ever experienced sexual harassment in the clinic setting from a patient?

Y N

3b) If YES, what was the nature of the harassment? Choose all that apply.

- a. Suggestive looks
- b. Sexual remarks
- c. Suggestive physical gestures
- d. Receiving inappropriate gifts
- e. Pressure for romantic dates
- f. Exposure of part of the body in a sexually suggestive manner
- g. Inappropriate brushing, touching or grabbing
- h. Unwanted contact
- i. Unwanted communication (ex: phone calls, email, twitter, facebook, etc)
- j. Other

Additional comments: _____

4. At the time of the incident, approximately how many years had you been in practice?

- a. Less than 1 year
- b. 1-5 years
- c. 5-10 years
- d. Over 10 years

Additional comments: _____

5. At the time of the incident, what was your approximate age?

- a. 25-30 years old
- b. 31-40 years old
- c. 41-50 years old
- d. 51-60 years old
- e. Over 60 years old

5. What was the gender of the patient?

- a. Male
- b. Female

6. What was the approximate age of the patient?

- a. Less than or equal to 25 years old.
- b. 26 – 35 years old
- c. 36 – 45 years old
- d. 46 – 55 years old
- e. 56 – 65 years old
- f. 65 years and above

Comments: _____

7. What was the duration of care of the patient prior to incident?

- a. Less than 3 months
- b. 3-6 months
- c. Over 6 months

Comments: _____

8. Following the incident, what was your plan of action?

- a. Continued care
- b. Ignored and continued care
- c. Verbal warning and continued care
- d. Immediate dismissal
- e. Delayed dismissal after attempted care
- f. Legal action
- g. Contacted governing body (CPPA)

Comments: _____

9. Did you anticipate the incident of harassment?

Y N

Comments: _____

10. Did you feel adequately prepared to handle the incident?

Y N

Comments: _____

11. Do you feel that additional training or preparation for such events provided through continuing education or time in college could have helped you anticipate or handle such an event?

Y N

Comments: _____

12. How would you rate the severity of the problem of harassment of practitioners by their patients?

- a. 0 (not a problem).
- b. 1
- c. 2
- d. 3
- e. 4 (a serious problem).

Comments: _____

13. Would you be willing to participate in a confidential interview following this survey?

Y N

Thank you for your participation.

What effect does chiropractic treatment have on gastrointestinal (GI) disorders: a narrative review of the literature

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The purpose of this study was to provide a narrative review of the literature of studies describing the management of disorders of the gastro-intestinal (GI) tract using 'chiropractic therapy' broadly defined here as spinal manipulation therapy, mobilizations, soft tissue therapy, modalities and stretches. Search limiters include access to full text studies published between 1980 and November 2012 in peer-reviewed journals, English language only involving human subjects. Twenty-one articles were found that met our inclusion criteria. Retrievable articles varied from case reports to clinical trials to review articles of management options. The majority of articles chronicling patient experiences under chiropractic care reported they demonstrated mild to moderate improvements in presenting symptoms. No adverse side effects were reported. This suggests chiropractic care can be considered as an adjunctive therapy for patients with various GI conditions providing there are no co-morbidities.

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KEY WORDS: gastro-intestinal, therapy, manipulation, chiropractic

L'objectif de cette étude était d'offrir un examen narratif des documents d'études décrivant la gestion de troubles du tractus gastro-intestinal (GI) à l'aide d'un traitement chiropratique ici au sens large, comme la manipulation vertébrale, les mobilisations, le traitement des tissus mous, les modalités et les étirements. Les limites de la recherche comprennent l'accès aux textes d'étude complets entre 1980 et novembre 2012 dans les journaux révisés par des pairs en anglais concernant des sujets humains. Vingt et un articles correspondant à nos critères d'inclusion ont été trouvés. Les articles consultables vont des exposés de cas et essais cliniques aux articles de revues sur les options de gestion. La majorité des articles rapportant des expériences de patients de soins chiropratiques indiquent qu'ils ont connu une amélioration légère à moyenne des symptômes présentés. Aucune réaction indésirable n'a été signalée, ce qui laisse entendre qu'on peut considérer les soins chiropratiques comme un traitement auxiliaire pour plusieurs maladies gastro-intestinales en absence de comorbidité.

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MOTS CLÉS : gastro-intestinal, traitement, manipulation, chiropratique

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Introduction

The purpose of this paper was to conduct a narrative review of the literature that investigated the effectiveness of chiropractic treatment for gastrointestinal (GI) disorders. A previous review by Gleberzon et al¹ reviewed the literature from 2007 to 2011 that investigated the use of one type of chiropractic treatment (spinal manipulative therapy) for pediatric health conditions one of which was colic, often considered a type of GI condition effecting infants [Authors' note: there is considerable debate whether or not 'infantile colic' is a GI condition, or simply 'baby back pain' and there is debate if the method used to monitor its existence (crying time) is a subjective or objective outcome measure.¹ That debate notwithstanding, for the purposes of this report, we have included colic as a GI condition].

To the best of our knowledge, there has not been a narrative review done specifically on the topic of chiropractic treatment and GI disorders, nor has there been a systematic review that has examined chiropractic treatment of gastrointestinal disorders spanning the broad population. One advantage of a narrative review is that it enables practitioners to learn about the effect a wide variety of treatment options have (or do not have) on a condition or group of conditions- in this case GI disorders- published in various article formats, ranging from well designed clinical trials to commentaries. By contrast, systematic reviews typically exclude by design case reports, expert opinions or other source material often referred to as 'grey literature'.

There is a significant worldwide prevalence of functional gastrointestinal disorders, including irritable bowel syndrome (IBS) and chronic constipation. IBS is the most common functional bowel disorder and has a prevalence of 5–25%. Chronic constipation is a common condition with a prevalence rate in the range 1.2–27%.² Gastro-esophageal reflux disease (GERD) is a common chronic condition in which gastric contents reflux from the stomach into the esophagus, causing heartburn and other manifestations. The prevalence of GERD has been increasing worldwide, possibly due to factors such as increasing longevity, rising obesity rates, and more widespread use of medications that affect the lower esophageal sphincter.² About 7–10% of individuals in the United States experience heartburn daily, and 25–40% experience symptomatic GERD at some point during their lifetime.³

However, since many affected persons control the signs and symptoms of GERD with the use of over-the-counter medications, the condition is likely underreported.⁴ Although GERD usually affects individuals over the age of 40 years, it can develop in individuals of any age. GERD is equally common in men and women, although men are more likely to develop complications.⁴ In general, it is important to successfully manage patients GI symptoms, not only for the pain and discomfort but studies have shown patients with uncontrolled symptoms such as heartburn have a substantially impaired self-reported quality of life.⁵

Methods and Procedures

For this study "chiropractic treatment" was defined as therapy provided by a licensed chiropractor involving any combination of spinal manipulation therapy (SMT), soft tissue therapy (STT), modalities, stretching and mobilizations. "GI disorders" have been used as an umbrella term, encompassing infantile colic, constipation, GERD, inflammatory bowel disease, and colitis. Search limiters included; access to full text, review studies published in peer-reviewed indexed journals; English language; human subjects and; citations published between 1980 and November 2012. Further, there is no limit to our population of interest since gastrointestinal disorders target individuals of all ages.

The following databases were searched: Index to Chiropractic Literature, CINAHL and MEDLINE, with no date restriction up until November 2012 (English only). Index to Chiropractic Literature was searched by using the heading of "Chiropract*" or "Chiropract* treatment." Results were individually combined with the text words colic, gastro-esophageal reflux disease, inflammatory bowel disease, constipation and colitis and searched with 'AND'. Both CINAHL and MEDLINE were searched through Ebscohost. For MEDLINE we used the following MeSH terms: Chiropractic, Manipulation-Spinal, Gastrointestinal Diseases, Gastroesophageal Reflux, Colic, Inflammatory Bowel Diseases, Constipation and Colitis. Key words searched included, "Chiropract* treatment," "Chiropract*," and "Gastrointest*." For CINAHL we followed the same search strategy that we used for MEDLINE. The entire search strategy gave us numerous citations. Citations were eliminated if they did not meet the inclusion criteria, were duplicate discussions of the same study, or were not peer-reviewed articles from an in-

dexed journal. After the search parameters were applied, 19 relevant citations were collected.

We then performed reference tracking, whereby we consulted the references from our 19 previously collected articles. We managed to find an additional 2 articles that met our search criteria, giving us a total of 21 citations for review.

Inclusion Criteria

We selected to review only those studies involving human subjects of all ages. Only those articles written in English were included in this review, which may have limited the cultural and geographic diversity of our paper. Lastly, in order to be included in our review, a description of the chiropractic treatment rendered and descriptions of the outcome measures used must have been clearly stated.

Exclusion Criteria

All papers that were not written in English were excluded. Moreover, papers that did not clearly state what intervention was used and what outcome measures were used to monitor patient progress were excluded. The two authors (KA and SA) who were responsible for article retrieval had to agree that an article should be included or excluded based on the aforementioned criteria. If they could not agree, the third author (BJG) made a final decision with respect to article inclusion or exclusion.

After sorting the citations into these headings, they were further divided into subheadings based on the type of study conducted (Randomized Control Trials, case studies, case reviews etc.). Some headings had low study numbers and therefore some headings are collapsed in certain sections. Where possible, articles were ordered chronologically.

Results:

A) GERD

a. Preliminary Randomized Clinical Trial study

- i. Hains G, Hains F, Descarreaux M. Gastroesophageal reflux disease, spinal manipulative therapy and ischemic compression: a preliminary study. *J Am Chiropr Assoc.* 2007;44(1):7-19.⁶ This preliminary randomized clinical trial examined the effects of chiropractic treatment on GERD symptoms in adults. Sixty-two adult subjects currently experiencing GERD symptoms were used in

the study. The subjects were divided into 2 groups, one group receiving SMT and ischemic compression; the other was randomly subdivided into either only receiving SMT or ischemic compression. The authors concluded that both SMT and ischemic compression are effective treatments for patients experiencing GERD symptoms. SMT and IC together were effective treatments for GERD symptoms; however, IC alone is more effective than SMT alone.

b. Prospective cohort study

- i. Clinical roundup: how do you treat gastroesophageal reflux disease in your practice? *Alternative & Complementary Therapies.* 2009;15(1):31-38.⁷

The purpose of this study was to determine whether spinal manipulation provided any therapeutic effect on functional disorders of the upper gastrointestinal (GI) tract. A prospecting cohort study was conducted using a convenience sample of 83 consecutive patients with symptoms of dyspepsia for a minimum of 2 years. Treatment consisted of chiropractic SMT as well as soft tissue modalities. Results found that severity and frequency of GERD symptoms decreased without any adverse events. Intervention was most effective in patients with proven endoscopy-negative GERD.

c. Case Report

- i. Fedorchuk C, St Bernard A. Case study – Improvement in gastro esophageal reflux disease following chiropractic care and the ALCAT procedure. *Ann Vert Sub Res.* 2011;(2):Online access only p 44-50.⁸

This case report examined the effects of chiropractic care on a 42-year-old female with chronic back pain and gastroesophageal reflux disease. The patient was adjusted using diversified full spine in combination with chiropractic biophysics (CBP) mirror image adjustment and traction. Results found that after 1 year of treatment symptoms resolved but returned within 5 months after stopping treatment. She began an Antigen Leukocyte Cellular Antibody test (ALCAT) diet, and 6 months after she was symptom free again. The SF-36 self reported quality of life survey indicated a 56% improvement from when treatment began 3 years prior. The authors concluded that CBP technique and the ALCAT diet was successful in treating thoracic subluxations associated with GERD.

Table 1: GERD

Reference	Objective	Trial Design	Number of Subjects	Intervention	Outcome Measures
Hains G, Hains F, Descarreaux M. Gastroesophageal reflux disease, spinal manipulative therapy and ischemic compression: a preliminary study. <i>J Am Chiropr Assoc.</i> 2007;44(1):7-19.	To determine the effects of chiropractic treatment on GERD symptoms in adults	<i>Preliminary randomized clinical trial</i>	62	One group receiving SMT and ischemic compression; the other was randomly subdivided into either only receiving SMT or ischemic compression	Changes in GERD symptoms were reported by patients using 2 questionnaires; one recorded the patient's symptoms and the other the patient's perceived impact of symptoms on social activities.
Clinical roundup: how do you treat gastroesophageal reflux disease in your practice? <i>Alternative & Complementary Therapies.</i> 2009; 15(1):31-38.	To determine whether spinal manipulation provided any therapeutic effect on functional disorders of the upper gastrointestinal (GI) tract	<i>A prospected cohort study</i>	83	Chiropractic SMT and soft tissue modalities	Severity and frequency of their GERD symptoms
Fedorchuk C, St Bernard A. Case study, Improvement in gastro esophageal reflux disease following chiropractic care and the ALCAT procedure. <i>Ann Vert Sub Res.</i> 2011; (2):Online access only p 44-50.	To determine the effects of chiropractic care on a patient with chronic back pain and gastroesophageal reflux disease	<i>Case report</i>	1	Diversified full spine adjustments in combination with CBP mirror image adjustment and traction	SF-36 self reported quality of life survey
Alcantara J, Anderson R. Chiropractic care of a pediatric patient with symptoms associated with gastroesophageal reflux disease, fuss-cry-irritability with sleep disorder syndrome and irritable infant syndrome of musculoskeletal origin. <i>J Can Chiropr Assoc.</i> 2008;52(4):248-55.	Unspecified	<i>Case report</i>	1	SMT (HVLA)	Assessment of symptoms
Wellhausen S. Nutrition and visceral manipulations a combined approach to GERD. <i>Nutritional Perspectives.</i> J Council on Nutrition. 2008;31(1):31-2, 34.	This article explored the different management options for GERD	<i>Review</i>	Unspecified	Comparison of drugs, surgical intervention, and nutritional and visceral manipulation	Assessment of symptoms
Jackson SB. Gastroesophageal reflux disease. <i>Topics in Clinical Chiropractic.</i> 1996;2(1):24-9.	Determine the pathophysiology, incidence and etiology, clinical findings, differential diagnosis, complications, conservative management and manual approaches of GERD	<i>Review</i>	Unspecified	Unspecified	Unspecified

ii. Alcantara J, Anderson R. Chiropractic care of a pediatric patient with symptoms associated with gastroesophageal reflux disease, fuss-cry-irritability with sleep disorder syndrome and irritable infant syndrome of musculoskeletal origin. *J Can Chiropr Assoc.* 2008; 52(4):248-55.⁹

3-month-old female patient presented with multiple symptoms of colic, plagiocephaly (flattening of subject's right occiput) and torticollis. The patient was previously diagnosed with GERD by her family phys-

ician. Diversified chiropractic SMT was used to treat her spinal dysfunctions. Craniosacral therapy was used to treat her cranial distortions of the right parietal and temporal bones and the temporomandibular joint (TMJ). Notable improvement occurred with each treatment and long-term follow up revealed full resolution of GERD, irritable baby and sleep disorder symptoms.

d. Review

i. Wellhausen S. Nutrition and visceral manipulations

a combined approach to GERD. *Nutritional Perspectives: J Council on Nutrition*; 2008;31(1):31-2, 34.¹⁰ This review discusses 4 different treatments for GERD: drugs, surgical intervention, nutritional supplementation and visceral manipulation. Acid neutralizers were recommended for temporary relief of GERD symptoms. There are three common surgical treatment options for GERD: Laparoscopic Nissen Fundoplication (MC), Stretta radiofrequency procedure, and EndoCinch. Since anatomy is constant and GERD is intermittent, it is a physiological and not anatomical problem. Results found that surgical change of the anatomy may improve the symptoms. GERD patients should avoid foods causing inflammation, irritation and spasm of the longitudinal esophageal muscles. The timing, quantity and quality of ingested food all have provocative factors.

Visceral manipulation can potentially improve the functioning of individual organs, the system of organs and the structural integrity of the entire body. Corrections of cervical and thoracic subluxations are essential and should be performed before the visceral manipulations to clear any somato-visceral negative feedback. Overall, the management of GERD requires a multimodal approach for the most successful results.

ii. Jackson SB. Gastroesophageal reflux disease. *Topics in Clinical Chiropractic*. 1995; 2(1):24-9.¹¹

This review paper discusses the pathophysiology, incidence and etiology, clinical findings, differential diagnosis, complications, conservative management and manual approaches of GERD. Conservative management of GERD involves three categories: mechanical, dietary and pharmacologic. Mechanical factors that lower intra-abdominal pressure should be applied. Dietary interventions that aid in tonifying the lower esophagus sphincter (LES) should be used. Over the counter drugs may also be an option for those with persistent symptoms. Lifestyle modification, mechanical activities and dietary considerations can all help to relieve GERD.

B) COLIC

a. Single blinded Randomized control trial

i. Browning M, Miller J. Comparison of the short term effect of chiropractic spinal manipulation and occipi-

to-sacral decompression in the treatment of infant colic: A single blinded, randomized, comparison trial. *Clinic Chiropr*. 2008;11(3):122-129.¹²

This study examined the effects of chiropractic treatment on infantile colic. 48 infant subjects were recruited and randomized into two groups. One group received SMT and the other occipit-sacral decompression. Results found that the mean hours of crying per day were significantly reduced in both groups and the mean hours of sleep per day were significantly increased in both groups. The authors concluded that both SMT and OSD appear to offer significant benefits to infants with colic.

ii. Olafsdottir E, Forshei S, Fluge G, Markestad T. Randomised controlled trial of infantile colic treated with chiropractic spinal manipulation. *Arch Dis Child*. 2001;84:138-141.¹³

This randomized controlled trial examined the efficacy of chiropractic spinal manipulation in the management of infantile colic. 86 infants were used in a randomized, blinded, placebo controlled clinical trial. The results showed that 32 of the 46 infants in the treatment group and 24 of the 40 in the control group showed some degree of improvement. The authors concluded that chiropractic spinal manipulation is no more effective than placebo in the treatment of infantile colic.

iii. Wiberg J, Nordsteen J, Nilsson N. The short-term effect of spinal manipulation in the treatment of infantile colic: a randomized controlled clinical trial with a blinded observer. *J Manip Physiol Ther*. 1999;22(8):517-522.¹⁴

This study examined the short-term effects of spinal manipulation for the treatment of infantile colic. Fifty colicky infants were recruited and randomly assigned to either the dimethicone treatment group or the spinal manipulation group. The authors concluded that spinal manipulation is effective in relieving infantile colic.

b. Longitudinal/Prospective Studies

i. Davies NJ, Jamison JR. Chiropractic management of irritable baby syndrome. *Chiropr J Austr*. 2007;37(1):25-9.¹⁵

This study is comprised of 3 chiropractic community-based clinics that specialize in the area of chiropractic pediatrics. A chiropractic adjustment was given to each subject based on detected subluxations.

Table 2: COLIC

Reference	Objective	Trial Design	Number of Subjects	Intervention	Outcome Measures
Browning M, Miller J. Comparison of the short term effect of chiropractic spinal manipulation and occipito-sacral decompression in the treatment of infant colic: A single blinded, randomized, comparison trial. <i>Clinic Chiropr.</i> 2008;11(3):122-129.	Comparison of the short term effect of chiropractic spinal manipulation and occipito-sacral decompression in the treatment of infant colic	<i>Single blinded Randomized control trial</i>	48	SMT and occiput-sacral decompression	Daily hours of crying of sleeping
Olafsdottir E, Forshei S, Fluge G, Markestad T. Randomised controlled trial of infantile colic treated with chiropractic spinal manipulation. <i>Arch Dis Child.</i> 2001;84:138-141.	Examination of the efficacy of chiropractic spinal manipulation in the management of infantile colic	<i>Single blinded Randomized control trial</i>	86	SMT and placebo adjustments	At each visit the parents described the effect of the last visit on a scale of five categories – “getting worse”, “no improvement”, “some improvement”, “marked improvement”, “completely well” – which were defined as the main outcome measure.
Wiberg J, Nordsteen J, Nilsson N. The short-term effect of spinal manipulation in the treatment of infantile colic: a randomized controlled clinical trial with a blinded observer. <i>J Manip Physiol Ther.</i> 1999;22(8):517-522.	Examined the short-term effects of spinal manipulation for the treatment of infantile colic	<i>Single blinded Randomized control trial</i>	50	SMT and dimethicone treatment	Unspecified
Davies NJ, Jamison JR. Chiropractic management of irritable baby syndrome. <i>Chiropr J Austr.</i> 2007; 37(1):25-9.	To determine if there is a relationship between chiropractic subluxations and irritable baby syndrome	<i>Longitudinal/ Prospective Studies</i>	3 Separate Clinics A. 30 B. 16 C. 5	A. Toggle Recoil, Logan Basic and respiratory assisted techniques B. Activator Technique C. Craniosacral	Unspecified
Klougart N, Nilsson N, Jacobsen J. Infantile colic treated by chiropractors: A prospective study of 316 cases. <i>J Manip Physiol Thera.</i> 1989;12(4): 281-288.	To describe the possible effect of spinal manipulation therapy on the course of infantile colic	<i>Longitudinal/ Prospective Studies</i>	316	SMT	The results were evaluated by analysis of a diary continuously kept by the mother and an assessment file comprised by interview
Hipperson A. Chiropractic management of infantile colic. <i>Clinical Chiropractic.</i> 2004; 7(4):180-186.	To examine the effects of chiropractic management of infantile colic	<i>Case series</i>	2	Diversified Chiropractic adjustments	Hours of sleep, vomiting and observation of colicky symptoms
Williams-Frey S. Management of atypical infant colic “A pain syndrome of infancy” and the emotional stress associated with it: Why treat a benign disorder? <i>Clin Chiropr.</i> 2011;14(3):91-96.	To examine the effects of chiropractic treatment on atypical infantile colic	<i>Case report</i>	1	Low force manipulative therapy in the cervical spine and low-pulsed impulses to the thoracic spine soft tissue stretching light touch cranial manipulative therapy	Resolution of symptoms
Wiberg K, Wiberg J. Retrospective study of chiropractic treatment of 276 Danish infants with infantile colic. <i>J Manip Physiol Ther.</i> 2010;33(7):536-541.	To examine the effects of chiropractic treatment of infants with infantile colic	<i>Retrospective Study</i>	276	SMT	Amount of crying time Any changes in crying
Kingston H. Effectiveness of chiropractic treatment for infantile colic. <i>Paediatric Nursing.</i> 2007;19(8):26.	To determine what evidence there is for chiropractic treatment of infantile colic and implications of this treatment	<i>Systems Review</i>	Unspecified	Unspecified	Unspecified

Clinic A favored the toggle recoil, Logan basic and respiratory-assisted techniques. Clinic B mostly used Activator technique and Clinic C used a craniosacral approach. Clinic A had 28/30 babies respond to treatment, Clinic B had 15/16 cases experience symptom relief and Clinic C had 4/5 cases resolved by the end of the study. The examiners found subluxations were present even when the babies symptoms had abated; therefore the link between chiropractic subluxations and symptoms of colic remain unproven. This study does not confirm or refute a cause and effect relationship between the chiropractic subluxation and irritable baby syndrome.

- ii. Klougart N, Nilsson N, Jacobsen J. Infantile colic treated by chiropractors: A prospective study of 316 cases. *J Manip Physiol Thera.* 1989;12(4):281-288.¹⁶

This prospective study attempted to describe the possible effect of spinal manipulation therapy on the course of infantile colic. Intervention consisted of spinal manipulative therapy to restricted articulations determined by the treating chiropractor; primarily in the upper cervical region. After 2 weeks of treatment 94% of patients had an improvement their symptoms; and at the 4 week follow up 97% of patients had improvement. This prospective study suggests that chiropractic manipulation for the treatment for infantile colic may be beneficial in most cases.

c. Case series

- i. Hipperson A. Chiropractic management of infantile colic. *Clinical Chiropractic.* 2004;7(4):180-186.¹⁷

This case series examined the effects of chiropractic management of infantile colic on 2 infants. In case 1, the infant received diversified chiropractic adjustments and 3 weeks after the initiation of chiropractic treatment the infant was sleeping 10 hours per night and was completely asymptomatic (frequency of treatment was unknown). In case 2, the infant received 6 treatments (diversified adjustments) over a 21-day period, after which the infant was also asymptomatic. The author concluded that there is a possible association between birth trauma, development of cranial and spinal segmental dysfunction and infantile colic.

d. Case report

- i. Williams-Frey S. Management of atypical infant colic

“A pain syndrome of infancy” and the emotional stress associated with it: Why treat a benign disorder? *Clin Chiropr.* 2011;14(3):91-96.¹⁸

This case report examined the effects of chiropractic treatment on atypical infantile colic. The subject of this study was a 16-week-old male infant and he was treated with low force manipulative therapy in the cervical spine as well as low-pulsed impulses to the thoracic spine. The author concluded that this case suggests a possible association between the development of cranial and spinal segmental dysfunction, muscular imbalance and consequential manifestation of symptoms of a pain syndrome in infancy.

e. Retrospective Study

- i. Wiberg K, Wiberg J. Retrospective study of chiropractic treatment of 276 Danish infants with infantile colic. *J Manip Physiol Ther.* 2010;33(7):536-541.¹⁹

This retrospective study examined the effects of chiropractic treatment of infants with infantile colic. The examination records of 749 infants from one Danish chiropractic practice were examined and 276 infants fulfilled the inclusion criteria of excessive crying spells of at least 3 hours per day. Besides chiropractic manipulation, the parents were given advice about carrying and handling their infant to avoid undue stress on the infant's spine. No apparent link between the clinical effect of chiropractic treatment and a natural decline in crying was found for this group of infants.

f. Systematic Reviews

- i. Kingston, H. Effectiveness of chiropractic treatment for infantile colic. *Paediatric Nursing.* 2007;19(8):26.²⁰

The purpose of this review was to determine what evidence there is for chiropractic treatment of infantile colic and implications of this treatment. No reports found spinal manipulation harmful to the baby or that it made symptoms worse. Wiberg et al (1999)¹⁴ conducted an RCT on infantile colic where SMT significantly reduced crying time compared to the medication group. Klougart et al (1989)¹⁶ studied 316 infants with colic and found that 94% of cases improved with SMT. Olafsdottir et al (2001)¹³ conducted a blinded study in which 100 colicky infants were assigned to either an SMT or control group. No significant difference between the two groups was found.

Table 3: COLITIS

Reference	Objective	Trial Design	Number of Subjects	Intervention	Outcome Measures
Blum CL. The resolution of chronic colitis with chiropractic care leading to increased fertility. J Vert Sublux Res (JVSR). 2003; Aug 31:5.	To examine the effects of chiropractic treatment on chronic colitis	Case Study	1	Sacro Occipital Technique including R+C factors utilizing orthopedic block placement and cervical stairstep procedures; occipital fiber analysis and treatment, bloodless surgery: chiropractic manipulative reflex technique (CMRT), and category one block placement and protocol	Symptom resolution

C) COLITIS

a. Case Study

- i. Blum CL. The resolution of chronic colitis with chiropractic care leading to increased fertility. J Vert Sublux Res (JVSR). 2003;Aug 31:5.²¹

This case study examined the effects of chiropractic treatment on chronic colitis. A 32-year-old female subject had been complaining of chronic colitis of 12 years duration. The patient was treated with the SOT method, occipital fiber evaluation and treatment, CMRT procedures for the colon, and category one protocol. The author concluded that it is difficult to extrapolate findings from one case result. However due to the prolonged nature of her inability to become pregnant the close proximity of her relief from colitis due to chiropractic care, further studies are indicated.

D) INFLAMMATORY BOWEL DISEASE

a. Descriptive study

- i. Burgmann T, Rawsthorne P, Bernstein CN. Predictors of alternative and complementary medicine use in inflammatory bowel disease: do measures of conventional health care utilization relate to use? Am J Gastroenterology. 2004;99(5):889-93.²²

This article investigated the relationship of complementary alternative medicine (CAM) alternatives used in the Canadian inflammatory bowel disease (IBD) population. The most popular CAM methods found in Canadian IBD were vitamins, herbals, diet, physical therapies (Chiropractic, massage, reflexology). With regards to demographics, no relationship between age, gender or disease diagnosis has been found; but an increase in CAM use has been found with increased disease duration. The most common symptoms being

Table 4: INFLAMMATORY BOWEL DISEASE

Reference	Objective	Trial Design	Number of Subjects	Intervention	Outcome Measures
Burgmann T, Rawsthorne P, Bernstein CN. Predictors of alternative and complementary medicine use in inflammatory bowel disease: do measures of conventional health care utilization relate to use? Am J Gastroenterology. 2004;99(5):889-93.	To determine the effect of CAM alternatives used in the Canadian inflammatory bowel disease (IBD) population	Descriptive Study	150	unspecified	Telephone survey and subjective reports

Table 5: CONSTIPATION

Reference	Objective	Trial Design	Number of Subjects	Intervention	Outcome Measures
Alacantara J, Mayer D. The successful chiropractic care of pediatric patients with chronic constipation: a case series and selective review of the literature. <i>Clinical Chiropractic</i> . 2008;11(3):138-47.	The successful outcome of chiropractic care in pediatric patients with chronic constipation	<i>Case series</i>	3	Full spine chiropractic (HVLA) and the activator technique	Self-reported bowel movement
Davis J, Alcantara J. Resolution of chronic constipation in a 7 year old male undergoing subluxation based chiropractic care: A case report. <i>J Pediatr Matern & Fam Health – Chiropr</i> . 2011;Fall (4):Online access only p 98-105.	To determine the effects of chiropractic care on a 7 year old male with headaches, neck pain and long-standing constipation	<i>Case report</i>	1	Gonstead technique	Patient’s bowel movement as reported by his mother
Horley M. Resolution of chronic constipation and neck pain following chiropractic care in a 6-year-old female. <i>J Pediatr Matern & Fam Health – Chiropr</i> . 2010(2):51-55.	Determine the effects of chiropractic treatment on a child with constipation, vertebral subluxations and neck pain	<i>Case report</i>	1	High-velocity, low-amplitude (HVLA) adjustments at specific vertebral locations were administered at the areas of vertebral subluxation	Mother and patient reported bowel movement
Quist DM, Duray SM. Resolution of symptoms of chronic constipation in an 8-year-old male after chiropractic treatment. <i>J Manip Physiol Thera</i> . 2007;30(1):65-8.	To describe the history, treatment, and proposed explanation of a positive outcome in a patient with chronic constipation	<i>Case report</i>	1	Manipulation of the sacral area using diversified adjusting procedures and External massage of the abdomen	Self-reported bowel function

treated by EDP and CAM were pain/cramps, diarrhea, gas/bloating, blood in stool, decreased energy, stress, joint pains and constipation. Subjective reports found patients’ undergoing EDP were provided symptom relief 95% of the time.

E) CONSTIPATION

a. Case Series

i. Alacantara J, Mayer D. The successful chiropractic care of pediatric patients with chronic constipation: a case series and selective review of the literature. *Clinical Chiropractic*. 2008;11(3):138-47.²³

Case Report #1 – A 21-month old 15 kg male infant with complaints of constipation since birth. Treatment of HVLA thrust and activator technique was performed 3 times a week for 3 weeks and based on patient response abated to weekly visits. Care employed immediate response. Follow up 1 year later found consistent, soft, painless bowel movements.

Case Report #2 – A 7-month old female with constipation since age of 2 months. Chiropractic care consisting of activator adjustments to areas of subluxation were given 2x/week for 3 weeks. After the 3-week treatment and at the 1-year follow up, the infant continued to have normal and unstrained bowel movements.

Case Report #3 – A 21-month old female with encopresis and severe constipation since 10 months old. Chiropractic care using HVLA thrusts to the subluxated segments were made. This resulted in immediate bowel movements. By the end of her 3-month treatment plan (frequency unspecified) the child had normal healthy bowel movements.

b. Case Report

i. Davis J, Alcantara J. Resolution of chronic constipation in a 7 year old male undergoing subluxation based chiropractic care: A case report. *J Pediatr Matern & Fam Health – Chiropr*. 2011;Fall(4):Online access only p 98-105.²⁴

This case report examined the effects of chiropractic care on a 7-year old male with headaches, neck pain and long-standing constipation. Chiropractic care was provided twice a week for 6 weeks, utilizing the Gonstead technique to the subluxations at C1, T2, and L5 was performed. Bowel relief was immediate after the first treatment. After 10 treatments, subject had almost daily natural bowel movements. The authors concluded that this case report provides supporting evidence that children with constipation may benefit from spinal adjustments to sites of vertebral subluxations.

- ii. Horley M. Resolution of chronic constipation and neck pain following chiropractic care in a 6-year-old female. *J Pediatr Matern & Fam Health – Chiropr.* 2010(2):51-55.²⁵

This case report study examined the effects of chiropractic treatment on a 6-year old child with constipation, vertebral subluxations and neck pain. The author concluded that chiropractic care was successful in increasing the frequency of bowel movement, and decreasing gastrointestinal and cervical pain in this 6-year-old patient.

- iii. Quist DM, Duray SM. Resolution of symptoms of chronic constipation in an 8-year-old male after chiropractic treatment. *J Manip Physiol Thera.* 2007;30(1):65-8.²⁶

Study involved an 8-year-old boy who underwent chiropractic treatment for his constipation. After the first chiropractic treatment the patient had almost daily, less painful bowel excretions. A follow up phone call 13 years after completion of care found the patient still having normal bowel function. This case report yielded immediate improvement of symptoms of chronic constipation with complete and permanent disappearance of symptoms after 1 month of treatments.

Discussion:

Twenty-one articles met the inclusion criteria of our study. Of these 21 studies, only 4 were randomized control trials; the other 17 were clinical trials of varying designs, case reports, case series or commentaries. With respect to safety, it appears that chiropractic treatment involving spinal manipulation therapy (SMT), soft tissue therapy (STT), modalities, stretching and mobilizations is safe to provide to individuals for treatment of GI disorders, provided there are no co-morbidities which would cause

contraindications. There were no studies that reported worsening of GI symptoms while receiving chiropractic treatment. Most studies reported patients experienced clinically meaningful improvements in their GI symptoms. Common trends show that chiropractic adjustments delivered using various chiropractic technique systems (Activator, Diversified, Thompson, Gonstead) resulted in improvements of GI symptoms. Other methods of treatment that reportedly improved patients' GI symptoms included soft tissue therapy (for example, ischemic compression), dietary changes and life style modifications.

Overall, the one randomized clinical trial (RCT) investigating the effects of diversified spinal manipulation therapy, ischemic compression and dietary alterations on patients with GERD reported significant improvement in symptoms. The use of visceral manipulations had equivocal findings.

There were two RCTs that examined chiropractic treatment for colic. Both found positive results with the use of diversified SMT and occiput-sacral decompression compared to controls. Spinal manipulation therapy was found to be significantly better at treating colic compared to over-the-counter medication. The Kingston review²⁰ was unable to confirm a relationship between chiropractic subluxations and colic symptoms; similarly, the Wiberg²² study determined that there was no link between chiropractic treatment and the management of colic.

Only one suitable study on colitis²¹ was found; hence it is unreasonable to extrapolate data from one case subject and infer it to a population. It was found that sacro-occipital technique had a positive effect on one subject's colitis²¹. Similarly, only one paper²² on inflammatory bowel disease was suitable to include in our review. That descriptive study reached the conclusion that exercise, diet and prayer were the most effective conservative methods to treat IBD.

Only case reports could be found surrounding the topic of chiropractic treatment for constipation²³⁻²⁶, all involving children. Studies that also had long-term follow-ups found that diversified, activator and Gonstead chiropractic techniques were beneficial in treating patient cases. Relative benefit of diet alterations, Thompson technique and abdominal massage were not reported. None of the case reports published found any negative findings for chiropractic treatment and constipation (that is, none reported a worsening of symptoms or adverse effects).

Limitations:

Most studies provided a thorough explanation of the type of chiropractic therapy used for patient care in terms of chiropractic technique system, frequency of sessions and duration of each intervention and location of the intervention (i.e. site of care); however other important details of treatment were often absent. Dietary modifications, soft tissue techniques and exercise routines were found to be effective for GI symptoms, but details of each therapy were often vague. Without being able to follow the study treatment plans employed, the usefulness of these papers in terms of reproducibility is questionable. With regards to over-the-counter medication treatments, the names and doses of the drugs were not included in some of the studies.

Although we performed reference tracking, we did not hand search all journals to identify articles that may have been missed by electronic searching, since that relies on the appropriate selection of keywords. In other words, it is possible we did not locate other articles that would have met our inclusion criteria due to the keyword used by the authors. Finally, as previously mentioned, non-English language articles were not included and therefore relevant studies might have been missed.

Conclusion:

The number and quality of research papers found for this narrative review were not high enough, and the studies that did exist were often not robust enough with respect to their design, in order to draw any concrete conclusions regarding the effectiveness of chiropractic treatment on gastrointestinal disorders. There were no reports of either worsening of symptoms or other adverse reactions by patients receiving various types of chiropractic therapy. Therefore, it would be fair to state that chiropractic therapy can be used as an adjunct to other forms of conventional treatment of GI disorders.

It is quite evident that there is a significant gap in the evidence base regarding chiropractic therapy for GI disorders, especially evidence coming from well-controlled clinical trials. Bearing that in mind, there is not currently any defensible treatment protocols or guideline that can be provided to practitioners to assist them in making reasonable choices with respect to chiropractic care planning decisions for patients with GI disorders.

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R + C Factors and Sacro Occipital Technique Orthopedic Blocking: a pilot study using pre and post VAS assessment

Charles L. Blum, DC*

Introduction: The concept of a systematic or predictive relationship between distant vertebral levels distinct from accumulative functional compensatory mechanisms, such as in scoliosis, has been perpetuated within chiropractic technique systems based on clinical observation and experience. This study seeks to investigate this relationship between the cervical and lumbar vertebrae.

Methods: Patients (experimental group n=26 and control group n=12) were selected from the patient base of one office, and were limited to patients that had sensitivity at specific cervical reflex points. Using a pre and post outcome measurement and sacro occipital technique R + C protocols, the related lumbar vertebra was adjusted in the direction indicated by the cervical vertebral sensitivity.

Results: Statistical analysis revealed there was a statistically significant difference between pre- and post-VAS measurements and found that the notable difference in mean change in VAS scores were statistically significantly different between the experimental and control groups ($p < .001$).

Conclusion: The findings of this study suggest that further research into cervical and lumbar vertebra interrelationships, and the efficacy of orthopedic block

Introduction : Le concept d'une relation systématique ou prédictive entre les niveaux distants vertébraux distincte des mécanismes compensatoires fonctionnels cumulatifs, comme en cas de scoliose, a été perpétué dans les systèmes de techniques chiropratiques fondés sur des observations cliniques et sur l'expérience. Cette étude cherche à examiner la relation entre les vertèbres cervicales et lombaires.

Méthodologie : Les patients (groupe expérimental n=26 et groupe de contrôle n=12) ont été choisis parmi la clientèle d'un bureau, et se limitaient à ceux qui avaient une sensibilité à certains points de réflexe cervical. À l'aide d'une mesure avant et après et des protocoles de technique sacro occipitale R + C, la vertèbre lombaire liée était ajustée dans la direction indiquée par la sensibilité vertébrale cervicale.

Résultats : Les analyses statistiques ont révélé une différence statistique importante entre les mesures avant et après VAS et ont indiqué que la différence de changement moyen des scores VAS étaient statistiquement très différente entre le groupe expérimental et le groupe de contrôle ($p < 0,001$).

Conclusion : Les trouvailles de cette étude laissent entendre que des recherches supplémentaires sur les relations entre les vertèbres lombaires et cervicales,

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treatment, may be warranted. Further studies are needed to confirm whether a causal relationship exists between lumbar manipulation and decreased cervical spine sensitivity.

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KEY WORDS: chiropractic, spine, cervical vertebra, lumbar vertebra, Sacro Occipital Technique, Lovett Brother, R+C Factors

Introduction:

Since the early 20th century, some within the chiropractic profession have posited that there is a functional relationship between the lumbar and cervical vertebrae and have incorporated this concept into methods of evaluation and treatment.¹ This concept has empirically been accepted by many chiropractors for decades and was based on the work of Robert W. Lovett.² Walther notes that, "The spine appears to function with a specific harmonious movement as an individual walks, runs, and otherwise performs daily activities... The vertebra working in conjunction with each other, such as the 1st lumbar and 5th cervical, are known as Lovett Brothers."³

As the name Sacro Occipital Technique (SOT) implies, DeJarnette a chiropractor and osteopath, found a similar relationship between the sacrum and occiput, as well as between the cervical and lumbar vertebrae.⁴ He described that a relationship exists between the atlas and the 5th lumbar vertebra, axis and the 4th lumbar vertebra and so forth, following that pattern all the way to the mid thoracic region. He called this relationship R + C (*resistance and contraction*) factors and found that each vertebrae within a pair affected one another (Figure 1).

This concept of a systematic or predictive relationship between distant vertebral levels distinct from accumulative, functional, compensatory or adaptive mechanisms, such as occur frequently in idiopathic scoliosis for example, has been perpetuated based on observation and clinical experience without published report of any systematic study. This pilot study seeks to investigate this relationship between the cervical and lumbar vertebrae.

ainsi que l'efficacité du traitement de bloc orthopédique, peuvent être justifiées. D'autres études sont nécessaires pour confirmer s'il existe une relation de cause à effet entre la manipulation lombaire et la baisse de sensibilité de la colonne cervicale.

(JCCA 2015; 59(2):134-142)

MOTS CLÉS : chiropratique, colonne, vertèbre cervicale, vertèbre lombaire, technique sacro occipitale, Lovett Brother, facteurs R+C

Methods

Patients

Patients were selected from the patient base of one office (Table 1) and were limited to those who had sensitivity at specific cervical reflex points.

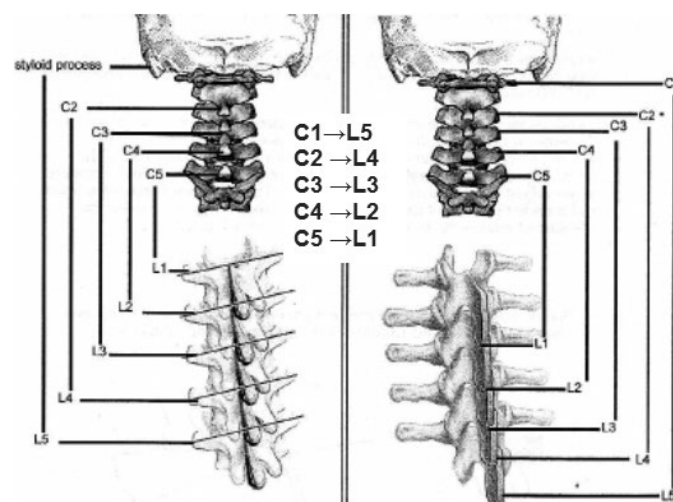


Figure 1.

R+C Factors relate to how sensitivity at the cervical vertebrae may relate to position of lumbar vertebrae. A relationship is illustrated suggesting that sensitivity at the cervical transverse process relates to an anterior rotation relating to the ipsilateral lumbar vertebrae's transverse process. Also sensitivity at the lateral cervical spinous process relates to an inferiority of the related ipsilateral lumbar vertebrae's transverse process.

Inclusion

To determine whether patients qualified for study inclusion, patients were palpated for tenderness at the cervical reflex points which are located at the temporal bone styloid processes (adjacent to C1), lateral spinous processes (C2-C7) and lateral tips of the transverse processes (C1-C7). Palpation over these bony landmarks constitutes part of the normative examination for SOT practitioners. Sensitivity to palpation over these reflex points is thought to indicate the need for lumbar ipsilateral decompression or rotational adjustment.⁴ During the normative examination, patients were asked if they felt pain or tenderness in response to approximately 1-2 pounds of digital pressure (estimated subjectively without instrumentation).

R + C palpation can be performed in the standing, sitting, supine or prone position. These cervical reflex points were determined to be positively tender or painful when the patient reported that they felt *significant* discomfort upon palpation, and that this discomfort was localized to the point being contacted (over any of the above-mentioned landmarks).

Excluded from this study were young children or any patients who had difficulty with communication or understanding questions (due to cognitive issues or language barriers).

Comparison groups

A non-randomized allocation method was used to enroll participants into two groups: an experimental group, where an adjustment was delivered after initial palpation and a baseline measurement of pain intensity, and a control group in which patients were not treated but were simply rechecked for palpatory tenderness after a brief waiting period of 3-5 minutes. Sequential patients were first enrolled into the experimental group and then into the control group.

Study maneuvers

Diagnostic Procedure

R + C Factors are reflex indicators at the cervical vertebrae used to identify vertebral rotation and lateral flexion inferiorities of the lumbar spine.⁴ Each lumbar vertebra is purported to have a corresponding "Lovett Brother" indicator in the cervical spine. The cervical vertebral reflexes can be found in any posture, but will be most prominent

when in the position that patients experience their greatest amount of low back discomfort.

Locations for orthopedic blocking and treatment

Sacro occipital technique (SOT) recommends the use of pelvic blocks and sustained pressure at the lumbar vertebra to allow the nervous system time to accommodate, the local connective tissue to remodel, and the lumbar vertebrae to experience gentle rotation or lifting pressures.⁴ The rationale for these procedures has been described in previous literature.⁵⁻⁸

Generally the Lovett Brother relationships found between the cervical and lumbar vertebrae are as follows: cervical lateral transverse process sensitivity indicates ipsilateral lumbar transverse process anterior rotation; cervical lateral spinous process sensitivity relates to ipsilateral lumbar transverse process inferiority; and, given the absence of a spinous process at C1, the temporal styloid process is used to determine inferiority of the ipsilateral L5 transverse process.⁹

Orthopedic Blocking: R + C Factors [See Figure 2]

- *Treatment of vertebral inferiorities/compression*

One method to treat inferiorities can be accomplished by placing the pelvic blocks under the ASISs bilaterally, with the blocks facing 45 degrees caudalward, with the patient lying prone. The angle of the blocks and their position tends to create a distractive affect on the lumbar and lumbosacral regions. The goal is to create a focused decompression at the level of lumbar vertebral segment malalignment, as directed by (i.e. related to) the corresponding location cervical reflex point sensitivity.

- *Treatment of vertebral rotations*

More typically, the related lumbar vertebra was adjusted opposite to the direction indicated by the cervical vertebral sensitivity (according to R + C protocol).⁴ A method of treating lumbar rotations involves the use of a block on the side opposite to that of lumbar vertebral (spinous or transverse process) rotation, with the patient lying prone. The placement of the block is usually between the ASIS and greater trochanter so as not to create any pelvic rotation along a transverse axis. The placement of the block on the contralateral side tends to create pelvic rotation along the vertical axis. Furthermore, on the side of block placement the tone of the paravertebral muscles

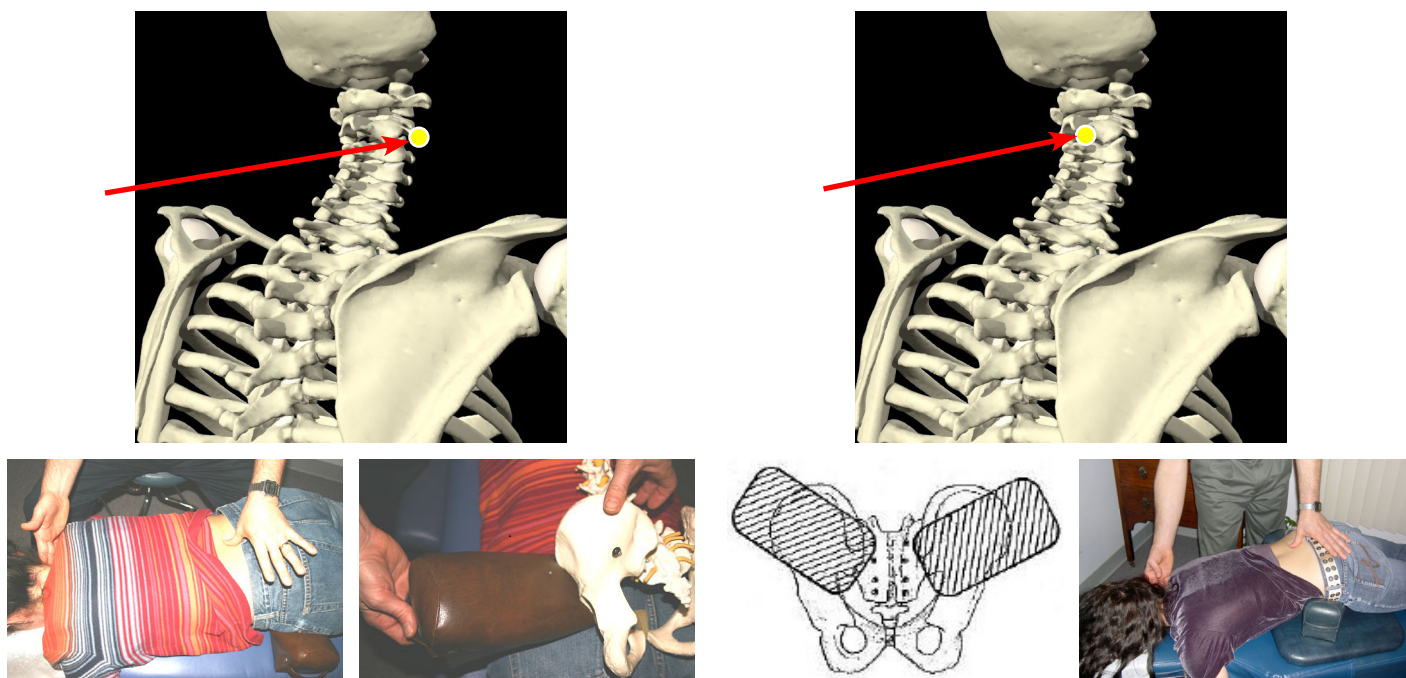


Figure 2.
Orthopedic Block Placement

Lumbar Vertebra Rotation: With lateral cervical transverse process sensitivity a pelvic block is placed with the patient prone under the contralateral pelvis (between ASIS and greater trochanter) and pressure is applied to the ipsilateral lumbar spinous process (e.g. right C2 transverse process sensitivity – pressure to L4 spinous process from right to left).

Lumbar Vertebra Inferiority: With lateral cervical spinous process sensitivity pelvic blocks are placed with the patient prone under the both ASIS (at a 45° angle inferiorward through the ASIS) and pressure is applied to the ipsilateral lumbar lamina/mamillary process (e.g. right C2 lateral spinous process sensitivity – pressure to L4 laminal/mamillary process from inferior to superior), as if to decompress and lift the vertebra.

will appear to increase. This increased muscular tone is theorized to help rotate the vertebra into its correct position or possibly, by effecting the crossed extensor/flexor reflex, relaxing the muscles holding the lumbar vertebra in rotation.⁴

Furthermore, with the block in position, the spinous, lamina or mamillary processes can be contacted to rotate the vertebra opposite to the direction indicated by the cervical vertebra transverse process sensitivity. For example, with a right C2 transverse process sensitivity, the block would be placed under a prone patient on the left side between the ASIS and greater trochanter, and the right side

of the L4 spinous process would be contacted, on the right side, with pressure directed from right to left.

Treating chiropractor

The treating chiropractor was in practice for over 30 years, and has taught and utilized sacro-occipital technique methods for that period of time, and the patients in the study were all from his practice.

Outcome

A validated instrument, the Visual Analogue Scale (VAS) (Figure 2),^{10,11} was utilized to measure patient self-re-

ported pain or sensitivity levels. The VAS has been used in studies measuring quality of life,¹² pain and trauma,¹³ risk assessments regarding risk proneness,¹⁴ and in both young and old patient populations.¹⁵ In this study, the VAS was used to measure pain/sensitivity to palpation over cervical reflex points. Both pre- and post-treatment scales employed a 10 cm line, anchored by the terms, “no pain” at one extreme, and “unbearable” (pain) at the other extreme. The patients were asked to mark the line at a position that corresponded to their current level of pain. The distance between “no pain” and each patient’s current pain intensity marking was measured on a 1-to-100 mm scale.

Timing of measurements

Baseline VAS measurements were recorded at study entry prior to any lumbar manipulation (experimental) or waiting period (control). Post-intervention VAS measurements were recorded immediately after manipulation (experimental) or a 3-to-5 minute waiting period (control). During the baseline assessment, a note was made on each patient’s study form documenting the point of vertebral contact and sensitivity (VAS measurement). To improve the reliability of the reflex point assessments, patients were asked to help confirm (to the best of their abilities) that the points of contact were consistent between the baseline and post-intervention evaluations.

The attempt to find a sham and provide a control for manual treatment is often fraught with difficulty.¹⁶ Therefore, in lieu of using a direct sham intervention, patients in the control group were simply left untreated during a brief waiting period. However, all selection criteria, and manual palpation and assessment maneuvers were standardized between the two groups. As with the experimental group, only patients who had a positive response to cervical reflex palpation were asked to be part of the control group. Between the two VAS administrations, patients’ histories, ranges of motion, and results of palpation to elicit sensitivity, as well as other tests were performed. In the control group, lumbar manipulative therapy was eventually administered as indicated by the normative examination, but only after a brief waiting period and repeated administration of the VAS.

Statistical Methods

Data were assessed for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Results of these

statistical tests were used to determine whether we could use parametric or nonparametric testing. To test for between group differences in the pre-test VAS scores an independent t-test analysis was used. Pre-test and post-test VAS scores were compared and tested using an independent t-test and confirmed using the Mann-Whitney statistic. An analysis of covariance was performed to control for baseline differences in VAS scores between groups.

Ethics

All patients signed a consent form which explicitly informed them that while participating in the study their normal care would not be affected apart from possibly taking a few minutes longer to complete their scheduled visit. Institutional review board approval for this study was received from Cleveland Chiropractic College.

Results:

Two children, ages 2 and 4 years old, were excluded. Another 4 patients were excluded because no sensitivity was noticed to palpation. This left 26 patients in the treatment group and 12 patients in the control group.

A total of 38 patients were enrolled into this pilot study; 26 into the experimental group and 12 into the control group (Table 1). Raw data from the VAS recordings were entered into SPSS, version 12.0 with 10% of observations being checked for accuracy. The data was checked for normality to determine whether parametric testing would be appropriate. Both the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that the data was normally distributed. We tested whether there was a statistically significant difference between mean VAS at baseline (Table 2). An independent t-test demonstrated that there was no statistically significant difference ($p=.189$) between groups. Although there was no statistically significant difference, there was an 8 point difference in the point estimates between groups, which was potentially clinically significant. Consequently, we also performed an analysis of covariance (ANCOVA) to compare the post-intervention means, while controlling for the difference in baseline VAS scores between groups. Also, upon comparing the pre-to-post changes in VAS measurements between groups, we found a statistically as well as clinically, important difference between groups (Table 2). Specifically, the decrease in sensitivity to palpation, as measured by

the VAS, was significantly greater in the experimental group ($p < .001$). Non-parametric test (Mann-Whitney U) was also significant ($p < 0.001$), confirming statistical significance. After controlling for baseline differences in VAS between groups a statistically significant difference ($p = 0.001$) was found between pre and post VAS measurement between the treatment and control groups using an ANCOVA test.

Table 1:
Number and sex distribution per group

Experimental Group	n	Mean age
Male	15	46
Female	11	39
Control Group		
Male	4	45
Female	9	47

Table 2:
*Mean change in pre and post VAS
per Experimental and Control Groups*

	Mean Pre-test VAS Measurement	Mean Post-test VAS Measurement	Mean Change in VAS
Experimental Group (n=26)	40.7 (SD 21.1)	14.4	-26.4
Control Group (n=12)	32.5 (SD 15.7)	31.6	-0.9
t-test (unadjusted)	$p = .189$	$p < .001$	$p < .001^*$
ANCOVA (adjusted)		$p = .001$ $\eta_p^2 = .292^{**}$	

* From parametric as well as non-parametric t-test for independent samples

** η_p^2 = partial eta-squared

Discussion:

While the Lovett Brother concept has been accepted by some within the field of chiropractic, there is a clear lack of research evidence to support its clinical existence. Why or how could localized points on cervical vertebrae be related to positions of the lumbar vertebra?

Some biologically plausible theories for the R + C Factors and its clinical treatment via blocking have been proposed.¹ These theories vary from myofascial¹⁷⁻²⁵ and myological²⁶ interrelationships, referred pain patterns²⁷⁻²⁹, facilitating tonic neck reflexes involving intersegmental spinal pathways,³⁰ as well as postural righting mechanisms involving the cervical spine as well as proprioceptive and plantar mechanoreceptors³¹. Optic feedback or gaze has been found to be associated with cervical³² and lumbar³³ spine accommodation. Dental occlusion has also been found to affect gaze and body posture.³⁴ However, in addition to gaze or optic feedback, there have also been some studies that have found vestibular, labyrinth and plantar mechanosensor relationships between posture and proprioceptive influences.³⁵⁻³⁸

It is possible that the R + C reflex points constitute complex neurological and myological interrelationships that are related to multifactorial influences. Some clinical findings have suggested that while lumbar vertebral dysfunction could affect its cervical component, it is possible that cervical vertebral dysfunction could also affect its lumbar component.³²

Various studies have found a clinical relationship between the lumbosacral spine and cervicocranial regions. Chinappi and Getzoff found that integrated dental orthopedic and craniochiropractic care ameliorated the lumbosacral pain and improved head, jaw, neck and back function.³⁹ Kessinger in another study noted a relationship between the effect of treatment to the cervical spine and improvement of lumbar spine ranges of motion.⁴⁰ Giggey and Tepe in their study showed a statistically significant improvement in cervical isometric extensor strength following orthopedic lumbosacral block placement.⁴¹

While some degree of biological plausibility may be present to support a relationship between the lumbar and cervical regions, what is challenging to understand is how thumb pressure for minutes to a lumbar vertebra along with pelvic block placement, could have a relative change in cervical vertebral sensitivity within seconds. A study by Meier et al found that thumb pressure to the lumbar

spinous processes had relatively immediate responses in the cortex and cerebellum.⁴² Theoretically this change in cortical and cerebellar activity could simultaneously affect cervical spine sensitization and accommodative function. Also Jonckheere et al described an electrophysiological phenomenon running up and down the spine that is elicited by pressure to the spine at specific points. They suggested that this electrophysiological phenomenon is associated with a standing spinal wave found in both normal and quadriplegic subjects. They suggest that “a standing spinal wave demonstrates that the neuronal circuitry is embedded in the spine”,⁴³ which combined with the Meire et al’s findings, may help us better understand this complex lumbar and cervical vertebra relationship.

Even though this study focused on the use of orthopedic pelvic block placement and evaluating levels of pain sensation at related cervical vertebrae, other studies might also be performed utilizing other chiropractic treatment methods, such as diversified adjusting methods. Using the cervical vertebrae sensitivity as described in this study could function as a pre- and post-assessment tool to help guide the direction or vector for the diversified adjustment to the lumbar spine, as well as help determine if the adjustment was sufficient to help reduce the cervical vertebra sensitivity. There may be an advantage to using pelvic blocks and a sustained thumb or finger contact to the lumbar spine because the lumbar osseous landmark (spinous or transverse process) is maintained continuously, minimizing fascial glide off of the lumbar contact. Sometimes a change of sensitivity at the cervical spine may be affected by a change of vector at the lumbar vertebra contact, and this could be utilized as a pre-assessment with either block or diversified techniques. Reducing cervical vertebrae sensitivity by directing force to specific lumbar vertebra and in specific vectors may help localize the optimal vertebrae and direction of correction, regardless of the technique utilized. Also theoretically, by adjusting the lumbar spine using the cervical indicators as guides, this may help improve function and relieve pain in the cervical spine with patients in whom cervical spine adjusting is contraindicated.

While this study appears to indicate that a relationship between pressure to the lumbar spine or its position may have an affect on related cervical spine sensitivity, what is important to determine is whether this has clinical significance. Currently there is limited low level evidence that

supports this clinical relationship. Therefore future studies investigating lumbar and cervical vertebral reflex relationships will need to determine whether this relationship is clinically meaningful, let alone causal in nature.^{1,5,8,9,44}

Limitations:

There are a multitude of limitations to the internal validity, reliability and generalizability of the findings derived from this practice-based pilot study that has initially demonstrated some relationship between R + C analysis results and orthopedic block treatment. First, the doctor, who was an unblinded practitioner and assessor in this study, may have exhibited an unconscious bias in placing too much pressure initially and less pressure post treatment. This would have to be amended in a future study by having an independent and blinded baseline assessor, as well as a blinded follow-up assessor to administer both the reflex point assessments, and the VAS measurements. Second, the control group procedure was not an appropriate ‘sham’ intervention and therefore did not replicate any of the potential contextual effects and/or other placebo effects that might have been associated with the experimental treatment. Third, a lack of randomization may have impacted the author’s ability to create similar groups with respect to other important confounding variables.

For a larger definitive study, greater clarity will be needed regarding subject recruitment and appropriate inclusion and exclusion criteria. In addition to the aforementioned sources of bias, a concealed randomization sequence will be needed to prevent any recruiting practitioner(s) from selectively enrolling participants in a manner that would favour the preponderance of prognostically *better* (i.e., prognostically more optimistic or responsive) participants within the experimental group. Furthermore, the use of a sham treatment protocol is recommended in order to simulate (and therefore control for the effects of) placebo or other contextual effects potentially associated with SOT therapy. Similarly, the recruitment of treatment-naïve participants into both arms would be helpful to keeping participants blinded to their allocated treatment, while simultaneously minimizing bias due to the effects of differential treatment expectations, and/or differential treatment preferences between the experimental and control arms. Also at this time there are no cross-sectional research studies assessing the validity and/or reliability of this particular diagnostic technique.

Beyond the obvious limitations of a poorly controlled study such as this, many questions arise as to what else may potentially explain the observed association between lumbar manipulation and reduced sensitivity in the cervical spine. More importantly, are non-validated clinical procedures such as those used in the current study--developed decades ago no less--clinically meaningful? Furthermore, are there other clinical indicators for monitoring actual anatomical positions of the vertebra that can be measured through or corroborated by radiographs and MRI? While clinical anecdotal reports on SOT procedures have suggested improved levels of patient reported pain, increased functionality, and reduction of disc herniation, sufficient study into this method of diagnosis and treatment has not been adequately performed to allow for definitively strong conclusions to date. The findings of this pilot study suggest that further research into cervical and lumbar vertebral interrelationships, as well as orthopedic block placement and treatment, may be warranted to determine the genuine reliability, validity, and efficacy of this particular system technique.

Conclusion:

This pilot study has attempted to investigate a relationship between SOT's R + C Factors method of diagnosis and lumbar spine dynamics. Following orthopedic block placement and pressure to the lumbar spine, the cervical spine reflex areas were contacted to determine if there was a change to treatment. In most cases there was a lessening to pain upon palpation following treatment as compared to the control group with findings reaching statistical significance. However, this study was affected by several methodological limitations and important threats to validity. The results of this must be interpreted extremely cautiously, but represent a valuable beginning for future studies.

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Use of spinal manipulation in a rheumatoid patient presenting with acute thoracic pain: a case report

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Background: There is limited research related to spinal manipulation of uncomplicated thoracic spine pain and even less when pain is associated with comorbid conditions such as rheumatoid arthritis. In the absence of trial evidence, clinical experience and appropriate selection of the type of intervention is important to informing the appropriate management of these cases.

Case presentation: We present a case of a patient with long standing rheumatoid arthritis who presented with acute thoracic pain. The patient was diagnosed with costovertebral joint dysfunction and a myofascial strain of the surrounding musculature. The patient was unresponsive to treatment involving a generalized manipulative technique; however, improved following the administration of a specific applied manipulation with modified forces. The patient was deemed recovered and discharged with ergonomic and home care recommendations.

Discussion: This case demonstrates a clinical situation where there is a paucity of research to guide management, thus clinicians must rely on experience and

Historique : Il existe peu d'études sur la manipulation vertébrale de douleur de la colonne dorsale sans complication, et encore moins lorsque la douleur est associée à des conditions comorbides comme la polyarthrite rhumatoïde. En l'absence de résultats d'essais cliniques, l'expérience clinique et le choix approprié du type d'intervention sont importants pour trouver la gestion appropriée de ces cas.

Présentation de cas : Nous présentons le cas d'un patient souffrant de polyarthrite rhumatoïde de longue date avec une douleur thoracique aiguë. Le patient a reçu un diagnostic de dysfonctionnement de l'articulation costo-vertébrale et une tension myofasciale de la masse musculaire qui l'enveloppe. Le patient ne répondait pas au traitement comprenant une technique de manipulation généralisée; cependant, il a démontré une amélioration à la suite de l'administration d'une manipulation spécifique avec des forces modifiées. Le patient a été jugé rétabli et a obtenu son congé avec des recommandations de soins ergonomiques et à domicile.

Discussion : Ce cas illustre une situation clinique où il y a n'y a pas assez d'études permettant d'orienter la gestion; par conséquent, les cliniciens doivent s'appuyer

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patient preferences in the selection of an appropriate and safe therapeutic intervention. The case highlights the need to contextualize the apparent contraindication of manipulation in patients with rheumatoid arthritis and calls for further research. Finally the paper advances evidence based decision making that balances the available research, clinical experience, as well as patient preferences.

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KEY WORDS: Rheumatoid arthritis, manipulation, mobilization, chiropractic

Background

Rheumatoid arthritis (RA) is a seronegative spondyloarthropathy that usually presents in females between the ages of 45 and 65.¹ The disease can lead to disability and significantly diminish quality of life by affecting a patient's physical, emotional and social functioning.^{2,3} Treatment commonly involves a pharmacologic approach, including such drugs as non-steroidal anti-inflammatories (NSAIDs), anti-tumor necrosis factors, disease modifying anti-rheumatics and/or corticosteroids.⁴ Non-pharmacologic management includes a vast array of interventions including manual therapies; however, there is limited scientific evidence to inform their use.

This case report demonstrates the utilization of spinal manipulative therapy (SMT) otherwise referred to as high velocity, low amplitude (HVLA) manipulation in the treatment of thoracic spine pain in a patient with RA. It also discusses the need for further research on the use and benefit of manual therapies, in particular manipulation, in the management of patients with RA.

Case presentation

History

A 66 year old female presented with a new complaint of left-sided mid-thoracic pain that radiated anteriorly to her lower chest and upper abdomen. The onset was attributed to lifting a 2kg bag of baking flour from the floor onto a 91 centimetre high counter. The pain was reported to be

sur l'expérience et les préférences du patient pour choisir une intervention de traitement appropriée et sécuritaire. Ce cas souligne le besoin de contextualiser la contre-indication apparente de la manipulation chez les patients avec de l'arthrite rhumatoïde et le besoin de recherche supplémentaire. Finalement, l'étude préconise un processus décisionnel fondé sur des preuves qui équilibrent les études consultables, l'expérience en clinique et les préférences du patient.

(JCCA 2015; 59(2):143-149)

MOTS CLÉS : arthrite rhumatoïde, manipulation, mobilisation, chiropratique

a constant dull ache, which became intensely sharp upon aggravation. Aggravating factors included extension and rotation movements of the spine, holding objects with her left arm outstretched, and coughing. Relieving factors included resting and taking over-the-counter pain medications along with an NSAID (i.e. naproxen). Associated symptoms included abdominal discomfort and nausea which she attributed to the commencement of her taking the medications.

She reported a history of neck, back and extremity joint pains which she associated to her rheumatoid arthritis (RA) (diagnosed at 18 years of age). Her RA was being managed pharmacologically with methotrexate but previously included gold injections, chloroquine and prednisone; however, she reported increasing intolerance to the medication. Other relieving factors for her pains included chiropractic treatments which consisted of spinal manipulation and mobilization, physical therapy modalities and soft tissue therapies. She had surgical excision of nodules in her feet and hands about 15 and 3 years ago, respectively. Aside from being hypertensive, she reported no other health problems.

Examination

On examination, she was able to ambulate and assume sitting positions without guarding. Blood pressure was 130/80. She had bilateral ulnar deviation with multiple Heberden's and Bouchard's nodes in the distal and proximal interphalangeal joints, respectively. The tender joint

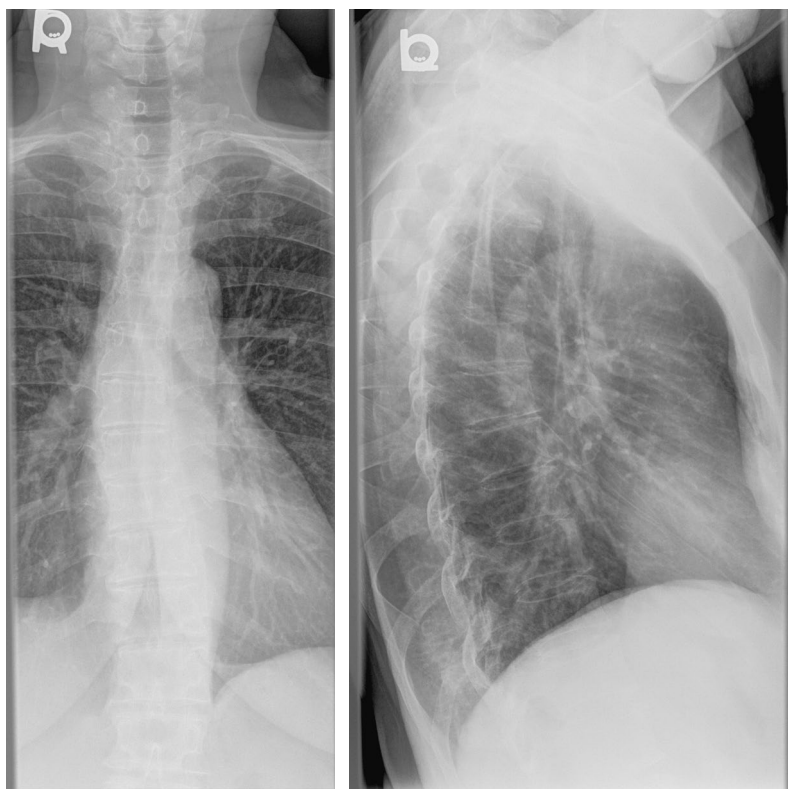


Figure 1A and 1B:
Anterior-posterior (A) and lateral thoracic (B) spine radiographs.

count was 20 and swollen joint count was 7. The active ranges of motion of her thoracic spine were mildly limited (20-25%) by pain in all directions. Deep breathing and coughing localized the sharp pain to the area of complaint. Global lateral and anteroposterior compression of the entire rib cage did not reproduce any local or radiating discomfort. Palpation of her thoracic spine revealed tenderness with restricted joint movement from T5-T7, as well as the left 6 and 7 costovertebral joints. The left intercostal space between rib 6 and 7 and the paraspinal musculature (rhomboids major, spinalis thoracis, longissimus thoracis, iliocostalis thoracis, multifidus thoracis) from T4 to the iliac crest were tender to palpation with increased myofascial tension, especially on the left.

Radiographic studies indicated moderate osteopenia, mild degenerative disc disease from T4-T9, mild uncov-ertebral arthrosis at C5-C6 and a mild s-shaped thoracolumbar curve ($<15^\circ$ Cobb angle) (See Figure 1).

Management

The patient was diagnosed with acute costovertebral joint dysfunction of the 6th and 7th ribs with associated myofascial strain. Differential diagnoses included reactive synovitis, a rib fracture, a sprain/strain, or gastritis. Due to the concerns of an underlying active RA and abdominal pain, she was requested to see her physician for co-management.

She received 4 treatments over the next 7 days. The first 2 treatments were provided by an associate chiropractor who performed soft tissue therapy and interferential current to control her pain, along with SMT in a postero-anterior direction to the mid thoracic spine. The patient was placed in a prone position while the chiropractor performed a prone, cross bilateral manipulation with thenar contact to double transverse processes of the thoracic spine. This procedure is described as a soft thenar contact over the area of the transverse process and application of



Figure 2:
Thenar eminence contact position for anterior thoracic spinal manipulation



Figure 3:
Anterior thoracic spinal manipulative procedure

a high velocity low amplitude body drop procedure as described by Byfield.⁵ The patient was advised to continue her daily walking and to rest intermittently as needed. She was also instructed to use cryotherapy for general pain control. After the second visit, the patient reported minimal and temporary relief. Furthermore, she reported that the cryotherapy aggravated her coughing symptoms and hence her mid-thoracic pain.

On the third visit, the plan of management was reviewed due to the minimal response to therapy. The diagnosis of costovertebral dysfunction was revisited and the next two treatments were delivered by her primary chiropractor who focused the manipulation to the hypomobile costovertebral joints. The manipulative technique was modified to a supine, single spinous supine thoracic manipulation utilising a soft thenar contact inferior to the restricted spinal segments of T5-T7 about the area of the costovertebral joints of the 6th and 7th ribs as described Byfield.⁵ With the patient supine and her arms folded across her chest, a minimal short lever, body drop procedure was used while modulating the depth (low amplitude) and speed (low velocity) of the thrust to the patient's tolerance (See Figure 2). This procedure was most comfortable to the patient, resulting in an audible joint cavitation with significant immediate pain relief. She was instructed

to avoid lifting but assume her normal activities of daily living.

She returned two days later reporting that the same original sharp pain in her thoracic spine had returned after having a "rough night" that she attributed to all-day gardening a day earlier. As in the third visit, treatment was directed to the costovertebral joint using SMT as per the third visit and the surrounding musculature with myofascial release therapy. Once again, she had immediate relief which was sustained over time. Her abdominal pain subsided upon her cessation of her taking naproxen. The patient was discharged with ergonomic advice and exercises, and managed collaboratively as necessary. There were no reported changes to her medications subsequent to her visiting her family physician.

Discussion

This case illustrates how management of thoracic pain may be complicated in a patient with co-existent underlying conditions. Clinicians are often faced with this dilemma as the typical plan of management or interventions utilized need to be evaluated with an emphasis on the potential changes to risks and benefits which may be altered based on the individual characteristics of each patient. The patient in this case had a history of RA and presented

with what was considered to be a recurrent episode of acute mechanical thoracic pain.

Literature suggests a limited role for manipulative therapy in managing the inflammatory component of RA⁶, yet it may provide symptomatic pain relief of mechanical origin caused by abnormal compensatory kinematics (of non-inflammatory origin). Shaikh suggests that clinicians differentiate inflammatory back pain from mechanical back pain during the clinical history.⁷ Inflammatory back pain typically presents as morning stiffness greater than 30 minutes, relief of pain with exercise but not rest, pain may be present at night which wakes the individual, and alternating buttock pain.⁷ However, the available scientific evidence is limited in guiding clinicians in differentiating between inflammatory and non-inflammatory pain when they may both be present and furthermore in the management of these cases.

The general consensus is that management of patients with RA includes a multidisciplinary approach incorporating both pharmacologic and non-pharmacologic interventions.^{8,9} In regard to non-pharmacologic interventions, dynamic exercises have been shown to be beneficial in improving aerobic capacity and muscle strength without detrimental effects on disease activity.¹⁰ Education has been shown to increase self efficacy, knowledge of disease management and decrease morning stiffness.¹¹ Physical therapy modalities (e.g. interferential current) have been reported to potentially facilitate pain modulation but their effectiveness is inconclusive.¹² While orthoses and assistive devices have been shown to decrease the swelling and pain of RA, they may limit dexterity and function when performing activities of daily living.¹³

As for manual therapy, recent guidelines recommend mobilizations but the level of evidence is that of expert opinion.¹⁴ Mobilizations involve positioning a joint at its restrictive barrier (i.e. end of passive range of motion) and then the practitioner uses a series of gentle, repetitive movements towards and through the restriction.¹⁵ Manipulation, commonly referred to as “an adjustment” by chiropractors, is another form of manual therapy which involves a joint positioned at its restrictive barrier and then the practitioner applies a quick, short impulse (HVLA) thrust.¹⁶ Both procedures are typically directed at hypomobile joints.

Hypomobile vertebral segments have been thought to result from “adhesions” within the zygapophysial joints.¹⁷

This hypomobility or aberrant joint motion is thought to be amenable to manipulation.¹⁸ Cramer et al. have suggested that spinal manipulation increases the gapping of vertebral joints compared to controls, presumably facilitating the breaking of these adhesions and improving joint kinematics.¹⁹ Considering the potential for alterations in joint kinematics and subsequent pain generation from compensatory mechanisms, as well as the inherent joint changes in rheumatologic patients, manipulative therapy may be a viable therapeutic option.

Alternatively, others have suggested a more neurophysiological theoretical framework to explain how spinal manipulation may modulate pain and movement. These include spinal reflex excitability²⁰, decreased electromyographic activity of paraspinal muscles^{21,22}, motor-neuron excitability²³, strength modulation^{24,25}, reflex inhibition of pain by stimulation of joint mechanoreceptors²⁶, activation of endogenous opioids²⁷, altering chemical mediators²⁸, and activating segmental inhibitory pathways or descending pain inhibitory systems^{29,30}. Hence manipulation may have mechanistic and neurophysiologic effects that should be considered when justifying its use.

Empirically, the use of manipulation is limited to non-inflammatory regions, and joints susceptible to inflammatory pathology are avoided. The World Health Organization reported that joint manipulation in patients with RA is an absolute contraindication in anatomical regions of involvement.³¹ For example, cervical spine manipulation in patients with RA is considered an absolute contraindication due to instability of the atlanto-axial joint and predisposition to transverse ligament rupture.³² It appears the utilization of the term “absolute” in patients with RA may have been generalized to all joints rather than being restricted to joints where risks associated with manipulation outweighs the potential benefits.

The thoracic spine has not been researched as much as the cervical and lumbar spine when considering manipulative therapy.¹⁵ The case described was that of a patient with RA and co-existent thoracic pain. Manipulation to the thoracic spine appears to be effective at restoring joint mechanics and the recovery of thoracic range of motion immediately after treatment.¹⁸ Treatment of this region also requires a more cautious approach due to the presence of numerous joints, the thoracic cage, autonomic ganglia, and the passage of the neurovascular bundle in the thoracic outlet.³³ Thus training and experience may be

important in modulating the selected manipulative procedure.³⁴

Bergmann³⁵ reported that manipulation requires a controlled delivery of the HVLA thrust that is developed with extensive training to perfect the psychomotor skills. Such training develops the palpatory sense and control to enable delivery of a thrust of appropriate depth and force and that has been postulated to be more effective compared to those with less training.³⁴

Additionally, timing of delivery of therapeutic interventions such as manipulation needs to be considered in patients with RA. The unpredictable pattern of changing symptoms in rheumatologic patients can differ day to day.⁴ Thus, the patient's symptoms need to be evaluated on each visit to ensure that the appropriate management options are being provided.

During episodes of acute pain, clinicians are faced with the challenge of sifting through the many grey areas of evidence which also includes clinical experience and patient values.³⁶ Patient preferences are a component of patient value that should be integrated into clinical decision-making.³⁷ In this case, the patient presented with RA and a history of adverse reactions to medications. She also reported a preference for alternative therapies for pain relief especially in light of prior benefit. In situations where a patient is seeking care for a therapy with limited evidence, clinical expertise becomes invaluable. In consideration of the patient's pre-existing condition and the rationale for conservative care, clinical experience guided the selection of an appropriate procedure and the applied force and location of intervention were modified to the patient's tolerance and preference.

Finally, co-management of the patient's pain was achieved with appropriate communication with the patients' family physician and rheumatologist to address the multiple factors that were contributing to the patient's symptoms.

Summary

The authors acknowledge the limitation of case reports in the evidence hierarchy. However to our knowledge, this is the first report of a rheumatoid patient receiving manipulation in the management of her acute symptomatic thoracic spine pain. The patient reported to have experienced significant and immediate pain relief from the procedure performed in the 3rd and 4th visit. Manipulative therapy

was limited to pain relief, while the patient also received ergonomic education and active exercises. This case report is meant to stimulate increased research in this field, question the generalization of contraindications without adequate evidence, and provide a basis for further investigation.

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The examination of soft tissue compliance in the thoracic region for the development of a spinal manipulation training mannequin

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Purpose: To determine if the soft tissue compliance of the thoracic paraspinal musculature differs based on gender and body type to help create a foam human analogue mannequin to assist in the training of spinal manipulative therapy.

Methods: 54 volunteers were grouped based on their gender and body types. In the prone position, thoracic paraspinal soft tissue compliance was measured at T1, T3 T6, T9 and T12 vertebrae levels bilaterally using a tissue compliance meter.

Results: There was no significant difference in tissue compliance when comparing the genders except at T1 ($p=0.026$). When comparing body types, significantly higher tissue compliance was found between endomorphs and the other groups. No significant difference was found between ectomorphs and mesomorphs. The compliance for the participants in this study ranged from 0.122 mm/N to 0.420 mm/N.

Objectif : Déterminer si la compliance des tissus mous de la masse musculaire thoracique paradorsale diffère selon le sexe et le type corporel afin de créer un mannequin en mousse de forme humaine pour aider à la formation en traitement par manipulation dorsale.

Méthodologie : On a regroupé 54 volontaires en fonction de leur sexe et de leur type corporel. En position allongée, on a mesuré la compliance des tissus mous thoraciques paradorsaux au niveau des vertèbres T1, T3, T6, T9 et T12 bilatéralement à l'aide d'un dispositif de mesure de compliance.

Résultats : Il n'y a pas de grande différence sur le plan de la compliance des tissus lorsqu'on compare les sexes, sauf à la vertèbre T1 ($p = 0,026$). En comparant les types corporels, une compliance des tissus bien plus élevée a été remarquée chez les endomorphes par rapport aux autres groupes. Il n'y a pas de différence importante entre les ectomorphes et les endomorphes. La compliance pour les participants à cette étude allait de 0,122 mm/N à 0,420 mm/N.

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Conclusion: *There are significant differences in thoracic spine soft tissue compliance in healthy asymptomatic patients between genders in the upper thoracic spine, and between different body types throughout the thoracic spine. It may be beneficial to create multiple versions of practice mannequins to simulate variations amongst different patients.*

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KEY WORDS: compliance, thoracic spine, mannequins, somatotypes, chiropractic

Introduction

The introduction of using force-sensing table technology in a chiropractic institution is providing increased opportunity for students to practice manipulative skills. Force-sensing table technology provides direct and immediate knowledge of results (KR).^{1,2,3} The force-sensing table is a typical chiropractic table that has been modified and fit with a force-plate and the software required to provide immediate KR.^{4,5} Knowledge of results is provided in terms of an immediate force-time profile, containing information about force, moments, and speed. Although the force-sensing table technology provides objective feedback, it is important to recognize that it cannot fully mimic a real clinical encounter, and a number of variables must be considered for its use. For example, to maintain a high level of safety, and to enhance manual manipulation skills, it would be ideal to have a simulated mannequin that can mimic the human body as closely as possible for students to practice. To maintain a reasonable level of fidelity, it is important to use a mannequin form that simulates real contours of a patient, and a compliant material similar to a human body. These foam human analogue mannequins would allow the students the opportunity to practice manual skills procedures while learning to modulate forces by receiving immediate KR using the force-sensing table. By learning more about tissue compliance and variability of the compliance of paraspinal musculature, it may be possible to create a human adult analogue mannequin with a high level of fidelity to accurately practice manual manipulation techniques.

Conclusion : *Il existe de grandes différences entre la compliance des tissus mous thoraciques dorsaux chez les patients en santé asymptomatiques entre les sexes dans la colonne thoracique supérieure et entre les différents types corporels dans toute la colonne thoracique. Il peut être bénéfique de créer plusieurs versions de mannequins de pratique pour simuler les variations chez les différents patients.*

(JCCA 2015; 59(2):150-156)

MOTS CLÉS : compliance, colonne thoracique, mannequins, somatotypes, chiropratique

Soft tissue compliance has been defined as the amount of displacement of the tissue with a fixed amount of force, as measured by a tissue compliance pressure meter (TCM).⁶ It has been shown that measuring compliance is a valid method to evaluate the paraspinal soft tissue.^{7,8,9,10} Previous research indicates there is a difference in compliance between genders, and by region in which the measurements were taken, but no significant differences exist for age or between symptomatic versus asymptomatic subjects.^{11,12} The purpose of this study is to evaluate whether body type (ectomorph, endomorph, or mesomorph)¹³ and gender impacts thoracic paraspinal soft tissue compliance as measured by TCM. Successful identification of any differences will aid in the development of a foam human analogue mannequin for manual skills training.

Methods

Sample Population

This study was approved by the CMCC Institutional Research Ethics Board. A convenience sample of healthy, asymptomatic, male and female subjects was used. Volunteer participants were screened by Investigator 1 using a questionnaire and Adam's forward bending test.¹⁴ Participants were excluded if they reported; thoracic back pain at the time of the interview; known history of scoliosis, fused vertebrae, Scheuermann's disease or Ankylosing Spondylitis; or had a visible rib hump during Adam's forward bending test.

The participants were divided into groups based on body type: ectomorphs, endomorphs, and mesomorphs.¹³ Investigator 1 assigned participants to the appropriate group based on visual approximation using the definitions of mesomorph, endomorph and ectomorph.¹³

Instrument

A TCM was used to measure the compliance of the thoracic region. The tool used in this study consists of a force gauge and a metal measuring rod with a 1cm² probe that is pressed into tissue, resulting in a surface deformation (Figure 1 and 2).¹⁵ Kawchuk et al. further explains



Figure 1:
Picture of the Tissue compliance meter.

“A collar surrounding the probe contacts the tissue and is believed to remain at the original surface level as the probe is moved downward. A marker on the collar measures how far the probe has passed into the tissue via a ruler-type scale. The amount of force that is used to push the instrument into the tissue is recorded by an analog gauge that is similar to a bathroom scale in mechanism. The overall result is a measurement of compliance that is expressed in millimeters per Newton (mm/N).”¹⁵

The TCM was used for all measurements in this study. Current literature supports the use of the TCM in measuring soft tissue compliance with low level variability for intra-examiner measurements.⁸ To maintain consistency, Investigator 2 collected all TCM data.

Experimental Maneuver

Investigator 1 grouped the participants according to body type, and then placed the participants in a prone position with their thoracic spine exposed. Investigator 2 was responsible for landmarking and measuring all tissue compliance sites. Using palpation skills and procedures from the text “A Manual Therapist’s Guide to Surface Anatomy and Palpation Skills” Investigator 2 located and marked with a washable marker the T1, T3, T6, T9 and T12 spinous processes.¹⁶ These measurements were taken two centimetres lateral to the spinous processes, bilaterally, to maintain consistency. The TCM was used to measure the displacement of tissues at these identified levels with a four kilogram (4 kg) force applied following a standard protocol.^{6,9,17} Investigator 2 recorded the displacement in millimeters at each of the chosen levels bi-

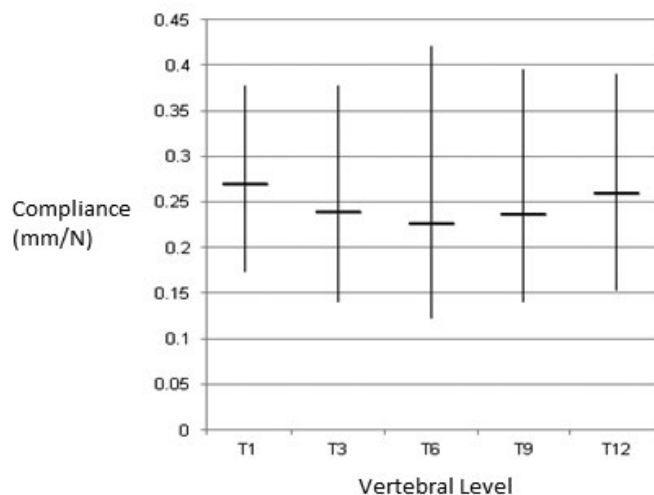


Figure 2:
The mean and standard deviation of thoracic soft tissue compliance in asymptomatic males and female subjects (n=54).

laterally. The compliance measurements were repeated a second time to test for consistency between the readings. An average of the two readings was recorded and used for statistical purposes.

Data Analysis

The data were converted to millimetres per Newton (mm/N) and divided into two different sets. The first set compared tissue compliance differences by gender, while the second compared tissue compliance differences by

Table 1:
Mean and standard deviation tissue compliance of males and females and body types at all vertebral levels in the thoracic spine (mm/N).

	Ectomorph	Endomorph	Mesomorph
Male	n=10 Mean; Standard Deviation T1: 0.271; 0.044 T3: 0.236; 0.071 T6: 0.218; 0.073 T9: 0.233; 0.080 T12: 0.260; 0.070	n=7 Mean; Standard Deviation T1: 0.320; 0.041 T3: 0.305; 0.046 T6: 0.287; 0.070 T9: 0.286; 0.043 T12: 0.307; 0.037	n=9 Mean; Standard Deviation T1: 0.273; 0.033 T3: 0.233; 0.054 T6: 0.215; 0.053 T9: 0.227; 0.035 T12: 0.261; 0.033
Female	n=9 Mean; Standard Deviation T1: 0.246; 0.580 T3: 0.209; 0.034 T6: 0.198; 0.037 T9: 0.208; 0.036 T12: 0.231; 0.055	n=7 Mean; Standard Deviation T1: 0.301; 0.040 T3: 0.277; 0.037 T6: 0.265; 0.049 T9: 0.277; 0.062 T12: 0.278; 0.038	n=11 Mean; Standard Deviation T1: 0.236; 0; 031 T3: 0.208; 0.036 T6: 0.206; 0.058 T9: 0.221; 0.050 T12: 0.242; 0.043

body types. The data were analysed using two-way analysis of variance (ANOVA) testing to compare potential differences between gender and body type at T1, T3, T6, T9 and T12 landmarks. Statistical significance was set at $p < 0.050$. Post hoc analysis using Tukey honestly significant differences (HSD) method¹⁸ with family confidence coefficient equal to 0.900 was completed if the two-way ANOVA demonstrated any interaction between body types.

Results

At baseline, 54 participants aged 23 to 58 met all the inclusion criteria. One participant dropped out of the study during testing due to discomfort with the procedure leaving a total of 53 participants; 27 female and 26 male. When divided into body types there were 19 ectomorphs, twenty 20 mesomorphs, and 14 endomorphs. The mean tissue compliance data are displayed in Table 1.

General Pattern

Upon visual inspection and descriptive statistical analysis, the general pattern of soft tissue compliance, regardless of body type or gender, showed greater compliance in the upper and lower thoracic regions when compared to mid (Table 1) (Figure 2). The data suggest the soft tissue

Table 2:
Two-way ANOVA results for all vertebral levels comparing body type and gender.

		F	p-value
T1	Interaction gender x body type	0.214	0.808
	Gender	5.254	0.026*
	Body type	8.526	0.0006*
T3	Interaction gender x body type	0.004	0.996
	Gender	3.880	0.055*
	Body type	10.546	0.0002*
T6	Interaction gender x body type	0.071	0.931
	Gender	1.104	0.299
	Body type	6.708	0.003*
T9	Interaction gender x body type	0.165	0.849
	Gender	0.840	0.364
	Body type	6.229	0.004*
T12	Interaction gender x body type	0.062	0.940
	Gender	3.649	0.062
	Body type	4.330	0.019*

Table 3:

Tukey HSD confidence intervals comparing body types with family confidence coefficient equal to 0.900.

Outcome	Endo – Ecto	Endo – Meso	Ecto – Meso
T1	(0.021; 0.083)	(0.025; 0.086)	(-0.025; 0.032)
T3	(0.038; 0.100)	(0.040; 0.102)	(-0.026; 0.030)
T6	(0.037; 0.099)	(0.035; 0.096)	(-0.031; 0.026)
T9	(0.030; 0.092)	(0.027; 0.088)	(-0.032; 0.025)
T12	(0.016; 0.078)	(0.011; 0.072)	(-0.034; 0.022)

Endo = Endomorph; Ecto = Ectomorph; Meso = Mesomorph

paraspinal compliance for the participants in this study range from a minimum of 0.122 mm/N to a maximum of 0.420 mm/N.

Male versus Female

The descriptive statistics are displayed in Table 1 and the two-way ANOVA results are displayed in Table 2. There was no significant difference found between male participants and female participants at any site except at T1 ($p=0.026$) and borderline significance at T3 ($p=0.055$).

Body Types

The descriptive statistics are displayed in Table 1 and the post hoc results are displayed in Table 3. The two-way ANOVA tests (Table 2) demonstrated that there was a significant difference between the three body types at all sites. Post hoc testing as displayed in Table 3 showed that endomorphs were significantly different than both the mesomorphs and ectomorphs, while there was no significant difference observed between the ectomorph and mesomorph groups. These groups had very similar values throughout the thoracic spine as confirmed by their descriptive statistics (Table 1). Conversely, the endomorphs were significantly different from both the ectomorphs and the mesomorphs (Table 3).

Discussion

The data suggests that there may be no significant differences in soft tissue compliance in the thoracic spine be-

tween males and females. Previous research has indicated that there is a significant difference between genders regarding soft tissue compliance, however, differences were found at C6, L3, and L5¹², while the current study examined only the thoracic spine. The only areas found to have a statistically significant difference in this study were at T1 ($p=0.026$) and borderline significance at T3 ($p=0.055$), with males having more compliance than females. With no statistically significant differences at T5, T7, T9 or T12, the findings of this study are mostly consistent with previous research.¹² The data appeared to be consistent with the previous studies showing that there is less compliance in the mid thoracic spine compared to cervico-thoracic and thoraco-lumbar junctions. These are transitional regions, which may require more extensive study of the spinal musculature as a whole in the future.

Of the three body types investigated, the mesomorphs and ectomorphs were found to be very similar, while the endomorphs were significantly more compliant from the other groups. This may be caused by the amount of adipose tissue in the area or differences in musculature of the ectomorphs and mesomorphs compared to endomorphs.

To effectively create a practice mannequin that has high fidelity to human patients, the results of this study inform that the soft tissue compliance of the thoracic spine could range from 0.122 mm/N to 0.420 mm/N with increased compliance in the cervico-thoracic junction (T1) which decreases towards the mid t-spine (T6) and starts to increase again at thoracic/lumbar junction (T12). (Figure 2)

The limitations in the research include the population investigated, the limited area inspected, and the method used to determine body type and the reliability of the TCM. There is disagreement in the literature about reliability of TCM. In 1995, Kawchuk and Herzog found poor reliability which they acknowledge may be a result of instrument design or application.¹⁵ However recently Wernicke et al. have validated TCM with low levels of intra-rater variability ($r > 0.940$, $p < 0.000$).⁸

The reliability and accuracy of spinal landmarking may also be a limitation in this study. Although a single researcher conducted all of the landmarking tasks to reduce inter-observer variability research has suggested that similar methods of palpation can be inaccurate in overweight and obese patients.¹⁹

The healthy adult sample used in this study also limits the application of results to different populations. Since the purpose of the research was to help design a human adult analogue mannequin, future research should investigate if there are any differences between age groups, and if there is a necessity to create mannequins based on age as well as body type. As well, there should be consideration of a symptomatic population, and the potential need for mannequins to reflect them. The focus on the thoracic spine allowed for a preliminary investigation. In the future, using compliance to match clinical populations throughout the full spine when constructing mannequins could improve the fidelity for training spinal manipulation. Further research should also attempt to determine body type by utilizing a more objective measurement system with higher reproducibility instead of using visual approximation.

Conclusion

With respect to the development of a foam human analogue mannequin for manual skills training, it is important to respect that some body types have differing soft tissue compliance in the thoracic spine paraspinal musculature. Endomorph body types, regardless of gender, have significantly higher compliance when compared to both ectomorph and mesomorph body types. Based on our sample population, the soft tissue compliance should range from 0.122-0.420 mm/N, and trends suggest it is highest in the upper and lower thoracic spine and stiffest mid-thoracic spine. When designing a mannequin it is important to replicate these values, and possibly make

different mannequins to accommodate each body type to maintain a high level of fidelity. Upon future research, other accommodations may include tissue compliance variations to replicate different age groups, symptomatic subjects, cervical spine or lumbar spine regions. This may lead to higher fidelity mannequin training for spinal manipulation, while reducing the need to train on human participants.

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Inter-examiner reliability of the interpretation of paraspinal thermographic pattern analysis

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Introduction: A few spinal manipulation techniques use paraspinal surface thermography as an examination tool that informs clinical-decision making; however, inter-examiner reliability of this interpretation has not been reported. The purpose of this study was to report inter-examiner reliability for classifying cervical paraspinal thermographic findings.

Methods: Seventeen doctors of chiropractic self-reporting a minimum of 2 years of experience using thermography classified thermographic scans into categories (full pattern, partial +, partial, partial -, and adaptation). Kappa statistics (k) were calculated to determine inter-examiner reliability.

Results: Overall inter-examiner reliability was fair

Introduction : Quelques techniques de manipulation vertébrale utilisent la thermographie de la surface paravertébrale comme outil d'examen qui éclaire la prise de décision clinique; cependant, la fiabilité entre examinateurs de cette interprétation n'a pas été rapportée. L'objectif de cette étude était de rapporter la fiabilité entre les examinateurs pour classer les trouvailles thermographiques cervicales paravertébrales.

Méthodologie : Dix-sept chiropraticiens déclarant avoir un minimum de deux ans d'expérience de pratique de la thermographie ont classé les examens thermographiques en catégories (motif complet, partiel +, partiel - et adaptation). Les statistiques Kappa (k) ont été calculées pour déterminer la fiabilité entre les examinateurs.

Résultats : Dans l'ensemble, la fiabilité entre les

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($k=0.43$). There was good agreement for identifying full pattern ($k=0.73$) and fair agreement for adaptation ($k=0.55$). Poor agreement was noted in partial categories ($k=0.05-0.22$).

Conclusion: Inter-examiner reliability demonstrated fair to good agreement for identifying comparable (full pattern) and disparate (adaptation) thermographic findings; agreement was poor for those with moderate similarity (partial). Further research is needed to determine whether thermographic findings should be used in clinical decision-making for spinal manipulation.

(JCCA 2015; 59(2):157-164)

KEY WORDS: chiropractic, technique, instrumentation, diagnosis

Introduction

Doctors of chiropractic (DCs) use complex clinical decision-making when determining where, when, and when not to perform spinal manipulation.¹ Factors considered may include the diagnosis, symptom severity, presence of co-morbid conditions, patient preferences, and other examination findings^{2,3} such as static or segmental motion palpation,^{4,5} posture analysis, leg length analysis,⁶ biomechanical interpretation of spinal radiographs, the presence of spinal/paraspinal tenderness, and abnormal muscle tone.⁷ Some chiropractic spinal manipulation techniques, particularly those focusing on upper cervical manipulation, use thermographic and other diagnostic instruments to provide primary information to determine whether treatment should or should not occur.⁸ The use of unique diagnostic instrumentation is not new to the chiropractic profession. B.J. Palmer, considered the “developer” of chiropractic, used an instrument called the electroencephaloneuromyotomograph and later, the neurocalometer.⁹ The neurocalometer was the predecessor of the current nervo-scope, which is still used by some practitioners using the Gonstead technique system.^{10,11}

A few studies indicate that there may be some potential

examineurs était passable ($k=0,43$). Il y avait une bonne entente dans l'identification des motifs complets ($k=0,73$) et une entente passable concernant l'adaptation ($k= 0,55$). Une mauvaise entente a été notée dans les catégories partielles ($k=0,05-0,22$).

Conclusion : La fiabilité entre les examineurs a indiqué une entente passable à bonne concernant l'identification de conclusions thermographiques comparables (motifs complets) et disparates (adaptation); l'entente était mauvaise pour ceux avec une similarité modérée (partiel). Des études plus poussées sont nécessaires pour déterminer si les conclusions thermographiques peuvent être utilisées dans la prise de décision clinique concernant la manipulation vertébrale.

(JCCA 2015; 59(2):157-164)

MOTS CLÉS : chiropratique, technique, appareillage, diagnostic

for thermography to provide information suggestive of underlying physiological processes¹² that may help inform spinal manipulation decisions.¹³ Roy reported changes in paraspinal surface temperature (comparing one side to the opposite side) using infrared thermographic methods following spinal manipulation.^{14,15} These findings suggest that paraspinal cutaneous and/or subcutaneous blood perfusion may be altered following spinal manipulation. However, without further study, it is unclear if these findings represent specific physiological mechanisms initiated by the manipulation or simply from normal changes over time or from tissue perturbation.

One application of thermography used by some practitioners, referred to as “pattern analysis,” is the interpretation of a series of skin surface temperature recordings obtained over the cervical spine. Similar thermographic findings obtained several hours apart are thought to suggest spinal dysfunction, which presumably contributes to a diminished autonomic response to external environmental cues resulting in muted adaptive changes in cutaneous and/or subcutaneous blood flow.⁸ The theory behind this interpretation is based on the following physiological principles: 1) skin temperature can serve

as an indirect gauge of autonomic function,¹⁶ 2) small variations in skin temperature over time suggest that the autonomic nervous system is appropriately functioning by adapting to an ever-changing environment,^{17,18} and 3) normal or abnormal environmental adaptation can be estimated by comparing sequential skin temperature measurements.

When an individual is “adapting” to their surroundings, it is assumed that autonomic mechanisms are functioning normally, resulting in subcutaneous blood flow change over time, detectable with thermography.¹⁹ Abnormal spinal function (vertebral subluxation complex) is thought to adversely impact spinal joints and neurological function, and initiate a compensatory neurovascular response(s) causing joint motion restriction, muscle contraction, vasomotor changes, and localized tenderness.^{20,21} Due to an impaired ability to maintain homeostasis over nearby spinal regions, these changes can potentially result in static thermographic findings.

A paraspinal thermographic “pattern” is determined when multiple scans, obtained over a period of several hours, reveal similar or identical temperature findings. When this occurs, autonomic malfunction is assumed to be caused by upper cervical spinal dysfunction and manipulative treatment is then considered appropriate. If few or no similarities exist between thermographic scans over several hours, a static pattern cannot be designated and treatment is usually considered unnecessary.²²

Establishing the reliability of a measurement tool is a necessary first step in determining whether information gained from its use can be used in a clinically meaningful way. Several authors have reported on the reliability of surface thermography in a chiropractic setting.^{18,19,23-26} Though thermography appears to reliably measure temperature, stable readings are dependent on strict environmental control^{27,28} and a single paraspinal measurement procedure has not yet been extensively tested, leading a recent systematic review to conclude that evidence is unfavorable for paraspinal skin temperature to be used to locate the site of manipulation.²⁹ However, the literature does not yet adequately address whether paraspinal skin temperature readings can inform a clinician regarding the need for spinal manipulation. Before that question can be logically answered, it is first necessary to determine if clinicians are able to interpret paraspinal thermographic findings consistently. In other words, what is

the inter-examiner reliability with respect to interpreting paraspinal thermographic findings?

The purpose of this study was to determine the inter-examiner reliability of interpreting paraspinal thermographic findings. Study findings are needed to help determine whether thermography can be a tool that informs clinical decision-making for spinal manipulation and to provide useful data to chiropractic educational institutions and practitioners seeking information that further informs evidence-based clinical practice.

Methods

Institutional review board approval for this project occurred in June 2011 through Palmer College of Chiropractic, IRB Assurance # X2011-6-15-M. The use of de-identified study data was determined exempt according to 45 CFR 46.101(b)(4); informed consent was obtained from the DCs who participated. The study was conducted from August of 2011 through January of 2012. This study complies with reporting standards as recommended by the Guidelines for Reporting Reliability and Agreement Studies (GRRAS).³⁰

This study used thermographic scans obtained in a separate clinical trial conducted to determine the effectiveness of upper cervical chiropractic manipulation on stage 1 hypertensive patients during February through June of 2010, NCT 01020435.³¹ Paraspinal cervical scans were performed using the Tytron C-3000 (Titronics Research & Development, Oxford, Iowa), as follows: 1) participants were instructed to avoid caffeine for 2 hours and tobacco for 4 hours prior to assessment; 2) upon arrival to the study site, participants acclimated in a room maintained at 70-75 degrees for approximately 15 minutes; 3) during the scan, participants sat with their head flexed slightly to allow exposure of the cervical area with the feet flat and hands resting on the thighs; and 4) the examiner moved hair away from the posterior neck (when present) with one hand, held the paraspinal thermographic scanning instrument with the other hand, and obtained measurements between the vertebral prominence (T1 area) and the base of the occiput. The entire procedure lasted approximately 30 seconds. The resulting scan image appeared on a computer screen and consisted of 3 lines. The left line (or channel) represented the temperature gradient on the left paraspinal region from T1 to occiput; the right line (or channel) represented the temperature gradient on the right paraspinal

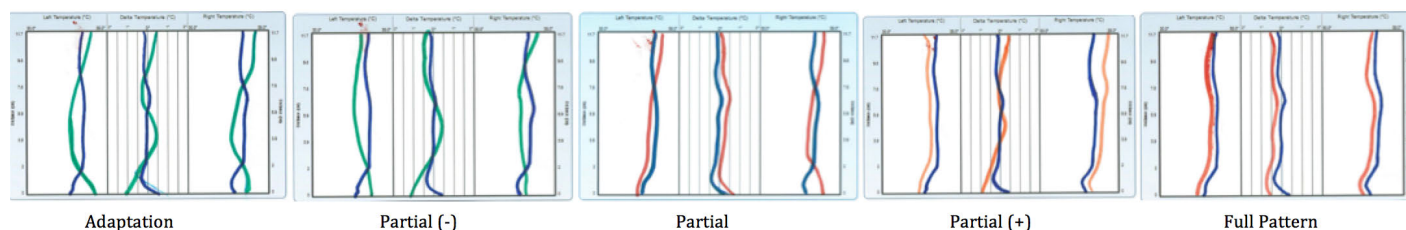


Figure 1.

Thermographic scans.

Lines in each column represent temperature readings over the cervical spine. Left column = left cervical spine region, Right column = right cervical spine region, Center column = average of left and right readings. Blue lines represent a static thermographic reading “pattern” obtained over the cervical spine (established by more than 1 reading over a \geq 24 hour period) and overlaid with a current reading represented by green, red, or orange lines. Categories are based on subjectively comparing a patient’s designated “pattern” (blue lines) with current findings (green, red, or orange lines). Examples of scans representing categories used in this study are displayed:

Adaptation = completely dissimilar, Partial (-)= modest similarity, Partial = moderate similarity, Partial (+) mostly similar, Full Pattern = virtually identical.

al region; and the center line (Delta) graphically displayed the difference between the right and left readings.

Prior to recruiting DC participants, de-identified scan pairings (2 scans from a single participant with at least 24 hours between scans), viewable on a computer monitor, were randomly selected. The final set included 17 scan pairings, which DC participants reviewed and classified.

Participant recruitment and eligibility

DCs self-reporting a minimum of 2 years of experience working with the Tytron software and using pattern analysis as a primary treatment indicator on a majority of their patients were eligible for this study. DCs were recruited at a chiropractic college event during a technique review class – a class that emphasizes the theories and application of thermography and pattern analysis. Knowledge of the study spread by word of mouth, and additional DCs volunteered over a period of six (6) months. Chiropractic college faculty DCs involved in teaching or research of pattern analysis or Tytron software were eligible if they met the above criteria. Basic demographic information was collected to determine eligibility.

Participant interpretation of scans

Interested DCs completed the basic demographic survey to determine eligibility. When eligibility was confirmed,

interested DC participants signed an informed consent document. DC participants were instructed to classify each scan pairing (left channel readings, delta readings, and right channel readings) into one of the following categories (see Figure 1):

1. Pattern: 3 lines are the same
2. Partial (+): 2 lines are the same and the 3rd line is similar
3. Partial: 2 lines are the same
4. Partial (-): 1 line is the same
5. Adaptation: 3 lines are different

Participating DCs either met in person or corresponded via e-mail and telephone with the lead author (BAM). All were provided the study objectives, instructions for participants and categorical classification definitions. If participants completed the study in person, they were guided through the Tytron software, viewed the scan pairings on the Tytron software, and categorized the scan pairings on the data collection form. The remainder of DCs received an Adobe® PDF file of scan pairings with written instructions and the scan analysis data collection form. DC participants designated each scan into one of five categories, and returned the data collection form via e-mail. Each participant viewed 17 unique scan pairings.

Data Entry and Analysis

Both the scan pairings and the DC raters were samples of convenience. The data were double key-entered and exported to and analyzed in SPSS for Windows (Version 17.0.0, SPSS, Inc. Somers, NY). The multi-rater un-weighted Kappa statistic³² and 95% confidence intervals based on Fleiss' corrected standard error³³ were calculated overall and for each of the 5 categories. Because SPSS does not calculate Kappa and associated confidence intervals for the multi-rater case, we used a publicly available SPSS macro.³⁴ Kappa statistics (*k*) were interpreted according to Fleiss: *k*>0.75 was considered excellent, 0.40 ≤ *k* ≤ 0.75 was fair to good agreement, and *k* <0.40 was poor or less than expected by chance.³⁵

Results

Seventeen DCs participated in the study, reporting use of the Tytron software a mean of 7.7 years (SD 4.5). Five DCs viewed scan pairings in person; 12 viewed scan pairings and returned the scan analysis form via e-mail. DCs reported using Tytron analysis as a primary clinical decision-making indicator on a mean of 82% of patients. While practicing DCs used various spinal manipulative techniques, 14 primarily focused their treatment on the upper cervical region, 7 of whom reported using upper cervical manipulative procedures exclusively. Five DCs held chiropractic college faculty positions (Table 1).

Overall inter-examiner reliability was fair, *k*=0.43 (95% CI 0.38, 0.47) (Table 2). Reliability coefficients were highest for the individual categories of full pattern (*k*=0.73) and adaptation (*k*=0.55), and lowest for partial pattern (*k*=0.05).

Discussion

To our knowledge, this is the first study investigating inter-examiner reliability of interpreting thermographic pattern scans as taught and practiced by a few chiropractic techniques (e.g., Toggle Recoil or Blair) focused exclusively on the cervical spine. Though paraspinal thermography has been studied in chiropractic settings, strong evidence demonstrating how it can be best used clinically is currently lacking, in part because of wide variations in how these findings are interpreted to relate to abnormal physiological states.

One method of interpretation compares paraspinal skin temperature at single vertebral levels from the occiput to

Table 1:
Demographics of doctors of chiropractic interpreting thermographic scan pairings (n=17).

Female/Male	3/14
Chiropractic College Faculty Status	5
Chiropractic Education	
<i>Logan College of Chiropractic</i>	2
<i>Palmer College of Chiropractic</i>	14
<i>Sherman College of Chiropractic</i>	1
Av Pts/Week †	85 (55.9)
# Techniques Used	
<i>Only 1</i>	7
Primary Technique	
<i>Upper Cervical</i>	14
<i>Palmer Package</i>	3
Other Techniques Used	
<i>Activator</i>	4
<i>Diversified</i>	5
<i>Gonstead</i>	4
<i>Palmer Package</i>	3
<i>Pierce Stillwagon</i>	2
<i>SOT</i>	4
<i>Thompson</i>	3
<i>Upper Cervical</i>	5
<i>Other</i>	2
Use of Tytron Years †	7.73 (4.5)
1° Adj Indicator	
% patients ‡	82.2 (33.5)

*counts unless otherwise noted

† mean (SD)

‡ median (IQR)

Table 2:
Kappa (k) statistics measuring inter-reliability [kappa] statistics of thermographic pattern identification.

Category	<i>k</i>	CI
Overall	0.43	(0.38, 0.47)
Full Pattern	0.73	(0.59, 0.87)
Partial +	0.22	(0.11, 0.33)
Partial	0.05	(-0.05, 0.15)
Partial -	0.22	(0.08, 0.37)
Adaptation	0.55	(0.34, 0.76)

the sacrum, i.e., segmental analysis. Findings potentially indicate subsurface hyperemia from abnormal physiology such as unilateral hypertonic muscle contraction or local inflammation;^{12,23} another method compares the temperature of the right and left mastoid fossa (slightly anterior and inferior to the mastoid process) as an indicator of general health.³⁶ Hart investigated paraspinal thermographic patterns and thermographic mastoid fossa temperature differences with patient health perceptions. However, no definitive conclusions were reached regarding a relationship between mastoid fossa temperature and health perceptions.³⁶⁻³⁸ Hart also recently proposed a statistical approach to tracking a patient's paraspinal thermographic mastoid fossa findings, which has not yet been validated.³⁹ Brown explored the association between mastoid fossa temperature findings and paraspinal thermographic patterns, concluding that mastoid fossa asymmetry does not necessarily co-exist with paraspinal thermographic patterns.⁴⁰ Roy identified statistically significant temperature changes at the L5 vertebral level after a lumbar side posture manipulation when compared to a sham treatment.¹⁵

Thermographic pattern interpretation differs significantly from "segmental" analysis because it assumes the ability to adapt to a changing environment (homeostasis) will result in disparate sequential time-delayed findings. According to this theory, these differences suggest normal physiological function and thus, no need for treatment. A patient's "pattern" is established when multiple scans, obtained over a period of several hours, reveal similar or identical temperature findings. Subsequent readings are compared to this "thumbprint" pattern to determine the need for additional treatment. If completely similar, the patient is considered to be non-adapting, and treatment to the upper cervical spine is indicated (see example "pattern," Figure 1). If completely dissimilar, no treatment is indicated (see example, "adaptation," Figure 1). Partial categories are defined to clarify readings on the continuum between the two clear readings – perhaps where many clinical presentations fall. When a "partial" reading appears closer to the patient's pattern (but not completely similar), a practitioner may rely on a few additional clinical findings (static or motion palpation findings, postural abnormalities, tenderness, or muscle tone) to determine the need for treatment. Conversely, when a "partial" reading appears closer to adaptation, a practitioner may deter-

mine that no treatment is needed unless significant other clinical findings are present. Note "partial +," "partial," and "partial -," in Figure 1. This study found inter-examiner reliability for identifying or interpreting "partial" patterns to be very poor. Thus we recommend reducing to three categories (pattern, partial, and adaptation).

If reliability regarding this interpretation classification system is established, further investigation is needed regarding its validity. With this pattern interpretation theory, a patient's adjustment is considered "successful" if the consistent static readings (pattern) begin to change after treatment. Future studies should focus on whether pattern readings do change after treatment, as well as whether pattern vs. adaptation readings correlate with patient outcomes.

Thermography provides relatively reliable and objective information compared with other measures used in a clinical exam such as motion palpation.⁴ However, the results of this study indicate that there is substantial subjectivity in interpreting thermographic findings creating a challenge with utilizing the information gained in a consistent and clinically meaningful manner. Thus, largely due to the need for additional evidence, there does not appear to be a consensus on how thermographic findings should influence clinical decisions regarding spinal manipulation.

This study identified "full" or "adaptation" reliability as good and fair, respectively. If the use of this instrument in education and practice will continue, research should focus on the validity of its use. Further, clinical outcomes based on this form of clinical decision-making have not yet been reported, and more research is needed to determine if inter-examiner reliability can be enhanced (by increasing the participation, providing more rigorous standardized training, and reducing the number of category classifications) or whether clinical decisions based on this technology are associated with clinical improvement.

Limitations

This study used a convenience sample consisting of self-reported experienced DCs in the use of thermographic pattern analysis. However, there are currently no criteria other than years of experience by which to determine relative expertise. The method by which each DC viewed the scans (i.e., consecutive on PDF v. guided through software) may have had an effect on the results of their

interpretation. Future studies may want to include DCs who use this method, regardless of how often, and those who do not. Study findings from a sample size of 17 also limits the generalizability of results. Further, as the scans were performed on patients being assessed for stage 1 hypertension, it may be argued that the scans were not representative of typical chiropractic patients.

Conclusion

Overall inter-examiner reliability of thermographic findings was fair. Although the reliability of those designated as “pattern” (completely similar to a reference scan) was good, reliability of those designated as “adaptation” (completely dissimilar to a reference scan) was fair, and there was poor agreement for scans with partial similarity. These findings indicate that other clinical findings should be relied upon to determine treatment necessity. Further research is needed to better understand if treatment decisions based on thermographic findings are related to clinical outcomes.

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Testing an association between baseline resting pulse rate averages and short-term changes in resting pulse rates: A pilot study

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Introduction: Resting heart (pulse) rate (RPR) monitoring may be a useful neurological assessment tool in chiropractic practice. Lower RPR generally reflects a better level of fitness and health status than higher RPR. However, the clinical significance of short-term changes in RPR remains unknown. The purpose of this study was to take an initial step towards understanding the clinical significance of short-term RPR changes, first, by describing short-term RPR changes between duplicated measurements, and second, by comparing RPR changes between groups with lower and higher baseline RPR.

Methods: Seventy-three healthy adult volunteers received an RPR measurement on two days within a 1-week period. The mean difference between the two measurements (RPR change) in patients with lower versus higher baseline RPR was compared.

Results: Mean RPR change in the low baseline group was -0.3 BPM (95% confidence interval [CI] = -2.7 to 2.1 BPM) whereas in the high baseline group, it was +4.4 BPM (95% CI = 1.2 to 7.6). This difference between groups was statistically significant ($P = 0.02$)

Introduction : Le contrôle de la fréquence cardiaque (pouls) au repos (FCR) peut constituer un outil d'évaluation neurologique utile dans la pratique de la chiropratique. Une FCR basse reflète généralement une meilleure condition physique et une meilleure santé qu'une FCR élevée. Cependant, l'importance clinique du changement de FCR à court terme reste inconnue. L'objectif de cette étude était de faire un premier pas vers la compréhension de l'importance clinique des changements de FCR, tout d'abord en décrivant des changements de FCR à court terme entre des mesures dupliquées et, ensuite, en comparant des changements de FCR entre des groupes avec des FCR basses et élevées.

Méthodologie : Soixante-treize adultes en bonne santé se sont portés volontaires pour que leur FCR soit mesurée à deux reprises sur une période d'une semaine. La différence moyenne entre les deux mesures (changement de la FCR) a été mesurée chez les patients ayant une FCR de départ plus basse et les patients ayant une FCR de départ plus élevée.

Résultats : Le changement moyen de FCR dans le groupe avec une indication basse au départ était -0,3 BPM (intervalle de confiance de 95 % = -2,7 à 2,1 BPM), tandis qu'avec le groupe avec une indication élevée au départ, il était de +4,4 BPM (IC 95 % = 1,2

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with a large effect size (Cohen's $d = 0.57$).

Conclusion: In this pilot study, a higher RPR at baseline was associated with increased RPR change, whereas a lower baseline RPR was associated with a stable or reduced RPR change. A future main study with a larger sample size and longer follow-up period is needed to better characterize both the natural variation of RPR over multiple repeated measurements, and the clinical significance of short-term RPR changes in terms of predicting longer-term health outcomes.

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KEY WORDS: pulse, heart rate, reproducibility of results, risk assessment, chiropractic

Introduction

Most chiropractors focus on a condition known as vertebral subluxation.¹ Essentially, a subluxation is defined in concept and in theory as a slight misalignment resulting in some type of neurological disturbance.²⁻³ The actual validity of this theoretical construct is yet to be established. In the meantime, methods for detecting putative subluxations have included such assessments as thermography and leg length analyses.⁴ In a recent publication, it was suggested that resting heart rate may be a useful proxy measure for neurological dysfunction in subluxation-type chiropractic practice.⁵ Resting heart rate is: a) considered an autonomic marker,⁶⁻⁸ and b) evidence-based inasmuch as a higher resting heart rate over time (e.g., 10 years) has been associated with worse health outcomes (e.g., higher cardiac death rates).⁹⁻¹² Previous studies have typically found linear relationships between increasing heart rate over time (in years) and adverse clinical events, although one study has reported a nonlinear relationship.¹² In the meantime, there is: a) good agreement between ECG-obtained resting heart rate measurements and manually ascertained resting pulse rate (RPR);¹³⁻¹⁴ b) good correlation of RPR with heart rate variability, particularly in terms of the standard deviation of normal-to-normal

à 7,6 BPM). Cette différence entre les groupes était statistiquement significative ($P = 0,02$) avec un grand effet de taille (Cohen's $d = 0,57$).

Conclusion : Dans cet étude pilote, une FCR élevée au départ était associée à un changement de FCR accru, tandis qu'une FCR plus basse au départ était associée à un changement de FCR stable ou réduit. Une étude principale avec un plus grand échantillon et une période de suivi plus longue est nécessaire afin de mieux caractériser à la fois la variation naturelle de la FCR lors de mesures répétées et l'importance sur le plan clinique des changements de FCR à court terme pour ce qui est de prédire les résultats sur la santé à long terme.

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MOTS CLÉS : pouls, rythme cardiaque, reproductibilité des résultats, évaluation du risque, chiropratique

beats (SDNN);¹⁵ and c) evidence that RPR may improve following chiropractic care.^{16,17} On the other hand, these changes in response to chiropractic care have only been documented over the course of a few days or weeks post-intervention, in which case, the clinical significance of such changes over the long-term remains unknown.

Traditional chiropractic theory would have us assume that reductions in RPR following successful adjustment are attributable to the removal of vertebral subluxation-related neurological dysfunction. However that line of reasoning presupposes the existence of both vertebral subluxation and subluxation-induced elevation of RPR prior to intervention. Again, vertebral subluxation (let alone the existence of clinically significant subluxation-related health effects) remains to be a validated construct. Therefore, a more plausible line of reasoning would be based on preliminary evidence from animal models showing that mechanical stimulation of somatic structures can result in visceral responses that include reductions in both blood pressure and heart rate.¹⁸

The clinical validity of office-based measurements such as RPR, blood pressure, and heart rate variability are typically determined from long-term studies, in which baseline measures are correlated with subsequent

health effects (i.e., clinically significant patient-centered outcomes) over many years of follow-up. An example of this would be reductions in systolic blood pressure, which have been shown to be correlated with reductions in cardiovascular mortality risk in large studies over long periods of follow-up. Similarly, decreases in RPR, have also been shown to be associated with healthier cardiovascular outcomes over the long-term,¹⁰ although admittedly not in all studies.¹² Overall, however, the existing literature supports the notion that increased RPR is associated with worse health outcomes compared to stable or reduced RPR in long-term studies.

The utility of a new test, or novel application of an existing test can be explored indirectly by correlating a range of its values with those of an already-established criterion method or measure (such as an isolated blood pressure or baseline RPR reading). Good correlation between the new and criterion measure helps to establish one form of validity (namely, *criterion* validity or, more specifically, *concurrent* criterion validity). For example, in an individual patient whose systolic blood pressure at one reading changes by 10 mm hg at a subsequent reading within a short-term period, it would be interesting to know if that short-term *change* between two consecutive measurements is systematically dependent upon the value of initial baseline reading. In this example, the short-term change between readings from two separate visits is the novel measure of interest, and the baseline reading is the criterion measure as it is already known to be a predictor of health outcomes over the longer-term.

For the current study, it was of interest to know if short-term changes (i.e., magnitude and direction of short-term variations) between duplicate RPR readings are systematically dependent on the baseline RPR reading, the latter of which by itself is a known predictor of longer-term health outcomes including cardiovascular morbidity and mortality. If found to be associated in this regard, there would be justification for further exploring the utility of this variable as a potential neurophysiological measure (in addition to RPR alone) to inform, as well monitor the longer-term general health effects of chiropractic intervention.

Unfortunately, most, if not all tests that purport to monitor a neurological function in subluxation type practices have not been adequately tested in either short- or long-term studies. The unique objective of the present study

Table 1:

Overall death rate (per 1000 persons) by resting heart rate category. Adapted from the Framingham study.²¹

RHR	Men death rate		Women death rate	
	Ages 35-64	Ages 65-94	Ages 35-64	Ages 65-94
30- 67	6	35	3	22
68- 75	8	43	4	28
76- 83	11	46	6	25
84- 91	13	61	8	30
92-220	24	64	9	35

was to compare short-term RPR changes to the mean of RPR on two visits. Literature on the clinical significance of *short term* RPR changes (e.g., a few days apart) is non-existent. Baseline RPR on the other hand has been shown to be a good predictor of health outcomes over time.^{6,19-21} As an example, data from the Framingham study indicate that as resting heart rate increases, (cardiovascular and overall) death rates also increase significantly.²¹ As Table 1 shows, for example, as each RPR category increases, death rates typically also increase.

The present study is a pilot study that investigates the magnitude and direction of short-term RPR changes among healthy volunteers, and to compare this variable between groups defined by their initial (baseline RPR) reading. Depending on the results of this pilot study, a larger main study could be planned to more definitively evaluate the validity of RPR change as a predictor of clinically significant patient-centered health outcomes. This in turn would help to validate the use of RPR change as a neurological measure to assist the chiropractor in deciding if the patient needs a chiropractic adjustment (assuming a slight biomechanical dysfunction is also present). In the meantime, the primary hypothesis for this pilot study was that greater increases in RPR over the short-term would be associated with higher RPR measurements at baseline.

Methods

The study was approved by the Institutional Review Board at Sherman College of Chiropractic. Informed consent was obtained from all participants. Participants were

Table 2:
Summary statistics for low versus high resting pulse rate.

Variable	Low RPR					High RPR				
	n	Mean	SD	Minimum	Maximum	n	Mean	SD	Minimum	Maximum
Age	38	27.3	7.0	20	57	35	27.9	5.7	21	46
BMI	38	25.6	3.8	18.8	36.6	35	24.8	3.9	17.7	33.1
RPR-V1	38	66.2	7.6	48	82	35	81.1	8.6	64	106
RPR-V2	38	65.8	7.0	46	76	35	85.5	9.5	72	110
RPR-V1V2	38	66.0	6.3	47	74	35	83.3	7.8	76	103
RPR change	38	-0.3	7.3	-18	16	35	4.4	9.3	-14	24
Female RPR change	14	0.4	5.3	-10	8	22	4.0	8.6	-12	18
Male RPR change	24	-0.8	8.4	-18	16	13	5.1	10.6	-14	24

RPR is expressed in BPM or beats per minute. V = visit. SD = standard deviation. P-value and effect size between RPR change in low RPR versus high RPR = 0.02 and 0.57 respectively.

recruited as a convenience sample and examined by the author on two days within a one week period. The mean number of days between visits was 1.8 (standard deviation [SD], 1.9; range, 1 to 7). The 73 participants consisted of 36 females with a mean age of 25.8 years (SD, 4.6) and 37 males with a mean age of 29.4 years (SD, 7.4). Participants abstained from receiving chiropractic care for at least 1 week prior to their baseline visit, up until after their second visit.

RPR measurements were palpated at the radial artery. Two different groups of participants were examined at different time periods. In the earlier group, measurements were averaged between two separate 15-second count periods (separated by 15 seconds) on each visit, and were multiplied by 4 to estimate the beats per minute (BPM). For the more recent group, the BPM value was based on a single 30-second count period and multiplied by two. Thus, all participants' RPR values are reported in BPM. In both groups the count for beats was begun with "1" rather than "0." This is because good agreement with electrocardiography, as well as with 60-second count times, is achieved when the first beat is counted as "1" (rather than zero), regardless of whether count times are 15, 30, or 60 seconds.²² All RPR measurements were preceded by at least 5 minutes of seated resting. Participants

then remained seated during the active measurement period. A digital timer on a wrist watch was used to mark time. Measurements were obtained within the same hour for both visits for each participant but not the same hour for all participants (e.g., some had both of their appointments during the 11:00 AM hour while others had both of their appointments at the 3:00 PM hour). Information on current medication use was documented during each visit.

Analysis

For the classification variable, RPR for visit 1 (RPR-V1) and RPR for visit 2 (RPR-V2) were averaged (RPR-V1V2) and categorized into two groups: 1) "low" RPR patients, defined as RPR-V1V2 less than or equal to the overall RPR-V1V2 mean; and 2) "high" RPR patients, defined as RPR-V1V2 greater than this overall mean. The dependent variable, RPR *change*, was calculated by subtracting RPR-V1 from RPR-V2 (i.e., RPR-V2 minus RPR-V1), which was then compared between the low and high baseline RPR groups. Averaging of the RPRs from the two visits was thought to allow for better estimation of baseline RPR (keeping in mind the random variability of RPR between isolated determinations), rather than using only one of the visits for baseline.

Body mass index was calculated with a formula pro-

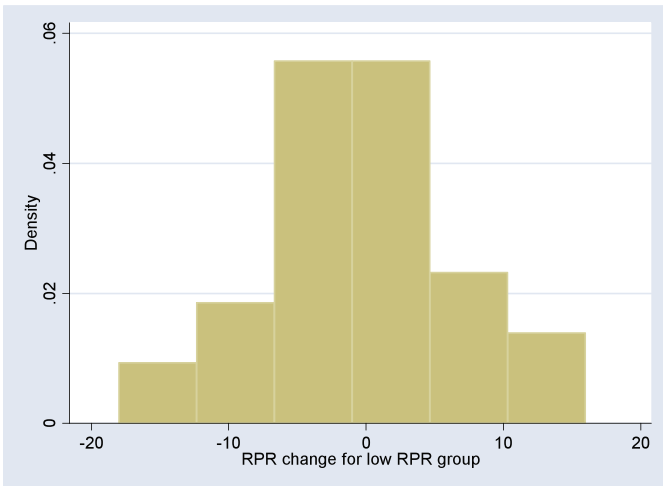


Figure 1:
Histogram of RPR change for low RPR group.

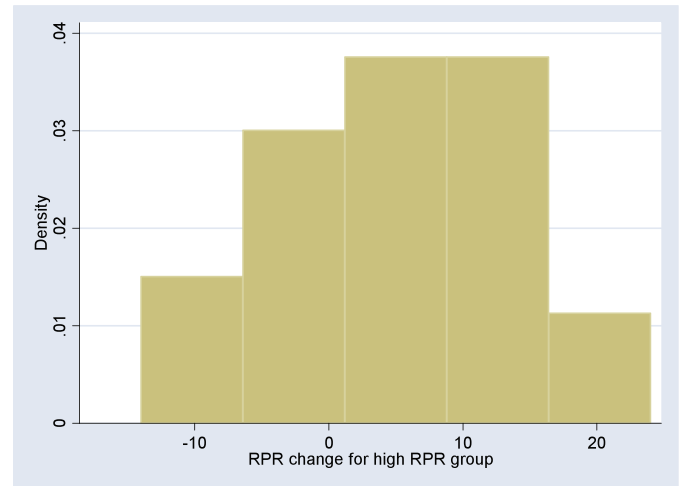


Figure 2:
Histogram of RPR change for high RPR group.

vided by the Centers for Disease Control and Prevention: $(\text{weight} / (\text{height})^2 * 703)^{23}$ and compared between low versus high groups.

The main statistical test consisted of assessing the difference between low and high RPR groups using the two sample *t* test (for groups with unequal variances). The analysis was performed in Stata IC 12.1 (StataCorp, College Station, TX). Since there were at least 30²⁴ observations (participants) in each group, the *t* test was considered appropriate. In addition, histograms for each group were examined to confirm normality of the data. The magnitude of this difference was quantified with the effect size statistic, using a pooled standard deviation, calculated, in Excel 2010 (Microsoft Corp., Redmond, WA). To test for a linear association between mean baseline RPR (RPR-V1V2) and the short-term RPR change, Pearson’s correlation coefficient was estimated. Two-tailed *p*-values less than or equal to the conventional alpha level of 0.05 were considered statistically significant for all analyses.

Results

Descriptive statistics are provided in Table 2. Mean age and BMI were essentially the same in both low and high RPR groups (Table 2). In the low RPR group, there were 14 females and 24 males. In the high RPR group, there

were 22 females and 13 males. Three participants had missing information regarding their use of medications during at least one visit. Another 11 participants indicated taking medication (vitamins in one case) that was the same for both visits. Six of these 11 medication users were in the low RPR group while the remaining five were in the high RPR group. Thus, changes in medication use were not considered a confounder in the current study.

Histograms indicated acceptable normality of the data (Figures 1 and 2). Mean RPR-V1 was 73.3 BPM (SD, 11.0) compared to 75.3 BPM (SD, 12.9) for RPR-V2. The difference here, of 1.9 BPM (SD, 8.6) was not quite statistically significant according to the paired *t* test (*p* = 0.06). A scatter plot of baseline RPR-V1V2 versus RPR change (Figure 3) suggested the presence of a weak positive linear trend, with larger positive increases being correlated with higher baseline RPR (*r* = 0.231, *p* = 0.0491). Overall mean RPR-V1V2, which separated the groups into low and high RPR, was 74.3 BPM (SD, 11.2).

Mean RPR change in the low RPR group was -0.3 BPM (SD, 7.3; 95% CI, -2.7 to 2.1). Mean RPR change in the high RPR group was +4.4 BPM (SD, 9.3; 95% CI, 1.2 to 7.6 [Figure 4]). The mean difference in RPR change between the low and high RPR groups (low minus high) was -4.7 BPM (95% CI, -8.6 to -0.8) and statistically sig-

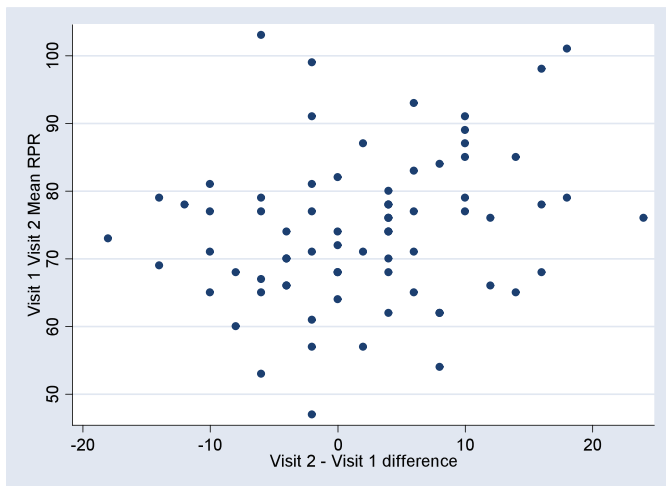


Figure 3:
Scatter plot for baseline versus Visit 2 minus Visit 1 differences in RPR.

nificant ($p = 0.02$) with a large effect size of 0.57 (Table 2 and Figure 4).

As RPR tends to be slightly higher among females (whose RPR-V1V2 mean in the present study was 78.0, compared to 70.8 for males), and as the low and high RPR groups differ in terms of their distribution by sex, mean RPR change by both sex and group was estimated. In this regard, mean RPR change did not appear to be substantially different between sexes within groups (Table 2).

Discussion

As previously noted, a number of studies show the predictability of health outcomes based on one or an average of multiple resting heart rate values.¹⁹⁻²¹ In the present study, the mean RPR-V1V2 was used as a classification measure and may potentially be an additional and convenient aspect of RPR measurements to consider for predicting future health outcomes. Within individual subjects, average RPR-V1V2 values for the low RPR group ranged from 47-74 BPM versus 76-103 in the high RPR group (Table 2). These ranges overlap with some of the categories of patients from the Framingham Study²¹ (Table 1), which specifically included groups defined by patients with 30-75 BPM and 76-220 BPM. In the Framingham study, participants were initially healthy, yet those with higher

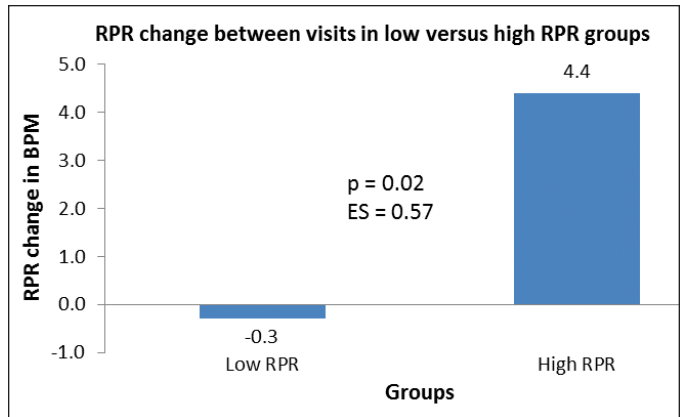


Figure 4:
Resting pulse rate (RPR) change in beats per minute (BPM) between two visits in low and high baseline RPR-V1V2 groups. ES = effect size. Note that the low RPR group is considered healthier than the high RPR group.

baseline heart rates (e.g., 76-220 BPM) had higher death rates. Framingham study participants with initially higher heart rates were at greater risk of adverse health outcomes (i.e., cardiac death) even within in each of the two age categories of relevance to the current study (Table 1).

Limitations to the study

There are several limitations to this study. Participants were young, relatively healthy adults (most were in their 20s in terms of age). Thus, these results are only generalizable to a similar population spectrum. Both the classification measure (RPR-V1V2) and the dependent variable (RPR change) in this study are calculated from the identical sets of measurements, that is, from RPR-V1 and RPR-V2. Given the mathematical correlation of these two measurements, the independent biological effect of baseline RPR on RPR change is not isolated in the current analysis. Furthermore, the estimation of baseline RPR was based on measurements on only two discrete days and therefore does not account for random variation in otherwise stable RPR measurements over multiple (more than 2) repeated measurements.

Future study ideas

The results from this pilot study provide necessary and

useful data for the planning of a future larger study. Previously, no studies on short-term changes in RPR were available from which a sample size calculation could be made. The present study's findings indicate that a sample size of 50 in each group would be needed to detect statistically significant differences in RPR change between low versus high mean RPR- V1V2 groups, assuming 80% power, a two-tailed alpha of 0.05, mean RPR change of -0.3 BPM and standard deviation change of 7.3 in the low mean RPR V1-V2 group, versus a mean RPR change of + 4.4 BPM and standard deviation of change of 9.2 in the high mean RPR-V1V2 group. In the meantime, the current study was able to detect a statistically significant difference between groups with sample sizes of only 38 and 35 in each group.

In future studies on short term RPR changes, more than two time points could be used and, perhaps the mean of the individual differences over time could be used to represent RPR change. However, because of natural RPR variability over time, it will be necessary to measure RPR change over multiple time points, and over longer time periods, in order to determine the normative distribution of this variable.

As chiropractic visits are often days rather than months or years apart, particularly in the case of a new patient, the goal would be to demonstrate that short-term changes in RPR are predictive of longer-term health outcomes when the short-term changes are used as a guide for determining when the patient needs a chiropractic adjustment. Another important line of research on RPR change could be done in the context of the maintenance care patient, in whom the frequency of care is typically once a month or so. For this purpose, the predictive validity of 30-day RPR changes could be examined.

In the present study, the classification variable was derived using baseline RPR as a source variable, but future studies could include comparisons of other independent variables, such as heart rate variability (HRV) or self-rated health perception. A similar study has been done previously with respect to HRV but only during a single visit where the RPR and HRV were measured simultaneously and therefore cross-sectionally.¹⁵ In a future study, one could examine for associations between, on the one hand, RPR change and, on the other hand, HRV and/or health-related quality of life over both the short-term and the long-term. Like RPR, HRV has a rather robust evi-

dence base.²⁵⁻²⁶ For neurological assessment on all visits, RPR has an advantage over HRV in that RPR requires no special equipment to ascertain, and is therefore user-friendly and feasible to use during routine patient visits.

One other research idea would be to use a longitudinal study design involving patients who were, versus those who were not, receiving care based on RPR change and follow them for 10 years or so. Critical health outcomes, such as death rates, could then be compared between groups. In such a study, the effects of other factors such as age, gender, and other clinical variables of interest on death rates could be either statistically controlled for and therefore treated as mere confounders, or, alternatively, measured and therefore analyzed as important additional independent variables of interest.

Finally, to achieve a more comprehensive value for resting pulse rate, RPR change could be added to baseline RPR to obtain a type of "pulse index." As an example, if two consecutive visits have RPR values of 70 and 72, this pulse index would be 73, calculated as follows:

$$\begin{aligned} \text{Baseline:} & \quad (70 + 72) / 2 = 71 \\ \text{RPR change:} & \quad 72 - 70 = 2 \\ \text{Pulse index:} & \quad 71 + 2 = 73 \end{aligned}$$

If the order of these two values was reversed, where there was a decrease in RPR on visit 2 compared to visit 1, the pulse index would be 69, calculated as follows:

$$\begin{aligned} \text{Baseline:} & \quad (72 + 70) / 2 = 71 \\ \text{RPR change:} & \quad 70 - 72 = -2 \\ \text{Pulse index:} & \quad 71 + (-2) = 69 \end{aligned}$$

In this type of pulse index, a lower number would be considered healthier than a higher number.

Conclusion

Among relatively healthy adult volunteers, a short term resting pulse rate (RPR) reduction, (mean change between visits of less than or equal to approximately zero BPM) was associated with a healthier (lower) RPR baseline compared to an RPR increase (mean change of +4 BPM or greater) which was associated with a less-healthy (higher) RPR baseline. These findings represent an initial step in the study of clinical significance for short-term resting pulse rate changes. Further research in a main study that would include other populations, longer-term outcomes, and a larger sample size is a reasonable next step.

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Craniocervical chiropractic procedures – a précis of upper cervical chiropractic

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

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

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

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

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

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

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

Introduction

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

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

Origins

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

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

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

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

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

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

Upper Cervical Anatomy

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

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

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

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

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

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

Theoretical physiologic mechanisms

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

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

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

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

Assessments for Care

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

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

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

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

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

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

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

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

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

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

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

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



Figure 1.

Supine Leg Check (SLC)

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

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

Palpation

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

Functional leg length inequality

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

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

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

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

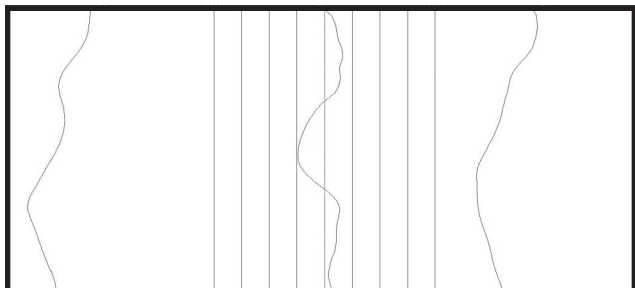
Manello (1992) outlined the state of LLI assessment within the chiropractic profession.⁴⁵ Prone leg check testing in the specific situations studied appears to have the needed inter-examiner reliability for clinical use.^{26,28-31}

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

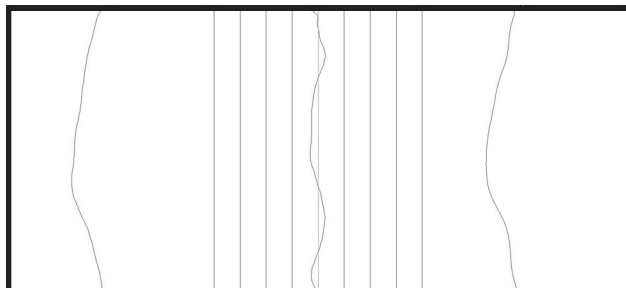
Thermography (thermometry)

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

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



2a. *Thermogram indicates adjustment needed*



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

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

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

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

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

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

Posture asymmetry

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

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



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



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

Figure 4.
The Gravity Stress Analyzer (GSA)



4b. GSA Shoulder calipers



4c. GSA Hip Calipers

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

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

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

Radiography

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

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

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

Figure 5.
Orthogonal Analysis Model Film Series



5a. Lateral



5b. Nasium



5c. Vertex

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

Figure 6.
Articular Analysis Model Film Series



6a. Lateral Cervical



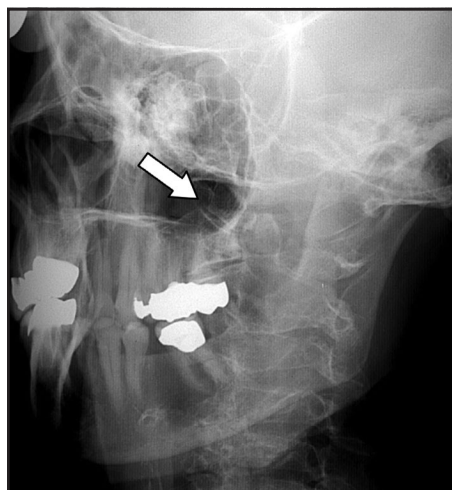
6b. Base Posterior (BP)



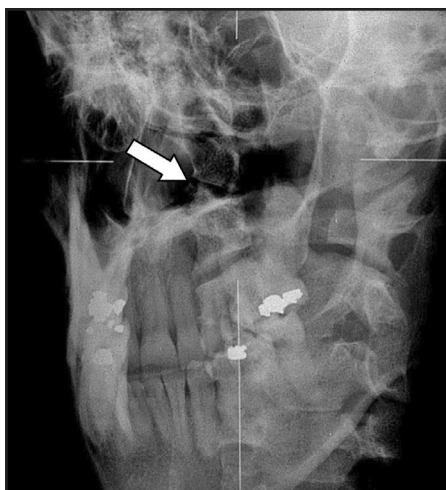
6c. Anterior-Posterior Open Mouth (APOM)

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

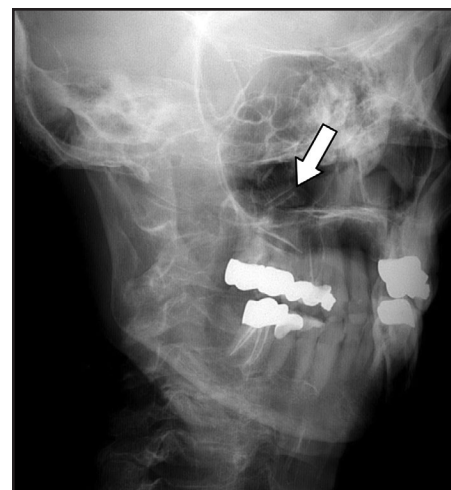
Figure 7:
Blair Protractoview showing condyle underlap/overlap (see white arrows)



7a. Protractoview C-1
Overlap (left)



7b. Protractoview C-1
Underlap (left)



7c. Protractoview C-1
Juxtaposed (right)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



Figure 8.
*Orthospinology Hand-held
Instrument Adjustment*



Figure 9.
*Orthospinology Table Instrument
Adjustment*



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

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

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

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

UCT Contrasts

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

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



Figure 11.
Knee Chest Adjustment



Figure 12.
Blair adjustment

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

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

Safety

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

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

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

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

Symptomatic reactions to UCT care

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

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

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

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

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

UCT Research

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

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

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

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

UCT Case Reports

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

Neurodegenerative Disorders

Parkinson disease (PD)

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

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

Multiple Sclerosis (MS)

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

Seizure Disorders:

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

Headache and Migraine:

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

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

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

Seizure and Migraine:

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

Fibromyalgia:

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

Chronic Fatigue Syndrome

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

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

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

Scoliosis:

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

Blood Pressure (Hypertension):

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

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

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

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

Miscellaneous

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

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

Limitations

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

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

Conclusion

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

Acknowledgements

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Handbook of Neurological Sports Medicine
Anthony L. Petraglia, Julian E. Bailes, Arthur L. Day
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A must have for sports-based clinicians and field practitioners, the *Handbook of Neurological Sports Medicine* covers the entire spectrum of neurological sports injuries. Designed for physicians, athletic therapists, physical therapists, and other sports-based health-practitioners, this text provides a highly-referenced and extremely current review of pertinent literature surrounding both common and rare neurological injuries.

The majority of this textbook provides a very comprehensive view of concussion injuries incorporating pathophysiology, biomechanics, acute on-field and clinical management, post-concussion syndrome, second impact syndrome, chronic traumatic encephalopathy, advanced imaging, as well as recent advancements in the literature surrounding pre-season baseline testing, diagnosis, and return-to-play strategies. The authors present a very unbiased viewpoint of existing literature through the critical appraisal of findings from numerous and often conflicting concussion research studies.

Although there is a heavy emphasis on sport-related concussions and brain injuries there are also chapters examining numerous central and peripheral nervous system injuries that often occur in a sports setting.

The title of this book is a little misleading as the 401 page hardcover book should be considered a medical textbook rather than a “handbook”, however I would strongly recommend this book to anyone involved in the field of sports-medicine, particularly those that manage concussed athletes.

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Watch Your Back! How the Back Pain Industry Is Costing Us More and Giving Us Less – and What You Can Do to Inform and Empower Yourself in Seeking Treatment.

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Watch Your Back! is an enjoyable new book by Dr. Richard Deyo that offers patients, physicians and policymakers an insightful, evidence-based, and highly readable account of the many, many options for people caring for their aching backs. Deyo’s voice is personable and knowledgeable – as if you’re talking over the backyard fence with your next-door-neighbor...a neighbor who just happens to have conducted research on just about every back pain treatment mentioned in his book. That research evidence is broken up with real world accounts of patients’ fruitless searches for pain relief and includes case studies of such famous back pain sufferers as General David Fridovich, Cindy McCain, Dr. Jerome Groopman and President John F. Kennedy. The text walks the reader through 15 short chapters of the major treatments available for back pain including medication, surgery, injections, ablations, fusions, gadgets, complementary approaches, and self-care. Some chapters really sing, such as those on diagnoses and imaging techniques, the marketing of back pain treatments, the proliferation of fusion techniques, and the role of the placebo effects underlying effective and ineffective therapies alike. Some chapters were mild disappointments, such as the discussion on complementary practices. Spinal manipulation, acupuncture and massage are described as generally safe, feel good treatments that work for many people. However, too many words in this sparse chapter were spent on a historical review of Drs. Palmer and Still as the originators of chiropractic and osteopathy, while not enough were devoted to the increasing, and increasingly sound, evidence from randomized controlled trials on the efficacy of complementary treatments for back pain. Perhaps the best chapters are those empowering patients to actively take their recovery from back pain into their own hands. Encouraged are the use of treatment decision aids and such self-care strategies as stress management, cognitive-behavioral therapy, and exercise. The book concludes with recommendations for

policymakers. Overall, *Watch Your Back!* provides a comprehensive yet concise look at what we're doing right in the treatment of back pain, and what treatments are not making an impact. This book is recommended for spine care professionals and their patients alike.

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