JCCA
Journal of the Canadian Chiropractic Association

(Formerly the Canadian Chiropractic Association Journal)

Published by the Canadian Chiropractic Association and issued quarterly

Printed and mailed at Toronto, Ontario.

Publications Mail Registration 09788

EDITORIAL AND EXECUTIVE OFFICES,

30 ST. PATRICK STREET, SUITE 600, TORONTO, CANADA M5T 3A3

General Information: The Journal of the Canadian Chiropractic Association is the official quarterly publication by the Canadian Chiropractic Association. The JCCA is published quarterly by the Canadian Chiropractic Association as a medium of communication between the Association and its members and is a forum for fair comment and discussion of all matters of general interest to the chiropractic profession and the Association. Readers are invited to comment and express their opinions on relevant subjects. Views and opinions in editorials and articles are not to be taken as official expression of the Association's policy unless so stated. Publication of contributed articles does not necessarily imply endorsement in any way of the opinions expressed therein and the Journal and its publisher does not accept any responsibility for them. Your membership fee to the Canadian Chiropractic Association includes a $27.50 voluntary subscription for the Journal of the Canadian Chiropractic Association. Subscription rates for non-members are $27.50 per year. Foreign subscriptions are $74.00 Canadian. Subscriptions outside Canada and USA are sent airmail. Additional copies and back issues, when available, may be purchased at $15.00 per issue. Business correspondence should be addressed to: the Editor of JCCA, 30 St. Patrick Street, Suite 600, Toronto, Canada M5T 3A3.

INDEXING SERVICES

JCCA is indexed by PubMed Central, CINAHL (Cumulative Index to Nursing and Allied Health Literature), MANTIS (formerly CHIROLARS), AMED, PASCAL, British Library Complementary Medicine Index, Index to Chiropractic Literature, and selectively by SPORTDiscus.

Contents

JCCA Vol 55 No 2 ISSN 00083194

Editorial Board

0008-3194/2011/69–75/$2.00/©JCCA 2011

The importance of diagnostic test parameters in the interpretation of clinical test findings: The Prone Hip Extension Test as an example

Paul Bruno, BHK, DC, PhD*

The use of diagnostic tests is a crucial aspect of clinical practice since they assist clinicians in establishing whether a patient has or does not have a particular condition. In order for any clinical test to be used most appropriately, it is essential that several parameters be established regarding the test and that these are made known to clinicians to inform their clinical decision making. These include the test's sensitivity, specificity, predictive values, and likelihood ratios. This article reviews their importance as well as provides an illustrative example that highlights how knowledge of the parameters for a given test allows clinicians to better interpret their test findings in practice.
(JCCA 2011; 55(2):69–75)

KEY WORDS: diagnostic test, clinical test, practice

L'utilisation de tests diagnostiques est un aspect crucial de la pratique clinique puisqu'ils aident les cliniciens à déterminer si le patient présente ou ne présente pas un état pathologique particulier. Pour que tout essai clinique soit utilisé de façon appropriée, il est essentiel que plusieurs paramètres soient établis en rapport au test, et que ceux-ci soient portés à la connaissance des cliniciens afin d'appuyer leurs prises de décisions cliniques. Cela comprend la sensibilité du test, la particularité, les valeurs prédictives et les rapports de vraisemblance. Cet article examine leur importance et fournit un exemple indicatif qui illustre comment la connaissance des paramètres pour un test donné permet aux cliniciens de mieux interpréter leurs résultats de test dans la pratique.
(JCCA 2011; 55(2):69–75)

MOTS CLÉS : *test diagnostique, test clinique, pratique*

Introduction

Since the fundamental purpose of any diagnostic test is to help determine whether a patient has or does not have a particular condition,[1,2] clinicians should be aware of certain parameters regarding the tests they use if these tests are to be applied most appropriately and effectively in practice. The most basic parameters that need to be established regarding any clinical test are that it demonstrates a sufficient degree of reliability and validity.[3–5] If these two important parameters are not met, then the test's value in assisting clinicians to arrive at a diagnosis, form a treatment plan, or monitor a patient's progress is questionable.[3–5]

Reliability refers to the consistency and repeatability of outcomes as measured by the clinical test.[3,4] This includes an assessment of whether a test result measured by one examiner would also be obtained by a different examiner performing the test on the same subject at the same time (i.e. inter-examiner agreement) or by the same examiner performing the test on the same subject at a different time (i.e. intra-examiner agreement).[3] Validity refers to whether the clinical test is accurate in measuring what it is purporting to measure.[3,4,6] Of the three types of validity, only "criterion" validity is relevant to the evaluation of a clinical test.[6] This involves the comparison of results obtained from the clinical test to those obtained from a

* Assistant Professor and CCRF Research Chair in Neuromusculoskeletal Health. Faculty of Kinesiology and Health Studies, University of Regina. Email: paul.bruno@uregina.ca. Faculty of Kinesiology and Health Studies. University of Regina, Regina, SK S4S 0A2. Canada. Tel: (306) 337-3343, fax: (306) 585-4854.

"reference" (i.e. "criterion") diagnostic test which, although it provides a more accurate assessment of the condition being investigated, is deemed to be too expensive and/or impractical to use routinely in clinical practice. Therefore, most clinical tests are used to classify patients as "positive" or "negative" depending on the presence or absence (respectively) of a particular sign or symptom, which is then presumed to be indicative of the presence or absence of the condition (i.e. a "positive" test result indicates that the patient has the condition). Assessing the validity of a clinical test's usefulness in this regard requires knowledge of a variety of parameters, all of which are important and must be individually considered by the clinician in order to appropriately interpret the results he/she obtains when performing the test on a patient.[5,7] These parameters include the test's *sensitivity*, *specificity*, *predictive values*, and *likelihood ratios*.

The *sensitivity* of a clinical test is the proportion of subjects with the condition who are correctly identified by the test and provide a "positive" result.[1,2,6–8] Thus, if the sensitivity is high, a "negative" test result will effectively rule out the condition.[2] The *specificity* is the proportion of subjects without the condition who are correctly identified by the test and provide a "negative" result.[1,2,6–8] Thus, if the specificity is high, a "positive" test result will effectively rule in the condition.[2] The *positive predictive value* is the proportion of subjects with a "positive" test result who are correctly diagnosed, whilst the *negative predictive value* is the proportion of subjects with a "negative" test result who are correctly diagnosed.[1,2,6,8] Since both the condition's presence (i.e. "present" or "absent") as well as the test result (i.e. "positive" or "negative") are categorical in nature, the resulting calculations for these parameters are based on constructing a 2×2 contingency table, as illustrated in Figure 1.

There is an important trade-off between these two pairs of parameters. Although the predictive values are more valuable to clinicians since they provide a direct assessment of the usefulness of the test in practice, they are also both influenced by the prevalence of the condition in the population to whom the test is applied.[1,2,6,8] A higher prevalence tends to lead to an increased positive predictive value and a decreased negative predictive value, whilst a lower prevalence tends to lead to an increased negative predictive value and a decreased positive predictive value.[8] Therefore, it is vital that the

		Condition	
		Present	Absent
Test Result	Positive	a	b
	Negative	c	d

a = "True Positives" Sensitivity = a/(a + c)
b = "False Positives" Specificity = d/(b + d)
c = "False Negatives" Positive predictive value = a/(a + b)
d = "True Negatives" Negative predictive value = d/(c + d)

Figure 1 *An illustration of how to calculate the sensitivity, specificity, positive predictive value, and negative predictive value for a clinical test from a 2×2 contingency table.*

predictive values that are calculated for a clinical test in a particular study sample should not be taken to apply universally. The sensitivity and specificity, on the other hand, are unaffected by the prevalence of the condition, but are not as useful to clinicians since they give little indication as to how good the test is at predicting the correct diagnosis.[1,2,6,8] For these reasons, the use of these four parameters alone can occasionally lead clinicians to make misleading inferences regarding the value of a clinical test and, therefore, the results they obtain when using it in practice.[6]

As a result, two other parameters, namely the *likelihood ratios of a positive and negative test*, have been suggested to be better indicators of the usefulness of a clinical test.[1,2,6] Effectively, these ratios compare the probability of getting a test result if the subject truly had the condition with the corresponding probability if he/she did not. Figure 2 illustrates how to calculate these parameters, as well as describes the general consensus on how to interpret the resulting values.[1,2,6]

Since these ratios effectively summarize the information contained in each of the four previously-described parameters and are not influenced by the prevalence of the condition, they are considered to be more valuable to clinicians.[2,6] In addition, since likelihood ratios (as well as each of the other four parameters) are proportions, they may be expressed as a percentage and should always be presented with an appropriate confidence interval.[1,7,8]

Likelihood ratio of a positive test = (sensitivity)/(1 – specificity)
Likelihood ratio of a negative test = (1 – sensitivity)/(specificity)

- The higher the likelihood ratio of a positive test, the more certain one can be that a positive test result indicates the subject has the condition. A value of 10 or more is considered an indicator that a positive test result is very good at ruling in the condition.
- The lower the likelihood ratio of a negative test, the more certain one can be that a negative test result indicates the subject does not have the disorder. A value of 0.1 or less is considered an indicator that a negative test result is very good at ruling out the condition.
- If a likelihood ratio is close to 1.0, then the test result is not a good indicator whether the subject has (for a positive test result) or does not have (for a negative test result) the condition.

Figure 2 *An illustration of how to calculate the positive and negative likelihood ratios for a clinical test and the general consensus on how to interpret the resulting values.*

The Prone Hip Extension Test

The Prone Hip Extension (PHE) Test was one of a series of clinical tests developed by Vladimir Janda as a means of evaluating for motor control deficiencies during specific movements which were proposed to be associated with the development of various musculoskeletal pain syndromes.[9,10] Based on his clinical observations, Janda suggested that this particular test could be used as a means of assessing for a particular functional muscle imbalance (variously referred to as "lower crossed syndrome," "distal crossed syndrome," or "pelvic crossed syndrome") that he deemed to be important in the development and/or perpetuation of low back pain (LBP). Despite slight variations in the traditional descriptions of how to perform the PHE Test, the general procedure was to have the patient lie prone and alternately lift each leg away from the table whilst the clinician observes and/or palpates four muscles of interest – namely the ipsilateral gluteus maximus (GM) and hamstring (HAM) muscles as well as the ipsilateral erector spinae (IES) and contralateral erector spinae muscles (CES) – in an attempt to determine their order of activation.[9–12] Although there was some debate as to what the "normal" order of activation should be during the movement, with both the GM and HAM being proposed as the muscle that should become active first, there was general agreement that these two muscles should become active prior to the CES and IES.[11-13] Regardless of this debate, the clinician was instructed to assess whether the erector spinae muscles were readily activated and/or the activation of the GM was delayed, which would be indicative of an "abnormal" motor pattern for this movement.[9–11,13]

As described, the theory behind this "traditional" use of the PHE Test was based primarily on clinical observations. However, the amount of published research supporting and quantifying its clinical usefulness in this regard is sparse. To the author's knowledge, there are no published studies which have investigated the validity and reliability of determining the motor patterns that patients use during PHE via observation or palpation. Ergo, the accuracy with which clinicians can detect the muscle activation order by either of these methods, as well as whether the results obtained for a particular patient are reproducible by different clinicians, are unknown. It has been shown that both asymptomatic subjects[14] and LBP patients[15] demonstrate a great deal of within-subject variability in the activation orders they use when performing PHE over a series of repetitions (which is how this test is commonly performed in practice), and that the absolute differences in the relative onset times of the four muscles are generally quite small.[15–18] Considering these findings, it seems reasonable to question whether a clinician could actually be expected to accurately detect these small differences in muscle onsets by a method other than electromyography, a concern which has also been expressed by other authors.[16,17]

Even if it was to be demonstrated that the reliability and validity of detecting muscle onsets by observation or palpation were sufficiently acceptable for the test to be used by clinicians in this manner, the actual clinical importance of the activation order a patient uses to achieve PHE is questionable. First, there does not appear to be "normal" nor "abnormal" muscle activation orders for PHE.[14,15] As well, the original contention that a GM onset after that of the erector spinae muscles was "abnormal" also appears to be incorrect as several studies have demonstrated that the GM seems to most commonly be the final muscle to become active during PHE.[14,15,17,18] Indeed, in both asymptomatic subjects and LBP patients, the HAM, IES, and CES appear to generally become active almost simultaneously and in a seemingly random order, followed by the

GM after a delay. Collectively, these points seriously challenge the appropriateness and clinical value of using the PHE Test as it was traditionally described.

More recently, Murphy et al.[5] provided an alternative description of how clinicians should perform and interpret the PHE Test. They proposed that rather than attempting to assess the motor pattern(s) a patient utilizes to achieve the movement, clinicians should instead observe for the presence of the following "abnormal" deviations of the lumbar spine during the movement: rotation of the lumbar spine such that the spinous processes appeared to move toward the side of hip extension; a lateral shift of the lumbar spine toward the side of hip extension; and extension of the lumbar spine. It was suggested that this may be a better indication of suspected "dynamic instability" of the lumbar spine than the traditional use of the test.

Importantly, the inter-examiner reliability of classifying LBP patients as "Positive" and "Negative" based on the presence or absence (respectively) of the three "abnormal" deviations of the lumbar spine motion described above has been found to be good.[5] There is, however, a paucity of published research attempting to explain the underlying motor control strategies that account for the presence or absence of these deviations. A preliminary study using asymptomatic subjects demonstrated that the presence of one or more of the deviations was associated with a significant delay in the onset of the GM.[19] Although it is unknown at present if these findings are generalizable to the LBP population, they would *seem* to suggest that the presence of these deviations have the potential to be used as an indirect indicator that an "abnormal" motor pattern is present in the form of a significantly delayed onset of the GM during PHE. However, in order for clinicians to more appropriately interpret their findings when using the PHE Test in this manner, they must first consider the validity of using the presence of these deviations as being "diagnostic" of this underlying motor pattern. To this end, knowledge of the test's sensitivity, specificity, predictive values, and likelihood ratios is necessary.

The Presence of "Abnormal" Lumbar Spine Deviations During the PHE Test as Being Diagnostic of a Significantly Delayed Onset of the GM: A Consideration of its Diagnostic Test Parameters

As outlined in the previous section, it has been shown that the presence of one or more of the lumbar spine deviations seems to be associated with a significant delay in the onset of the GM during PHE in asymptomatic subjects. It must be stressed, however, that this finding was based on the calculation and comparison of group averages. In other words, the average onset time of the GM during sets of PHE that demonstrated the deviations was compared to the average onset time of the GM during sets of PHE that did not. As an author of this particular paper, I can attest to the fact that not all of the sets classified as "Positive" demonstrated a large delay in GM onset compared to those classified as "Negative." The same holds true for those classified as "Negative" (i.e. a minority of these sets demonstrated a delay in GM onset comparable to those classified as "Positive"). Thus, the presence of these "false positives" and "false negatives" necessitate the calculation of the test's sensitivity, specificity, predictive values, and likelihood ratios in order to comment on the inherent value that "positive" and "negative" test results would have for clinicians. One caveat that must be emphasized at this point is that since only asymptomatic subjects were used in the cited study, values for these parameters cannot be established for the LBP population based on these data. The following calculations are provided merely for illustrative purposes and should not be taken to inform clinical decisions if/when the PHE Test is performed in clinical practice on LBP patients.

It has been highlighted that diagnostic test parameters analyze a test's ability to diagnose the presence or absence of a condition by the presence or absence of a particular sign or symptom. As such, the first issue that must be addressed is to define the "condition" that the PHE Test is being used to diagnose in this case. Simply stating that the test is attempting to determine the presence or absence of a "significantly delayed GM onset" during PHE is insufficient since the muscle onset time data is continuous in nature and the test parameters require categorical outcomes for the condition (i.e. the condition is either present or absent). It is therefore necessary to select a specific magnitude for the onset delay above which the relative onset of the GM is defined as "significantly delayed" (i.e. the condition is present), and below which it is defined as "not significantly delayed" (i.e. the condition is absent).

Since there is no universally accepted standard that is used to define that a particular muscle's onset is "significantly delayed" for this movement, the decision as to

Figure 3 *The sensitivity, specificity, predictive values, and likelihood ratios of the PHE Test for diagnosing the presence or absence of a "significant delay" in GM onset as calculated from the data collected in Bruno et al. (2008).*[19]

		"Significantly Delayed" GM Onset	
		Present	Absent
PHE Test Result	Positive	7	6
	Negative	4	26

Sensitivity = 7/(7 + 4) = 0.636	63.6% (95% CI: 35.4 to 84.8)
Specificity = 26/(6 + 26) = 0.813	81.3% (95% CI: 64.7 to 91.1)
Positive predictive value = 7/(7 + 6) = 0.538	53.8% (95% CI: 29.1 to 76.8)
Negative predictive value = 26/(4 + 26) = 0.867	86.7% (95% CI: 70.3 to 94.7)
Likelihood ratio of a positive test = (0.636)/(1 – 0.813)	3.394 (95% CI: 1.437 to 7.803)
Likelihood ratio of a negative test = (1 – 0.636)/(0.813)	0.448 (95% CI: 0.184 to 0.831)

what magnitude of onset delay to select for the "cut-off" will need to be somewhat subjective for the purpose of this example. Several studies have demonstrated a significant delay in the onset of the transversus abdominis during various arm and leg movements in LBP subjects, with the magnitude of the delay varying from ~60 ms to 165 ms depending on the specific movement the subjects were asked to perform.[20–22] It has been suggested that these onset delays are potentially indicative of motor control deficits that may lead to inefficient lumbar spine stabilization. A delayed onset of 110 ms will therefore be selected as being indicative of a motor control deficit during PHE that represents inefficient lumbar spine stabilization since it is the approximate mid-point of the range provided. Thus, the "condition" will be deemed present (i.e. the GM onset will be deemed "significantly delayed") if the relative onset delay exceeds 110 ms. Conversely, the "condition" will be deemed absent if the relative onset delay is less than 110 ms.

Using this definition, an analysis of the raw data collected for the cited study (not presented) can be analyzed to categorize the PHE sets classified as "Positive" into "true positives" (i.e. those which demonstrate a "significantly delayed" GM onset) and "false positives" (i.e. those which do not demonstrate a "significantly delayed" GM onset). This reveals 7 "true positives" and 6 "false positives." Likewise, the "Negative" PHE sets can be categorized into "true negatives" (i.e. those which do not demonstrate a "significantly delayed" GM onset) and "false negatives" (i.e. those which demonstrate a "significantly delayed" GM onset). This reveals 26 "true negatives" and 4 "false negatives." These values can then be inserted into a 2 × 2 contingency table and used in the calculations in each of the test parameters (see Figure 3).

These calculated values lend themselves to several implications regarding the appropriateness of using the presence of the previously-described "abnormal" lumbar spine motion patterns during the performance of the PHE Test as being diagnostic of an underlying "significant delay" in GM onset. Although the specificity indicates that the value of a positive test result at ruling in the condition is relatively high, only 53.8% of the positive test results were correct. In addition, whilst 86.7% of the negative test results were correct, the sensitivity indicates that the value of a negative test result at ruling out the condition is only moderate. Since predictive values are affected by the prevalence of the condition, it could be argued that these apparent contradictions may be explained by the relatively low prevalence of the condition in this particular sample of subjects, which may have had an effect to raise the negative predictive value and lower the positive predictive value. This reinforces the need to consider the calculated likelihood ratios, both of which indicate that the value of positive and negative test results are "somewhat useful."[6]

It would be essential for clinicians to know and con-

sider all of these factors if they decide to use the PHE Test in this manner since they would be able to more appropriately interpret and use the test results obtained for a particular patient in their overall clinical decision making. It should be emphasized once again, however, that the implications described above should not be generalized to the LBP population since the parameters have only been calculated here for illustrative purposes.

Conclusion

It is essential that, whenever possible, clinicians know and make use of specific parameters related to the diagnostic tests they use in practice in order to appropriately interpret their clinical findings. This would allow for more informed decision making when it comes to the diagnosis and management of a patient's condition. Although these parameters have been established for many tests used in health care, this is not universally true. Henceforth, it is crucial that further research be conducted to establish these parameters for the variety of clinical tests that are used by health care practitioners.

Acknowledgements

The author would like to acknowledge Jeff Bagust, Jennifer Bolton, Jonathan Cook, and Neil Osborne at the Anglo-European College of Chiropractic for the assistance they provided in the conduction of the research that formed the framework for this paper.

Declaration

The research that formed the framework for this paper was conducted whilst the author was a Research Fellow at the Anglo-European College of Chiropractic. The funding for this fellowship position was provided by the Anglo-European College of Chiropractic and The College of Chiropractors. The author has no conflicts of interest to declare regarding this paper or the material described therein.

References

1 Altman DG. Diagnostic Tests. In: Altman DG, Machin D, Bryant TN, Gardner MJ, editors. Statistics with confidence 2nd Ed. Bristol: BMJ Books; 2000. p. 105–19.
2 Davidson M. The interpretation of diagnostic test: a primer for physiotherapists. Aust J Physiother. 2002; 48(3):227–32.
3 Khan KS, Chien PF. Evaluation of a clinical test. I: assessment of reliability. BJOG. 2001 Jun; 108(6):562–7.
4 Seffinger MA, Najm WI, Mishra SI, Adams A, Dickerson VM, Murphy LS, et al. Reliability of spinal palpation for diagnosis of back and neck pain: a systematic review of the literature. Spine. 2004 Oct 1; 29(19):E413–25.
5 Murphy DR, Byfield D, McCarthy P, Humphreys K, Gregory AA, Rochon R. Interexaminer reliability of the hip extension test for suspected impaired motor control of the lumbar spine. J Manipulative Physiol Ther. 2006 Jun; 29(5):374–7.
6 Chien PF, Khan KS. Evaluation of a clinical test. II: Assessment of validity. BJOG. 2001 Jun; 108(6):568–72.
7 Bland M. An Introduction to Medical Statistics. Oxford: Oxford University Press; 1987.
8 Altman DG. Practical Statistics for Medical Research. London: Chapman & Hall; 1991.
9 Jull GA, Janda V. Muscles and Motor Control in Low Back Pain: Assessment and Management. In: Twomey LT, Taylor JR, editors. Physical Therapy of the Low Back. New York: Churchill Livingstone; 1987. p. 253–78.
10 Janda V. Evaluation of Muscular Imbalance. In: Liebenson C, editor. Rehabilitation of the Spine: A Practitioner's Manual. Baltimore: Lippincott Williams & Wilkins; 1996. p. 97–112.
11 Lewit K. Manipulative Therapy in Rehabiliation of the Locomotor System. 2nd ed. Oxford: Butterworth-Heinemann; 1991.
12 Chaitow L, DeLany JW. Clinical Application of Neuromuscular Techniques. Volume 2 – The Lower Body. Edinburgh: Churchill Livingstone; 2002.
13 Janda V, Frank C, Liebenson C. Evaluation of Muscular Imbalance. In: Liebenson C, editor. Rehabilitation of the Spine: A Practitioner's Manual 2nd Ed. Baltimore: Lippincott Williams & Wilkins; 2007. p. 203–25.
14 Bruno P, Bagust J. An investigation into the within-subject and between-subject consistency of motor patterns used during prone hip extension in subjects without low back pain. Clin Chiropr. 2006; 9(1):11–20.
15 Bruno P, Bagust J. An investigation into motor pattern differences used during prone hip extension between subjects with and without low back pain. Clin Chiropr. 2007; 10(2):68–80.
16 Pierce MN, Lee WA. Muscle firing order during active prone hip extension. J Orthop Sports Phys Ther. 1990; 12(1):2–9.
17 Lehman GJ, Lennon D, Tresidder B, Rayfield B, Poschar M. Muscle recruitment patterns during the prone leg extension. BMC Musculoskelet Disord. 2004 Feb 10; 5:3.
18 Sakamoto AC, Teixeira-Salmela LF, de Paula-Goulart FR, de Morais Faria CD, Guimaraes CQ. Muscular activation patterns during active prone hip extension exercises. J Electromyogr Kinesiol. 2009 Feb; 19(1):105–12.
19 Bruno P, Bagust J, Cook J, Osborne N. An investigation into the activation patterns of back and hip muscles during prone hip extension in non-low back pain subjects: Normal

vs. abnormal lumbar spine motion patterns. Clin Chiropr. 2008; 11(1):4–14.
20 Hodges PW, Richardson CA. Inefficient muscular stabilization of the lumbar spine associated with low back pain. A motor control evaluation of transversus abdominis. Spine. 1996 Nov 15; 21(22):2640–50.
21 Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. J Spinal Disord. 1998 Feb; 11(1):46–56.
22 Hodges PW, Richardson CA. Altered trunk muscle recruitment in people with low back pain with upper limb movement at different speeds. Arch Phys Med Rehabil. 1999 Sep; 80(9):1005–12

0008-3194/2011/76–95/$2.00/©JCCA 2011

A narrative review of the published chiropractic literature regarding older patients from 2001–2010

Brian J. Gleberzon, BA, DC, MHSc*

Introduction: *The purpose of this article was to perform a narrative review of the chiropractic literature regarding older patients between 2001 and 2010.*

Methods: *A three step search strategy of the literature involved electronic searching, hand searching and reference tracking.*

Results: *One hundred and eighty eight articles germane to chiropractic geriatric practice and education were retrieved.*

Discussion: *Compared to the review of the literature conducted prior to 2000, the number of references on chiropractic geriatric education increased from 3 to 11, the number of demographic studies increased from 9 to 18, the number of case reports increased from 25 to 83, the number of clinical trials increased from 4 to 21 (only two RCTs found) and the number of references on clinical guidelines and general clinical information increased from 18 to 55.*

Conclusion: *This review found 188 retrievable articles available to practitioners to effectively care plan for their older patients, a better than three fold increase in the number of references found during a similar review conducted at the end of the previous decade. However, there is clearly a gap in the evidence base of chiropractic geriatric care, particularly the under-representation of clinical trials of all kinds involving older chiropractic patients.*

(JCCA 2011; 55(2):76–95)

KEY WORDS: geriatric, chiropractic, older patient

Introduction : *Le but de cet article était de faire une revue narrative de la littérature chiropratique au sujet des patients plus âgés entre les années 2001 et 2010.*

Méthodes : *Une stratégie de recherche à trois étapes de la littérature comprenait la recherche électronique, la recherche manuelle et le suivi de références.*

Résultats : *Cent quatre-vingt huit articles pertinents à la pratique de chiropractie gériatrique et à l'éducation furent retracés.*

Discussion : *En comparaison avec la revue de documentation réalisée avant l'année 2000, le nombre de références sur la formation de la chiropractie gériatrique est passé de 3 à 11, le nombre d'études démographiques est passé de 9 à 18, le nombre de rapports de cas est passé de 25 à 83, le nombre d'essais cliniques est passé de 4 à 21 (seulement deux essais cliniques aléatoires trouvés), et le nombre de références sur les principes directeurs des activités cliniques et sur l'information clinique générale est passé de 18 à 55.*

Conclusion : *Cette recherche a recensé 188 articles mis à la disposition des praticiens pour planifier efficacement des soins pour leurs patients plus âgés, une augmentation de plus de trois fois le nombre de références trouvées au cours d'une étude similaire menée à la fin de la décennie précédente. Toutefois, il y a clairement un fossé dans les soins de chiropractie gériatrique fondés sur l'expérience clinique, en particulier la sous-représentation d'essais cliniques de toutes sortes impliquant des patients de chiropractie plus âgés.*

(JCCA 2011; 55(2):76–95)

MOTS CLÉS : gériatrique, chiropractie, patient plus âgé

* Professor and Chair, Department of Applied Chiropractic, Canadian Memorial Chiropractic College, 6100 Leslie St. Toronto, ON M2H 3J1. E-mail: bgleberzon@cmcc.ca

Introduction

After World War Two, the surge in the birth rates in the Allied Power countries (i.e. Canada, the United Kingdom, Australia and the United States) began what is now colloquially referred to as the "baby boom," with this demographic group spanning the years between 1946 and 1965.[1] The Boomers represent the largest single demographic cohort in these countries and their influence, in terms of sheer numbers, monetary impact and political clout has been felt in virtually every socio-cultural institution, from education to labour to healthcare.[1] The year 2011 is something of a watershed moment since the leading edge of the Boomers will turn 65 years old, the age traditionally associated with turning "old" since it is the age of eligibility for most national entitlement programs (social insurance, for example).

Several years ago, this author conducted a review of the literature on *chiropractic geriatric care* prior to the year 2001 in an attempt to further strengthen the profession's cultural authority and establish an evidence-based care approach.[2] Since that time, there has been an exponential growth in the number of publications and presentations on this topic and it would therefore be timely to perform a narrative literature review of the chiropractic literature regarding older patients during the intervening years, published between 2001 and 2010.

Methods

Search Strategy

A three step literature review strategy was employed for this study. The first step involved a conventional electronic literature search using the following search strategy: The databases Index to Chiropractic Literature, PubMed and CINAHL were searched from 2000–2010 (English only) to August 2010. The Index to Chiropractic Literature was searched using subject headings "Aged" or "Geriatrics" or "Geriatric Assessment" and text words: senior* or older or geriatric* or elder.* PubMed was searched using text word chiropract* and the following MeSH terms: Accidental Falls, Geriatric Assessment, Health Services for the Aged, and (Aged or Aged 65+ or 80. Key words "Manipulation," "Spinal Manipulation," and "Chiropractic" were combined with the age limiters and the search also included "In Process" records for Chiropract* using the EBSCO MEDLINE. The same search strategy was used to search CINAHL.

This strategy yielded 112 articles, 3 of which, upon subsequent review, were found to be introduction and subsequent discussion of the same case study. Fourteen of the articles found did not meet the inclusion requirements (see below); thus, this search strategy yielded 95 relevant citations.

The second step of this review involved handsearching chiropractic journals (Journal of the Canadian Chiropractic Association, Journal of Chiropractic Medicine, Journal of Chiropractic Education, Journal of Manipulative and Physiological Therapeutics, Clinical Chiropractic, Topics In Clinical Chiropractic, Journal of Neuromusculoskeletal Systems, and Journal of the American Chiropractic Association) and two international chiropractic conferences (World Federation of Chiropractic and Association of Chiropractic Colleges – Research Agenda Conference) between 2001–2010. However, in order to not over-inflate the number of references retrieved by this review, if a topic was presented at a conference and subsequently published in a peer-reviewed journal, those manuscripts were combined and only counted once. Since this article is meant to capture all the literature germane to chiropractic and older patients, a decision was made to include conference proceedings even though it must be emphasized that the level of peer review for such conferences is often much less stringent than it is for publication of manuscripts in indexed journals. The reader is reminded that this study is a tabulation of the literature retrievable between 2001 and 2010 and not a systematic review of that literature. That said, the next step will be to conduct a systematic review of the case series, systematic reviews, observational studies and randomized clinical trials retrieved during this study.

The third step of this study was reference tracking (reviewing the references of many of the articles retrieved by the first two search strategies to further capture other pertinent references). This tertiary step yielded additional source material, principally in the form of textbook chapters, conference workshops, government briefs, Cochrane Reviews and Guidelines from organizations such as the American Geriatric Society and the World Health Organization; however, those references not specifically germane to *chiropractic* geriatric care are listed under "*miscellaneous references*" and were not included in the final tally.

Inclusion Criteria

All citations found that discussed *chiropractic* and patients *age 55 years* and older published between 2001–2010 have been included in this study, following the example of the review article that characterized older chiropractic patients published by Hawk et al. in 2000.[3] Studies that involved mixed populations[4–13] were excluded; however, studies that utilized "osteopathic manipulation" were included in this study given the biomechanical similarity of this modality in the chiropractic and osteopathy professions. Lastly, articles that were included in the previous review by Gleberzon[2] were not included in this review even if they appeared in any of the search strategies employed.

Grouping of the articles retrieved during this study was problematic given the divergent nature of many of these studies. It was therefore decided that, in order to facilitate the comparison of the articles retrieved during this study with the articles retrieved from the previous study published in 2001[2] the same topic headings would be used: These were:

- (a) *chiropractic geriatric education* (this included articles that discuss education and training of students in the area of geriatric care taught at accredited chiropractic colleges);
- (b) *demographics and epidemiological studies* (this included studies on utilizations rates of chiropractic services by older patients and the characteristics of those patients);
- (c) *case reports and case series*
- (d) *clinical trials* (this includes outcome studies, observational studies as well as practice-based and randomized clinical trials) and;
- (e) *guidelines and other clinical information* (this was often in the form of general information for patient care and systematic reviews on a particular topic such as falls prevention).

To better position the articles retrieved, manuscripts that discuss clinical trial protocols, patient recruitment or study feasibility have been included in section (d) *clinical trials* under a sub-heading of "*clinical trials to be conducted.*" Retrieved articles that are thematically-based reviews (i.e. fall prevention, assessment procedures for older patients, importance of exercise for the elderly) have been included under section (e) *guidelines and clinical information* (see Table 1).

Where ever possible, articles are ordered first chronologically (by year of publication) and then alphabetically (by last name of first author) in each sub-heading.

Results

(a) Geriatric Chiropractic Education (n = 11)

Eleven articles were found on geriatric chiropractic education. On these articles, six[14,17,20–23] discussed the structure and development of the geriatric courses in the core curriculum or as an elective at specific chiropractic colleges (often emphasizing the importance of an interdisciplinary approach), one discussed the development of a community-based program for interns,[15] one specifically described strategies to combat ageism through student education,[16] two discussed developing "Best Practices" for older patients[18,19] and one article was a survey of all chiropractic courses offered in North America.[24]

(b) Demographics and Epidemiological Studies(n = 18)
Studies investigating utilization rates of chiropractic services by older patients and characteristics of older people who seek out chiropractic care (n = 14)

Fourteen articles were found that essentially identified the types of complementary and alternative medicines (CAMs) in general and chiropractic care in particular, that older persons sought out and the characteristics that predicted they would do so.[25–28] Each study involved different survey instruments and sought to gather different information. In general, taken as a group, these articles indicated that CAM use was high among older patients and that they most commonly sought out herbal remedies, chiropractic or massage therapy in various order depending on the reference. Acupuncture was the next most common CAM modality reportedly used by older patients. Predictors of CAM use in general and chiropractic use in particular were being female[34,37] [with the exception of the article by Ness et al[27] which reported men were more likely to seek out chiropractors although less likely to seek out CAM providers in general], having a higher education,[33,35,37] higher income,[27,29,35] more frequent visits to physicians,[27,29] alcohol use[27,29] and being able to drive.[29] Also, older patients who identified themselves as being more spiritual were more likely to seek out CAM care.[33,34,37] African-American[29,34] and Hispanic[29,34] patients were less likely than Caucasians to seek out CAM

Table 1 *Articles retrieved by search strategy of this study published between 2001 and 2010 (n = 188)*

Type of Study	Subheading	Number of references retrieved
Chiropractic geriatric education *(n = 11)*		11
Demographic and Epidemiological studies *(n = 18)*	Utilization rates of chiropractic services by older patients and their demographic characteristics	14
	Epidemiological studies on older patients and predictors of pain	4
Case Reports & Case Series *(n = 83)*	Successful management of clinical condition by chiropractor	39
	Serious clinical condition masquerading as back pain	40
	Adverse reactions to manipulation	2
	Case series	2
Clinical Trials *(n = 21)*	Clinical trials not yet conducted	8
	Clinical trials involving older patients not involving manual therapy	5
	Clinical trials involving older patients involving manual therapy	8
Guidelines & Clinical Information *(n = 55)*	General practice guidelines for chiropractic care planning for older patients	42
	Workshops, Conference Platform & Other Chiropractic Geriatric References	13

or chiropractic care. This data is similar to the information gathered by Hawk et al. in 2000.[3]

Older patients most commonly sought out CAM providers for pain-related symptoms,[26,29,30,37,38] most notably various types of arthritis.[29,30] Second to pain, one study indicated that older patients sought out chiropractic care to improve their quality of life[26] and two studies reported older patients sough out chiropractic care for health maintenance.[26,30] This finding is similar to an earlier study by Rupert et al.[39] Older patients reported being satisfied with the care they received in two studies[30,33] and respondents in another study reported the care they received was beneficial to them.[26] These finding are also consistent with early studies by Hawk et al.[3] and Rupert et al.[39]

Epidemiological studies involving older patients and predictors of pain (n = 4)

Four studies sought to investigate various factors influencing the development of back pain among older persons.[40–43] D'Astolfo and Humphreys[40] reported that the majority of residents in a long term care (LTC) facility in Ontario were women, osteoporotic with mild to moderate dementia but low levels of depression and could walk independently or with an assistive device. Three studies by

Hartvigsen et al.[41–43] reported that genetic factors played a modest role in older men developing low back pain but no role in older women[41] and genetic factors did not play an important role at all among either group of older patients with respect to neck pain.[42] However, Hartvigsen et al. did confirm that commonly held belief that strenuous physical activity at least once a week is a protective factor against the development of low back pain, based on a review of 1387 older twins aged 70–100 years.[43]

(c) Case Reports and Case Series (n = 83)

In general, case studies fell into two distinct groups: Those studies that (i) chronicled the successful management of a diagnosed clinical condition[44–82] (*n = 39*) or that (ii) chronicled a more serious clinical condition masquerading as uncomplicated back pain that was diagnosed by the clinician or upon subsequent referral[83–122] *(n = 40)*. There were two case reports of adverse reactions to manipulation among older patients with complicated clinical profiles[123,124] and two case series[125,126] were retrieved in this study.

Successful management of diagnosed clinical conditions by chiropractors (n = 39)

Thirty-nine articles chronicled the successful management of the following clinical conditions treated with a plethora of presenting chief complaints. These were: osteoarthritis of the knee,[44] chronic constipation,[45] lumbar spinal stenosis,[46] "unsuccessful" post-cervical surgery,[47] cleidocranial dysplasia,[48] diffuse idiopathic skeletal hyperostosis[49,50] cervical spine stenosis and radiculopathy,[51] "low force adjustments,"[52] greater occipital neuralgia,[53] two cases of cervical spondylotic radiculopathy,[54] spondylosis of L2 in identical twins,[55] acute fracture of the eighth thoracic vertebrae,[56] far lateral disk herniation,[57] grade II acromioclavicular joint separation,[58] cervical spine stenosis,[59] upper cross syndrome,[60] atypical polymyalgia rheumatica,[61] two cases of lumbar spine synovial cysts,[62] gemelli-obterator internus complex,[63] bilateral shoulder pain subsequent to a fall,[64] subacute lumbar compartment syndrome,[65] cervical spondylosis and ossification of the posterior longitudinal ligament,[66] myelopathy,[67] medically-treated asthma,[68] depressive symptoms in an elderly patient with LBP,[69] post-polio syndrome,[70] "apparent mechanical" femoral neuropathy,[71] delayed-onset post-traumatic headache subsequent to a motor vehicle accident,[72] spinal synovial cysts with intersegmental instability,[73] vertebral artery calcification,[74] acute idiopathic costrochronditis,[75] chronic migraine,[76] intractable back pain associated with compression fracture treated by percussion vertebroplasty,[77] adhesive capsulitis and improvement in kyphoscoliosis,[78] cervicogenic headaches,[79] lateral epicondylitis,[80] tarsal tunnel syndrome[81] and lumbar stenosis resulting in low back and knee pain using Class IV laser.[82]

Serious clinical conditions masquerading as back pain (n = 40)

Forty articles discussed the diagnosis of a serious clinical condition initially attributed to mechanical back pain or an otherwise relatively innocuous problem. These articles chronicled the following clinically significant conditions presenting among older patients to chiropractors' offices: B-cell lymphoma masquerading as low back and leg pain,[83] heart failure and insufficiency of aortic and mitral valve secondary to rheumatoid arthritis,[84] fracture of heterotrophic bone fracture in patient with myositis ossificans traumatica,[85] cervical fracture-dislocation,[86] neuropathic arthropathy in the foot of a patient with diabetes,[87] porcelain gallbladder presenting as low back and heel pain,[88] post-traumatic compression fracture,[89] bizarre neurological symptoms precipitated by a fall diagnosed as Dejerine-Roussy Syndrome,[90] atypical presentation of a deep vein thrombosis,[91] popliteal aneurysm presenting as leg pain,[92] comorbidity of low back pain (LBP) and abdominal aortic aneurysm,[93] prostatic metastasis causing LBP and leg pain,[94] bilateral acrometastasis secondary to breast cancer,[95] breast cancer presenting as sacroiliac pain and radiculopathy,[96] low back pain caused by disk herniation visible upon surgical inspection but not on advanced imaging,[97] abnormal course of vertebral artery found in a cadaver,[98] congestive heart failure presenting as neck and shoulder pain,[99] malignant pleural mesothelioma,[100] vertebral osteomyelitis presenting as LBP,[101] fracture of the hip mimicking LBP and hip pain,[102] abdominal aortic aneurysm presenting as back pain,[103] osteomyelitis of the knee causing LBP,[104] pathological fracture of C2 subsequent to vertebral metastasis,[105] erosive osteoarthritis resulting in bilateral hand pain,[106] gout resulting in wrist,[107] bone infarct (osteonecrosis) presenting as knee pain,[108] Parkinson's disease masquerading as LBP,[109] knee pain diagnosed as a Schwannoma,[110] abdominal aortic aneur-

ysm,[111] metastasis from breast cancer presenting as non-specific back pain,[112] thoracic spine pain attributed to upper gastrointestinal hemorrhage,[113] minimally response carpal tunnel syndrome diagnosed as avascular necrosis of the scaphoid,[114] spontaneous cervical epidural hematoma presenting as severe neck pain,[115] chronic low back pain diagnosed as vertebral sarcoidosis,[116] renal cell carcinoma causing LBP,[117] hyperparathyroidism presenting as back pain and swelling of fourth digit,[118] brain stem compression and atlantoaxial instability secondary to rheumatoid arthritis presenting as chronic neck pain,[119] detection of aortic abdominal aneurysm,[120] abdominal and low back pain diagnosed as metastasis from prostate cancer[121] and Paget's disease resulting in progressive thoracic pain.[122]

Adverse reaction to manipulation among older patients (n = 2)

Two articles discussed adverse reactions to manipulation among older patients with serious clinical conditions. In one case, a spinal epidural hematoma occurred in an older patient on anticoagulants after spinal manipulative therapy[123] and another case discussed anterior and posterior fixation of a cervical fracture induced by chiropractic spinal manipulation in an older patient with ankylosing spondylitis.[124]

Case series (n = 2)

Zhang et al. reported on a retrospective case series involving 13 older patients (only two under age 55 years) with urinary incontinence (UI) who were treated using the Pro-Adjuster technique.[125] The patients all presented with spinal or leg complaints but divulged that they also had UI during their interviews. Patients were treated between 1 and 8 weeks. The primary outcome measure was frequency of nocturia, as recorded by the patient. All 13 patients reported improvements in their urination frequency after their treatment schedules, and two patients reported improvements after only 2 adjustments. Similarly positive results were reported by Hains et al.[8]

Doherty reported a case series involving 8 frail older women, ages 68–89 years old, all of whom had chronic obstructive lung disease.[126] Doherty treated these patients (1 man, 7 women) using spinal manipulative therapy, rib mobilization and/or instrumented adjusting over a 4 week period of time (total of 12 manipulative sessions provided). At each treatment, patients were asked to describe any adverse events they experienced from the previous treatment session and to grade the severity of the adverse reaction on a pain visual analog scale (pain-VAS) from 0 (no pain) to 10 (worse pain imaginable). One patient did not report any adverse reactions at all. Among the other 7 patients, the number of adverse events ranges from 2 to 8 per patient over the course of care and these patients reported the severity of pain ranged from 2.0 to 5.9 on the pain-VAS. All the adverse reactions reported were mild transient events. None of the patients reported any serious adverse events over the course of therapy, such as fracture or significant bruising.

(d) Clinical Trials (n = 21)

Studies in this category were divided into two main groups: (i) Studies that describe clinical trials that have yet to be conducted *(n = 8),*[127–134] and (ii) studies that provide the results of clinical trials that have been conducted *(n = 13).*[135–147] Of those studies that have been completed, five did not involve the use of manual therapies[135–139] whereas the other eight[140–147] investigated the effects of manual therapies on older patients, one study using mobilization (administered by a physiotherapist)[140] and seven using manipulation administered by a chiropractor[141–144] or an osteopath.[145–147] To date, there have only been two randomized clinical trials involving chiropractic adjustments/manipulation and older patients.[141,147]

Clinical Trials to be conducted (n = 8)

Eight studies were found that describe the recruitment, design, protocols or feasibilities of various interventions for older patients.[127–134] Specifically, studies described future clinical trials involving older patients LBP only,[127] LBP or neck pain,[128] knee pain,[129] dizziness, neck pain and balance issues[130–133] and pneumonia.[134]

Completed clinical trials involving older patients not involving manual therapies (n = 5)

With respect to interventional studies not involving manual therapies, five studies were retrieved.[135–139] Two of these studies[135,136] were cross-sectional observational studies and the other three studies[137–139] were interventional studies.

Uthaikhup and Jull reported that the cranial cervical flexion test, thought to test the coordination of the deep and superficial cervical flexor muscles, is altered in a group of

healthy asymptomatic elderly test subjects compared to a similar group of younger patients.[135] Another study by Champagne et al. reported that lumbopelvic muscle endurance and perceived exertion did not differ between two groups of healthy older and younger test subjects.[136]

Haas et al. reported that a chronic disease self-management program had no advantages over a wait-list control group of older patients with chronic LBP with respect to improving pain, general health, self-efficacy and self-care attitudes, although there may have been some benefit with respect to patient's emotional well-being, fatigue, functional disability and days with disability.[137] Lorig et al. reported that Internet-based arthritis self-management program (ASMP) were a viable alternative to small group ASMP among a group of older patients with arthritis and fibromyalgia in terms of significant improvement in 4 of 6 health status measurements.[138] Lastly, Hess and Wollacott reported that high intensity strength-training targeting lower extremity muscles can be used safely and effectively in balance-impaired older patients, resulting in significant improvement in functional balance ability and decreased risk of falls, as monitored using the Berg Balance Scale, Timed Get and Go Test and Activities-Specific Balance Confidence Scale.[139]

Completed clinical trials involving older patients involving manual therapies (n = 8)

A rather unique study was conducted by Bautmans et al. involving 15 older patients with severe dementia and dysphagia.[140] Trained physiotherapists administered cervical spine mobilization in a randomized controlled trial with cross-over. The control group consisted of socializing visits. The researchers reported that swallowing capacity improved significantly after cervical spine mobilization after one session and after one week of treatment.[140] No adverse effects were reported.

Seven studies[141–147] monitored the effects of manipulation on older persons, four studies involving chiropractic manipulation and three studies involving osteopathic manipulation.

Hawk et al. described a study involving 81 older patients who were experiencing chronic musculoskeletal pain.[141] One group was treated using BioEnergetic Synchronization Technique (BEST), a mind-body, non-manipulation light touch approach, along with verbal suggestions, group lectures, self-empowerment strategies and lifestyle and nutritional modifications. This group was compared to a group of patients who received HVLA thrusting Diversified-style manipulations, in addition to modalities, soft tissue therapies, and advice on exercise and nutrition. For this study, outcome measures included Pain Disability Index (PDI), Beck Depression Inventory, clinicians' expectation of improvement, patients' expectation of improvement, time spent during intervention, and evaluation of clinic services. Treatment in both groups was provided over a four week period, and treatment sessions for patients in the BEST group lasted one to two hours whereas treatment sessions of patients receiving SMT lasted 10 to15 minutes.[141]

At the end of the four week study, changes in the PDI for patients under BEST care was 6.9; for patients receiving Diversified care, PDI scores were on average 6.4. These differences were not statistically or clinically significant. However, it was interesting to read that *all* the doctors delivering BEST care *expected* all of their patients to completely recover whereas only two thirds of the Diversified doctors expected their patients to recover at all. This may speak to the impact the practitioner's expectation of patient's outcome has on the degree to which patients respond to care and the subsequent power of the clinical encounter, especially if it is augmented by positive expectations by both the doctor and patient.[141]

In 2009, Hawk et al. reported the results of a larger practice-based clinical trial investigating the effects of two different schedules of care compared to a schedule of no care, for a group of older patient with dizziness, balance difficulties and spinal pain.[142,143] Specifically, 34 patients were enrolled in this study and divided into three different groups. Group 1 (*n = 13*) received a schedule of chiropractic care (described below) for 8 weeks, with 2 visits per week ("limited schedule"). Group 2 (*n = 15*) received chiropractic care for 8 weeks with 2 visits per week followed by 10 months with one visit per month (extended schedule). Chiropractic care consisted of spinal manipulative therapy (SMT, described as "Diversified technique"), including extravertebral manipulations of the hip, knee, ankle and foot, in addition to soft tissue therapy and the application of hot packs. In the event SMT was contraindicated, the practitioner substituted instrumented-adjusting or table-assisted procedures. The third group (*n = 6*) were only provided with brochures containing lifestyle advice and instructed to do home ex-

ercise. Although a number of factors were monitored in this study, the primary outcome measure was scoring as measured by the Berg Balance Scale (BBS).[142,143]

Among those patients with dizziness, improvement on the BBS was demonstrated only among participants in both Group 1 and 2 of the study at 1 month and remained much lower than baseline throughout the study. This improvement was not seen among Group 3 participants. Moreover, pain as measured by the Pain Disability Index showed greater improvement from baseline to 1 year in Group 2 compared with the other groups. There were no treatment-related adverse effects reported.[142,143]

Another randomized clinical trial compared two types of SMT to minimal conservative care for older adults 55 years and older with low back pain was conducted by Hondras et al.[144] In this study involving 240 participants (average age 63 years) subacute or chronic low back sufferers received either HVLA side-posture Diversified-style spinal manipulation or low velocity, variable-amplitude spinal manipulation, such as Cox-Flexion distraction technique. Patient responses from both intervention groups were compared to a group of patients who received minimal conservative care (control group). Participants in both intervention groups were scheduled to receive a maximum of 12 treatments at a frequency of no more than 3 times for the first two weeks and 2 times per week for the third and fourth week and once per week thereafter. Manipulation in both groups was restricted to between T12 and L5 spinal levels and the SI joints. Participants in the control group were given a 30-minute home exercise program.[144]

At the end of the treatment sessions, the study team reported that both biomechanically distinct forms of spinal manipulation did not lead to different outcomes among older low back pain patients, and both forms of therapy were associated with small yet clinically important changes in functional status as compared to the control group. No adverse reactions were reporting during this study. The authors concluded that patient preference as well as clinical experience should drive how clinicians and patients determine which form of spinal manipulation to use for older patients with back pain.[144]

Noll and his colleagues have published a number of articles chronically the effects of osteopathic manipulation on patients with pneumonia, three of which met the inclusion criteria of this study.[145–147] The most recent article, a randomized clinical trial involving 35 elderly (>65 years old) patients reported that the osteopathic manipulation group displayed a statistically significant decrease in forced expiratory flow at 25% and 50% of vital capacity and at midexpiratory phase, a decrease in expiratory reserve volume and airway resistance. In addition, this group of patients had a statistically significant improvement in residual volume and total lung capacity. Most subjects (82%) of patients receiving osteopathic manipulation reported "breathing easier." In their systematic review of manual therapies, Bronfort et al. concluded that "*there is inconclusive evidence in a favorable direction regarding the effectiveness of manual therapy for the treatment of acute pneumonia in elderly hospitalized patients.*"[148]

(e) Guidelines and Clinical Information (n = 55)

General practice guidelines for chiropractic care planning for older patients (n = 42)

A number of articles by content experts have been published in the peer reviewed literature to assist practitioners with the appropriate case management of the myriad of health challenges that preferentially effect older patients. Schneider described the role of chiropractors in pain management for oncology patients,[149] Morley described recent advances in geriatric care from a medical perspective in 2001 in one article,[150] provided nutritional considerations of older people in another[151] and Stump reviewed management of neuroarticular lesions on the elderly.[152] Other articles have discussed, in general terms, the challenges practitioners confront when managing older patients,[156,158,159,160,161] the importance of an integrated approach to manage these challenges[153,154] and the advocacy for a wellness-based approach to health care.[155,157,162]

One article specifically discussed the chiropractic management of foot problems[163] and four articles discussed the chiropractic management of disorders of the upper limb[164–167] among older patients. Other articles discussed the chiropractic management of osteoporotic fractures,[168] the management of osteoarthritis and osteoporosis from a chiropractic perspective,[169] the role of chiropractic in managing patients with multiple sclerosis[170] the signs and symptoms of stroke[171] and the benefits of exercise for older patients.[172]

Eleven articles by chiropractic authors specifically dis-

cussed strategies to reduce falls (fall prevention) in the peer-reviewed literature.[173–183] In addition, a national program in Canada for chiropractors targeting their older patients discussed fall prevention; a DVD containing risk factors, demographic information, assessment tools and management recommendations was mailed to all members of the Canadian Chiropractic Association in 2008.[184]

Stuber et al.[185] reviewed the literature on the use of chiropractic for the treatment of lumbar spinal stenosis (LSS), a condition commonly affecting elderly patients. These reviewers were only able to find 6 articles that met their inclusion criteria (4 case reports, 1 case series and 1 observational cohort study). Despite this paucity of evidence, these reviewers concluded that the available evidence pointed towards chiropractic care (most often in the form of SMT or flexion-distraction manipulation) was potentially beneficial for patients with LSS.[185] Additionally, Kline recently authored two editorials that consisted of interviews of content experts who discuss the appropriate management of LSS.[186,187]

Three articles have been written specifically on the topic of providing spinal manipulation/adjustments for older patients[188–190] and the most current article found during this search was a Best Practice consensus document by Hawk et al.[191] That Best Practice article used a Delphi process of over 30 content experts and provides an evidence-based approach to the assessment (history taking, physical examination, diagnostic imaging) and management (use of different chiropractic technique systems, care planning) of older patients, including issues of jurisprudence, safety and a list of absolute and relative contraindications to care.[191]

Workshops, Conference Platform & Other Chiropractic Geriatric References (n = 13)

A number of workshops and platform presentations have been provided at large international conferences between 2001 and 2010 on the topic of chiropractic care for older patients. Byfield,[192–194] Doherty[195] and Sportelli[196] have provided important information on providing chiropractic care (specifically spinal adjusting) for older patients and Gleberzon[197,198] and Freedman[199] provided platform presentation and a workshop on issues of quality of life for seniors (wellness, fall prevention and mental health).

Since 2001, there have been two textbooks published specifically on the topic of chiropractic geriatric care,[200,201] the "White House" brief, a submission on chiropractic care to Congress in the United States[202] and two textbook chapters on issues specific to older chiropractic patients.[203,204]

Miscellaneous references

It would be remiss to not cite those references that, although not specific to chiropractic geriatric care, provide important information towards it. Important sources of information include Guidelines on fall prevention and pain management for older patients by the American Geriatric Society,[205–207] the Report on Senior's Falls in Canada by the Public Health Agency of Canada,[208] two reports by the World Health Organization (WHO), one on "Active Ageing"[209] and the other on falls prevention[210] and four reports from the Cochrane Collaboration on the topics of fall prevention,[211] rehabilitation for older patients,[212] exercise[213] and strength training[214] for improvement in balance and physical function.

Discussion

Compared to the review of the literature conducted in 2001[2] there has been a greater than threefold increase in the number of retrievable articles and references on geriatric chiropractic care of older persons (see Table 2). Specifically, the number of references pertaining to chiropractic geriatric education has increased from 3 to 11, the number of demographic and epidemiological studies has increased from 9 to 18, the number of case reports and case series has increased from 25 to 83, the number of clinical trials has increased from 4 to 21 (although four of these clinical trials investigated osteopathic rather than chiropractic manipulation) and the number of references on clinical guidelines and general clinical information for practitioners has increased from 18 to 55; this includes the publication of two textbooks that exclusively focus on chiropractic care for older patients.[200,201] In total, then, there has been an increase in the number of published references in the chiropractic literature regarding older patients from 59 up to the year 2000 to 188 between 2001 and 2010.

That said, only two studies published in between 2001 and 2010 were randomized clinical trials which, despite their limitations, are still considered the "gold standard" of research evidence.[148] Despite this paucity of RCTs in the evidence base, Bronfort et al. concluded in their ex-

Table 2 *Comparison of the number of references retrieved between a review of the literature published in 2001[1] and this review*

Type of Study	Number of studies found In 2001 review[1]	Number of studies found during this review (c2010)
Chiropractic geriatric education	3	11
Demographic/ Epidemiological	9	18
Case studies/ series	25	83
Clinical trials	4	21
Guidelines and general clinical information	18	55
Total all studies	59	188

tensive review of the literature of manual procedures that there is "*moderate quality evidence that spinal manipulation/mobilization is an effective treatment option for subacute and chronic LBP in older adults.*"[148:p17]

From Evidence-Based to Best Practice to Patient-Centred Care

It bears repeating that "Best Practices" do not and should not rely solely on the results of RCTs or meta-analyses of these RCTs.[215–218] Sackett was very clear in this regard when he first advocated for the Evidence-Based Medicine (EBM) movement in the late 1990s. His oft-quoted position was that:

> *"EBM means integrating individual clinical expertise with the best available external clinical evidence from systematic research … By best available external clinical evidence, we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient-centered clinical research. Without clinical expertise, practice risks becoming tyrannized by external evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best external evidence, practice risks becoming rapidly out of date, to the detriment of patients."*[(215p1186)]

Furthermore, during his testimony before an Inquest held in Ontario in 2004, when asked about relying only on evidence to guide health care decisions, Sackett informed the jury that, while at Oxford, only 47% of medical procedures used for patient care had been proven effective and banning procedures not shown to be effective by randomized clinical trials "*would shut down the healthcare system,*" essentially grinding it to a screeching halt.[216]

Echoing the sentiments by Mootz[219] who discussed the importance of both a molecular and contextual approach to patient care, with the utilization of both qualitative and quantitative outcome measures respectively as described by Bolton,[220] Triano[218] reminded the reader that the "evidence-based" was never meant to be "evidence-entrained" and the elements of "context" that matter for clinical decision making include (i) the complexity of the case, (ii) best available evidence, (iii) practitioner's expertise and experience and, (perhaps most importantly) (iv) patient preferences and beliefs.[218] These factors are important since RCTs can rarely be applied to individual patients since they attempt to "fit to the mean," thus theoretically not taking into account the 50% of cases that deviate from the norm.[218] Elsewhere, Rosner has discussed the limitations of RCTs.[217] Meta-analyses present similarly problematic limitations, including (i) bias of the selection criteria of studies to be included for review, (ii) lack a standardized analyses and systematic method to validate new analysis methods and, (iii) poor consistency and/or accuracy of investigative reviewers during the application of criteria during the analysis.[218] Haynes and his colleagues may have captured this issue best when they wrote:

> *"Subsequent versions of evidence-based decision-making have emphasized that research evidence alone is never an adequate guide to action. Rather, clinicians must apply their expertise to assess patient's problem, and must also incorporate the research evidence and the patient's preference or values before making a management recommendation"*[(221pA11)]

Thus there seems to be emerging a new paradigm, one that can be termed "Patient-Centered Evidence-Base Health Care" which is constructed from an amalgam of patient preference, research evidence and clinical experience and can have as its rallying cry: "*Evidence does not make decisions- people do.*"[221pA11]

Chiropractic care and adverse effects

With respect to safety, it would appear that spinal manipulative therapy can be safely provided for older patients, even the frail elderly.[126] Cassidy et al.[222] sought to investigate the association between chiropractic care and vertebrobasilar artery (VBA) stroke and to compare it the association between recent primary care physicians (PCP) care and VBA stroke, using an epidemiological design. Based on a review of all VBA stroke cases admitted to Ontario hospitals between 1993 and 2002 (mean age of patients 63 years), the researchers concluded that, firstly, VBA stroke is a very rare event with only 818 cases occurring in that time span and, secondarily patients over 45 years old were three times as likely to seek out a chiropractor or a PCP before experiencing a stroke. In other words, patient with headache or neck pain were just as likely to consult either a chiropractor or PCP before their stroke and there was no evidence of excess risk of VBA stroke associated with either chiropractic or medical care. In all likelihood, these patients were experiencing a stroke-in-progress and the care they sought did not exacerbate the stroke itself. A study of 280 patients (13% of whom were over the age of 60 years) reported most adverse effects related to chiropractic care were minor transient muscle soreness that typically resolved with 24 hours of its occurrence[223] and a systematic review conducted in 2009 reported that most side effects associated with spinal manipulation are benign and transitory in nature, and the incidence of serious side effects is rare.[224]

Based on the most comprehensive review of the literature of the use of manual (principally manipulative) therapies for older patients to date, Cooperstein and Killinger[225] opined that not only do older patients not experience more injuries than do younger patients they may actually experience fewer. They attribute this observation to three possible factors: (i) greater prudence by the doctor who may either apply high velocity low amplitude (HVLA) thrusts with less pressure by using a broader surface area contact or the substitution of lower force procedures (instrumented adjusting, use of pelvic wedges or other low force techniques) or; (ii) greater joint stiffness of an older patient (including the absence of the disc nucleus with age) or; a combination of the two. Furthermore, with respect to optimum care planning, Cooperstein and Killinger suggest that practitioners, when confronted with a patient presenting with neck, shoulder or scapula pain consider the interconnectedness of these regions and examine all of them, even if a patient only expresses pain in only one of them. Common chief complaints that may only be ameliorated by addressing dysfunctions of this entire region include cervicogenic headaches, thoracic outlet symptoms and scapulocostal syndrome. Similarly, pain in the lumbothoracic region may originate from dysfunctions of the pelvic due to gait abnormalities, all of which respond to chiropractic intervention of some kind.[225]

In addition to there being a number of low force chiropractic technique systems that purportedly are safer for use for older patients ([226] and see Table 3a), the use of HVLA spinal manipulative therapies has yet to be proven more harmful than low-force or no-force techniques and there are various strategies can be employed by practitioners to minimize any potential risk of harm. If a practitioner is confronted with a patient with mid-back back pain who is severely osteoporotic, rather than attempt to manipulate the patient in either the supine or prone position, during which a fracture could occur due to the compressive forces generated through the patient's body, the clinician may choose to position the patient in either a side-lying or seated position ([227,228] and see Table 3b). In that manner, the clinician could still provide a HVLA thrust on the clinical target with a greatly reduced fear of causing harm.[227]

Conclusion

> *"Evidence-based medicine is not kind to the elderly. This movement trusts only the products of randomized clinical trial or, preferentially, meta-analyses*

Table 3a *List of non-HVLA chiropractic technique systems by that may be preferentially used for care of older patients*[226]

- Instrumented adjusting (i.e. Activator Methods Chiropractic, Atlas Orthogonal)
- Use of padded wedges (Sacro-Occipital Technique)
- Drop-piece table (i.e. Thompson Terminal Point)
- Mechanical mechanized tables (i.e. Cox Flexion-Distraction)
- Low-Force techniques (i.e. BioEnergetic Synchronization, Network Spinal Analysis, Toftness, Logan Basic, Upper Cervical, Cranial techniques)

Table 3b *Recommendations to enhance patient safety of older patients judged to be at greater risk of injury during delivery of HVLA adjustments/manipulations*[225,228]

- Increase surface area [thus decreasing net pressure (not force)] through the use of a more broad contact by doctor (flat hand rather than pisiform/hypothenar or thenar) on patient (contact more than one vertebral segment and avoid contacting spinous pressure or transverse processes)
- Preferentially position patient side-posture or seated to provide thoracic adjustments (thus avoiding compression of thoracic cage)
- Use drop pieces to reduce amount of force during delivery of prone HLVA spinal adjustments/manipulations

> *of those trials. But subjects over the age of 75 years are rarely found in such trials, thus rendering this population invisible to scientific medicine. If we teach only what we know, and if we know only what we can measure in clinical trials, then we can say little of importance about the care of the elderly. The most important resources required in caring for the old – sufficient time and empathy – are not included in the critical pathways of managed care"*(229p1285)

The exponential accrual of the evidence base of chiropractic care for older patients is certainly encouraging and bodes well for the profession's future. That said, there is clearly a gap in the evidence base of chiropractic geriatric care, with the under-representation of clinical trials of all kinds at the forefront of this gap. Even so, this review found 188 retrievable articles available to practitioners to augment their clinical expertise in order to effective care plan for their older patients, a better than threefold increase from a similar review conducted at the end of the previous decade.

Over 20 years ago, the World Health Organization (WHO) defined health as "*a state of complete physical, social and mental wellbeing and not merely the absence of disease or infirmity*"[230] and this resonates well with the holistic and biopsychosocial approach chiropractors champion with their patients with studies of all kinds indicating patient are very satisfied with the high-touch low-tech approach that is patient-focused.[231] Furthermore, as indicated by the increased focus of chiropractic care of older patients as evidenced by this review, the profession can align itself with the WHO's definition of "disease prevention" that "*covers measures not only to prevent the occurrence of disease, such as risk factors reduction, but also to arrest the progress and reduce its consequences once established*"[230] and health promotion that "*is the process of enabling people to increase control over, and to improve, their health.*"[232]

Acknowledgement

The author would like to thank Anne Taylor-Vaisey for her invaluable assistance in conducting the electronic search used in this study.

References

1 Gleberzon BJ. Geriatric demographics. In: Gleberzon BJ, Editor. Chiropractic care of the older patient. First Ed. Butterworth-Heinemann. Oxford, UK. 2001; 13–21

2 Gleberzon BJ. Chiropractic care of the older person: Developing an evidence-based approach. J Can Chiropr Assoc. 2001 September; 45(3):156–71.

3 Hawk C, Long CR, Boulanger KT, Morschhauser E, Fuhr AW. Chiropractic care for patients aged 55 years and older: report from a practice-based research program. J Am Geriatr Soc. 2000 May; 48(5):534–45.

4 Tucker M et al. Relative effectiveness of a non-steroidal anti-inflammatory medication (Meloxicam) versus manipulation in the treatment of osteo-arthritis of the knee. Eur J Chiro. 2003; 50:163–183.

5 Murphy DR, Hurwitz EL, Gregory AA et al. A non-surgical approach to the management of lumbar spinal stenosis: A prospective observational cohort study. BMC Musculoskeletal Disorders. 2006; 7:16.

6 Beyerman KL, Palmerion MB, Zohn LE et al. Efficacy of treating low back pain and dysfunction secondary to osteoarthritis: Chiropractic care compared with moist heat alone. J Manipulative Physio Ther. 2006; 29(2): 107–111.

7 Hains G, Hains F, Descarreaux M. Gastroesophogeal reflux disease, spinal manipulative therapy and ischemic compression: A preliminary study. J Am Chiro Assoc. 2007; Jan/Feb:7–19

8 Hains G, Hains F, Descarreaux M, Bussieres A. Urinary incontinence in women treated by ischemic compression over the bladder area: a pilot study. J Chiro Med 2007; 6(4):132–140.

9 Schellingerhout JM, Verhagen AP, Heymans MW et al. Which subgroups of patients with non-specific neck pain are more likely to benefit from spinal manipulation therapy, physiotherapy, or usual care? Pain. 2008 October 31; 139(3):670–80.

10 Pollard H, Ward G, Hoskins W et al. The effect of a manual therapy knee protocol on osteoarthritic knee pain: a randomized clinical trial. J Can Chiro Assoc. 2008; 52(4):229–242.

11 Fish D, Kretzmann H, Brantingham JW. A randomized clinical trial to determine effects of combining a topical capsaicin cream and knee joint mobilization in the treatment of osteoarthritis of the knee. J Am Chiro Assoc. 2008; 45(6):8–23

12 Atkinson W, Matthews B, Brantingham JW. A randomized clinical trial to assess the efficacy of shoulder manipulation versus placebo in the treatment of shoulder pain due to rotator cuff tendinopathy. J Am Chiro Assoc. 2008; 45(9)11–26

13 Hartvigsen J, Nielsen J, Kyvik KO et al. Heritability of spinal pain and consequences of spinal pain: a comprehensive genetic epidemiologic analysis using a population-based sample of 15,328 twins ages 20–71 years. Arthritis Rheum. 2009 October 15; 61(10):1343–51.

14 Hawk C, Byrd L, Killinger LZ. Evaluation of a geriatrics course emphasizing interdisciplinary issues for chiropractic students. J Gerontol Nurs. 2001 July; 27(7): 6–12.

15 Gleberzon BJ. Developing a community-based educational program for older persons. J Can Chiropr Assoc. 2001 March; 45(1):18–25.

16 Gleberzon BJ. Combating ageism through student education. Top Clin Chiropr. 2002; 9(2):1–12.

17 Dusio ME, Killinger LZ. Increasing active and individualized learning in a large cohort geriatric course. J Chiro Ed. 2002; 16(1):10.

18 Killinger LZ, Dusio ME. Chiropractic student's knowledge, attitudes, and interdisciplinary perceptions on caring for older patients. J Chiro Ed. 2002; 16(1):23.

19 Killinger LZ. Developing Best Practices for chiropractic care for aging patients: the long and winding road. J Chiro Ed. 2004; 18(1):64.

20 Killinger L. Chiropractic and geriatrics: a review of the training, role, and scope of chiropractic in caring for aging patients. Clin Geriatr Med. 2004 May; 20(2):223–35.

21 Doherty P. Chiropractic education in a federally funded geriatric education center. J Chiro Ed. 2006; 20(1):61.

22 Plezbert JA. The implementation of a geriatric elective course in the chiropractic curriculum. J Chiro Ed. 2006; 20(1):93.

23 Killinger LZ. A VA rotation for chiropractic students: Learning to assess older patients in an interdisciplinary setting. J Chiro Ed. 2009; 23(1):75.

24 Borggren CL, Osterbauer PJ, Wiles MR. A survey of geriatrics courses in North American chiropractic programs. J Chiro Ed. 2009; 23(1):28–35.

25 Mertz JA. Alternative medicine use in older Americans. J Am Geriatr Soc. 2001 November; 49(11):1577.

26 Williamson AT, Fletcher PC, Dawson KA. Complementary and alternative medicine. Use in an older population. J Gerontol Nurs. 2003 May; 29(5):20–8.

27 Ness J, Cirillo DJ, Weir DR, Nisly NL, Wallace RB. Use of complementary medicine in older Americans: results from the Health and Retirement Study. Gerontologist. 2005 August; 45(4):516–24.

28 Nichols E, Sullivan T, Ide B, Shreffler-Grant J, Weinert C. Health care choices: complementary therapy, chronic illness, and older rural dwellers. J Holist Nurs. 2005 December; 23(4):381–94.

29 Wolinsky FD, Liu L, Miller TR et al. The use of chiropractors by older adults in the United States. Chiropr & Osteopr. 2007 September 6; 15:12.:12.

30 Cheung CK, Wyman JF, Halcon LL. Use of complementary and alternative therapies in community-dwelling older adults. J Altern Complement Med 2007 November; 13(9):997–1006.

31 Votova K, Wister AV. Self-care dimensions of complementary and alternative medicine use among older adults. Gerontology. 2007; 53(1):21–7.
32 Cuellar N, Aycock T, Cahill B, Ford J. Complementary and alternative medicine (CAM) use by African American (AA) and Caucasian American (CA) older adults in a rural setting: a descriptive, comparative study. BMC Complement Altern Med. 2003 November 18; 3:8.:8.
33 Ryder PT, Wolpert B, Orwig D, Carter-Pokras O, Black SA. Complementary and alternative medicine use among older urban African Americans: individual and neighborhood associations. J Natl Med Assoc. 2008 October; 100(10):1186–92.
34 Loera JA, Reyes-Ortiz C, Kuo YF. Predictors of complementary and alternative medicine use among older Mexican Americans. Complement Ther Clin Pract. 2007 November; 13(4):224–31.
35 Ganguli SC, Cawdron R, Irvine EJ. Alternative medicine use by Canadian ambulatory gastroenterology patients: secular trend or epidemic? Am J Gastroenterol. 2004 February; 99(2):319–26.
36 Ramsey SD, Spencer AC, Topolski TD, Belza B, Patrick DL. Use of alternative therapies by older adults with osteoarthritis. Arthritis Rheum. 2001 June; 45(3):222–7.
37 Callahan LF, Wiley-Exley EK, Mielenz TJ et al. Use of complementary and alternative medicine among patients with arthritis. Prev Chronic Dis. 2009 April; 6(2):A44.
38 Martin CM. Complementary and alternative medicine practices to alleviate pain in the elderly. Consult Pharm. 2010 May; 25(5):284–90.
39 Rupert RL, Manello D, Sandefur R. Maintenance care: health promotion services administered to US chiropractic patients aged 65 and older, part II. J Manipulative Physiol Ther. 2000; Jan 23(1):10–19.
40 D'Astolfo CJ, Humphreys BK. A record review of reported musculoskeletal pain in an Ontario long term care facility. BMC Geriatr. 2006 March 23; 6:5.:5.
41 Hartvigsen J, Christensen K, Frederiksen H, Petersen HC. Genetic and environmental contributions to back pain in old age: a study of 2,108 Danish twins aged 70 and older. Spine. 2004; 29(8):897–901.
42 Hartvigsen J, Christensen K. Active lifestyle protects against incident low back pain in seniors: a population-based 2-year prospective study of 1387 Danish twins aged 70–100 years. Spine. 2007; 32(1):76–81.
43 Hartvigsen J, Petersen HC, Frederiksen H, Christensen K. Small effect of genetic factors on neck pain in old age: a study of 2,108 Danish twins 70 years of age and older. Spine. 2005; 30(2):206–8.
44 Law A. Diversified chiropractic management in the treatment of osteoarthritis of the knee. J Can Chiro Assoc. 2001; 45(4):232–240.
45 Redley M. The effects of chiropractic care on a patient with chronic constipation. J Can Chiro Assoc. 2001; 45(3):185–191.
46 Snow GJ. Chiropractic management of a patient with lumbar spinal stenosis. J Manipulative Physio Ther 2001; 24(4):300–304
47 Alcantara J, Plaugher G, Thornton RE et al. Chiropractic care of a patient with vertebral subluxation and unsuccessful surgery of the cervical spine. J Manipulative Physio Ther. 2001; 24(7):477–482.
48 Feldman VB. Cleidocranial dysplasia: a case report. J Can Chiro Assoc. 2002; 46(3):185–191.
49 Foshang TH, Mestan JA, Rigss LJ. Diffuse idiopathic skeletal hyperostosis: a case of dysphagia. J Manipulative Physio Ther. 2002; 25(1):71–76.
50 Troyanovich SJ, Buettner M. A structural chiropractic approach to the management of diffuse idiopathic skeletal hyperostosis. J Manipulative Physio Ther. 2003; 26(3):202–6.
51 Kruse RA, Gregerson D. Cervical spine stenosis resulting in radiculopathy treated with flexion-distraction manipulation: a case study. J Neuromusculoskel. 2002; 10(4); 141–147.
52 Johnson I. Low force chiropractic adjustment and post-isometric muscle relaxation for the ageing cervical spine: A case study and literature review [case report]. Br J Chiropr. 2002; 5(3):50–9.
53 Comley L. Chiropractic management of greater occipital neuralgia. Clin Chiropr. 2003; 6(3–4):120–128.
54 Dufton JA, Giantomaso T. The chiropractic management of two cases of cervical spondylotic radiculopathy. J Can Chiro Assoc. 2003; 47(2):121–16.
55 Young KJ, Koning W. Spondylosis of L2 in identical twins. J Manipulative Physio Ther. 2003; 26(3):196–201.
56 Alcantara J, Plaugher G, Elbert RA et al. Chiropractic care of a geriatric patient with an acute fracture-subluxation of the eighth thoracic vertebra. J Manipulative Physiol Ther. 2004 March; 27(3):E4.
57 Erhard RE, Welch WC, Liu B et al. Far-lateral disk herniation: case report, review of the literature and a description of nonsurgical management. J Manipulative Physio Ther. 2004; 27(2):123.
58 Kiner A. Diagnosis and management of grade II acromioclavicular joint separation. Clin Chiropr. 2004; 7(1):24–30.
59 Kukurin GW. The amelioration of symptoms in cervical spine stenosis with spinal cord deformation through specific chiropractic manipulation: a case study. J Manipulative Physio Ther. 2004; 27(5):366.
60 Moore MK. Upper crossed syndrome and its relationship to cervicogenic headaches. J Manipulative Physio Ther. 2004; 27(6):414–420.
61 Winter A. Atypical polymyalgia rheumatica in a 70 year old male chiropractic patient: a case report. Clin Chiropr. 2004:7(4):174–179.

62 Cox JM, Cox JM II. Chiropractic treatment of lumbar spine synovial cysts: A report of two cases. J Manipulative Physio Ther. 2005; 28(2):143–147.
63 Cox JM, Bakkum BW. Possible generators of retrotrochanteric gluteal and thigh pain: The gemelli-obturator internus complex. J Manipulative Physio Ther. 2005; 28(7):534–538.
64 Gleberzon BJ. Successful chiropractic management of a centenarian presenting with bilateral shoulder pain subsequent to a fall [case report]. Clin Chiropr. 2005 June; 8(2):66–74.
65 Hammer WI, Pfefer MT. Treatment of a case of subacute lumbar compartment syndrome using the Graston technique. J Manipulative Physio Ther. 2005:28(3):199–204.
66 Middleton J. Cervical spondylosis and ossification of the posterior longitudinal ligament: case report of a Caucasian patient. Clin Chiropr. 2005; 8(3):145–150.
67 Patel SN, Kettner NW, Osbourne C. Myelopathy: A report of two cases. J Manipulative Physio Ther. 2005; 28(7):539–546.
68 Gibbs AM. Chiropractic co-management of medically treated asthma. Clin Chiropr. 2006; 8(3):140–144.
69 Hawk C, Lawrence DJ, Rowell RM. Relief of depressive symptoms in an elderly patient with low back pain. Clin Chiropr. 2006 March; 9(1):34–8.
70 Simpson S. The palliative care of a post-polio syndrome patient. Clin Chiropr. 2006; 9(2):81–87.
71 Desmarais A, Descarreaux M. Diagnosis and management of "an apparent mechanical" femoral mononeuropathy: a case study. J Can Chiro Assoc. 2007; 51(4):210–216.
72 Stupar M, Kim PSY. Delayed-onset post-traumatic headache after a motor vehicle collision: a case report. J Can Chiro Assoc. 2007; 51(2):83–90.
73 Taylor DN. Spinal synovial cysts and intersegmental instability: a case report. J Manipulative Physio Ther. 2007; 30(2):152–157
74 Guagliardo J, Linaker K. Radiographic evidence of vertebral artery calcification in a 71-year-old female. J Chiro Ed 2008; 22(1):59.
75 Hudes K. Low-tech rehabilitation and management of a 64 year old male patient with acute idiopathic onset of costrochondritis. J Can Chiro Assoc. 2008; 52(4):224–228.
76 Turchin PJ. A case of chronic migraine remission after chiropractic care. J Chiro Med. 2008; 7(2):66–70.
77 Zhang R, Tao C, Yocham TR. Use of percussion vertebroplasty for intractable back pain associated with compression fracture in an 80-year-old female. J Manipulative Physio Ther. 2008; 31(4):319–322.
78 Lewis C, Erhard R, Drysdale G. Kyphoscoliosis improvement while treating a patient for adhesive capsulitis using active therapeutic movement version 2. J Manipulative Physio Ther. 2008; 31(9):715–722.
79 Ormos G, Mehrishi JN, Bakacs T. Reduction in high blood tumor necrosis factor-alpha levels after manipulative therapy in 2 cervicogenic headache patients. J Manipulative Physio Ther. 2009; 32(7):586–591.
80 Radpasand M. Combination of manipulation, exercise and physical therapy for the treatment of a 57 year old woman with lateral epicondylitis. J Manipulative Physio Ther. 2009; 32(2):166–172.
81 Hudes K. Conservative management of a case of tarsal tunnel syndrome. J Can Chiro Assoc. 2010; 54(2):100–106.
82 Knapp D. Class IV laser therapy treatment of multifactorial lumbar stenosis with low back and knee pain: A case report. J Am Chiro Assoc. 2010; 47(1):10–15.
83 Guben JN, Van Der Mark RLJ, Yeghiayan E. B-cell lymphoma presenting as mechanical low back pain with leg pain: the importance of the physical and ultrasound examination of the buttock in patients with low-back and leg pain: a case report. J Can Chiro Assoc. 2001; 45(2): 81–85.
84 Killinger LC, Gutierrez PS. Heart failure and insufficiency of the aortic and mitral valves in a 68-year-old woman with rheumatoid arthritis. Arq Bras Cardiol. 2001 October; 77(4):369–76.
85 Mestan MA, Bassano JM. Fractured heterotopic bone in myositis ossificans traumatica. J Manipulative Physio Ther. 2001; 24(4):296–299.
86 King SW, Hosler BK, King MA et al. Missed cervical spine fracture-dislocation: the importance of clinical and radiographic assessment. J Manipulative Physio Ther. 2002; 25(4):263–9.
87 Osterhouse MD, Kettner NW. Neuropathic osteoarthropathy in the diabetic foot. J Manipulative Physio Ther. 2002; 25(6):416–422.
88 Young KJ, Johnson J. Porcelain gallbladder. J Manipulative Physio Ther. 2002; 25(8):534–7.
89 Woodhouse D. Post-traumatic compression fracture. Clin Chiropr. 2003; 6(2):67–72.
90 Hadley R. Dejerine-Roussy Syndrome. Clin Chiropr. 2004; 7(2):79–83.
91 Horsburgh J. Case report of a deep vein thrombosis in the femoral vein, an atypical presentation. Clin Chirop. 2004; 7(3):120–126.
92 Kaufman RL. Popliteal aneurysm as a cause of leg pain in a geriatric patient. J Manipulative Physiol Ther. 2004 July; 27(6):Online.
93 Kaur RA. Co-morbidity of low back pain and abdominal aortic aneurysm: a case study. Clin Chirop. 2004; 7(2): 67–72.
94 Lishchyna N, Henderson S. Acute onset low back pain and hip pain secondary to metastatic prostate cancer: a case report. J Can Chiro Assoc. 2004; 48(1):5–12.
95 Osterhouse MD, Guebert GM. Bilateral acrometastasis secondary to breast cancer. J Manipulative Physio Ther. 2004; 27(4):275–9.

96 Verbeeck A. Bone metastases from breast cancer: Guidelines for diagnosis. J Manipulative Physio Ther. 2004 27():211–215.
97 Schneider M, Santolin S, Farell. False negative magnetic resonance imaging results: A report of 2 cases. J Manipulative Physio Ther. 2005; 28(4):278–284.
98 Cagnie B, Barbaix E, Vinck E. A case of abnormal findings in the course of the vertebral artery associated with an ossified hyoid apparatus. A contraindication for manipulation of the cervical spine? J Manipulative Physio Ther. 2005; 28:346–351.
99 Osterhouse MD, Kettner NW, Boesch R. Congestive heart failure: A review and case report from a chiropractic teaching clinic. J Manipulative Physio Ther. 2005; 28(5):356–364.
100 Patel SN, Kettner NW. Malignant pleural mesothelioma: A case report. J Manipulative Physio Ther. 2005; 28(9):724–729.
101 Ursprung WM, Kettner NW, Boesch R. Vertebral osteomyelitis: A case report of a patient presenting with acute low back pain. J Manipulative Physio Ther. 2005; 28(9):713–718.
102 Gleberzon BJ, Hyde D. Hip fracture presenting a mechanical low back pain subsequent to a fall: a case study. J Can Chiro Assoc. 2006; 50(4):255–262.
103 Patel SN, Kettner NW. Abdominal aortic aneurysm presenting as back pain to a chiropractic clinic: A case report. J Manipulative Physio Ther. 2006; 29(5):409.
104 Young M, Wessely MA. Geriatric low back pain: Discussion [case report]. Clin Chiropr. 2006 September; 9(3): 109–111,160–4.
105 Davies MA, Taylor JAM. A case of vertebral metastasis with pathological C2 fracture. J Manipulative Physio Ther. 2007; 30(6):466–471.
106 Grenier JM, McKinney-Pettinato S, Pettinato S et al. A 57-year old woman with bilateral hand pain: case presentation. Clin Chiropr. 2007; 10(1):1–3, 55–58.
107 Jacobs CL, Stern PJ. An unusual case of gout in the wrist: the importance of monitoring medication dosage and interaction. A case report. Chiropr & Osteopr. 2007; 15(16):Online.
108 Timchur MD, James FAP, Wessely MA, McCarthy PW. A 74-year-old woman with right knee pain: Case presentation. Clin Chiropr. 2007 December; 10(4):177–8, 222–226.
109 Burton RR. Parkinson's disease without tremor masquerading as mechanical back pain: a case report. J Can Chiro Assoc. 2008; 52(3):185–192.
110 Hoiriis KT. Schwannoma: a case report and literature review. J Chiro Ed. 2008; 22(1):63.
111 Sherman PR, Lehman JJ. Abdominal aortic aneurysm: evaluation and management by a doctor of chiropractic. J Am Chiro Assoc. 2008; 45(4):12–18.
112 Wessely MA, Mick TJ. Case Challenge. Non-specific low back pain in a 60-year-old female: Case discussion. Clin Chiropr. 2008 December; 11(4):173–4, 221–4.
113 George JW, Skaggs CD. Upper gastrointestinal hemorrhage after nonresponsive thoracic spine pain: a case report. J Chiro Med. 2009; 8(2):86–89.
114 Morehouse K, Grand S, Niblack C. Minimally responsive carpal tunnel syndrome with underlying avasuclar necrosis of the scaphoid: a case report. J Chiro Ed. 2009; 23(1):82.
115 Nourbakhsh A, Chaljub G, Garges KJ. Spontaneous cervical epidural hematoma masquerading as an abscess on magnetic resonance imaging scan. J Manipulative Physio Ther. 2009; 32(5):391–395.
116 Poirier JN, Petrie C. Vertebral sarcoidosis of the lumbar spine: a case study. J Chiro Ed. 2009; 23(1):88.
117 Rectenwald R. A case study of back pain and renal cell carcinoma. J Chiro Med. 2009; 7(1):24–27.
118 Wessely MA. A 58-year old female patient with back pain and a swollen fourth digit Case presentation. Clin Chiropr. 2009; 12(3):93–94, 123–126.
119 Bonic EE, Stockwell CA, Kettner NW. Brain stem compression and atlantoaxial instability secondary to chronic rheumatoid arthritis in a 67-year –old female. J Manipulative Physio Ther. 2010; 33(4):315–320.
120 de Boer NJ, Knaap SFC, De Zoete A. Clinical detection of abdominal aortic aneurysm in a 74-year-old man in chiropractic practice [case report]. J Chiropr Med. 2010 March; 9(1):38–41.
121 Johnson TL. Abdominal and back pain in a 65-year-old patient with metastatic prostate cancer. J Chiropr Med. 2010 March; 9(1):11–6.
122 Wessely MA. Case Challenge. Geriatric chronic, progressive thoracic pain: Case presentation. Clin Chiropr. 2010 June; 13(2):146–7, 160–6.
123 Whedon JM, Quebada PB, Roberts DW et al. Spinal epidural hematoma after spinal manipulative therapy in a patient undergoing anticoagulant therapy: a case report. J Manipulative Physio Ther. 2006:29(7):582–585.
124 Liao CC, Chen LR. Anterior and posterior fixation of a cervical fracture induced by chiropractic spinal manipulation in ankylosing spondylitis: a case report. J Trauma. 2007 October; 63(4):E90-E94.
125 Zhang J, Haselden P, Tepe R. A case series of reduced urinary incontinence in elderly patients following chiropractic manipulation. J Chiro Med. 2006; 5(3): 88–91.
126 Doherty P. Safety of spinal manipulation in the frail older adult: a case series. J Chiro Ed. 2006; 20(1):62–63.
127 Groupp E, Haas M, Fairweather A, Ganger B, Attwood M. Recruiting seniors with chronic low back pain for a randomized controlled trial of a self-management program. J Manipulative Physiol Ther. 2005 February; 28(2):97–102.
128 Maiers MJ, Hartvigsen J, Schulz C, Schulz K, Evans RL,

Bronfort G. Chiropractic and exercise for seniors with low back pain or neck pain: the design of two randomized clinical trials. BMC Musculoskelet Disord. 2007 September 18; 8:94.:94.

129 Bennell KL, Hunt MA, Wrigley TV, Hunter DJ, Hinman RS. The effects of hip muscle strengthening on knee load, pain, and function in people with knee osteoarthritis: A protocol for a randomised, single-blind controlled trial. BMC Musculoskelet Disord. 2007; 8(121):Online.

130 Strunk RG, Hawk C. Effects of chiropractic care on dizziness, neck pain, and balance: a single-group, preexperimental, feasibility study. J Chiropr Med. 2009 December; 8(4):156–64.

131 Hawk C, Hyland JK, Rupert R, Hall S, Colonvega M, Boyd J. Chiropractic care for older adults at risk for falls: a preliminary assessment. JACA Online. 2005 September; 42(7):Online-18.

132 Hawk C, Hyland JK, Rupert R, Hall S, Colonvega M. Assessment of balance and risk for falls in a sample of community-dwelling adults aged 65 and older. Chiropr & Osteo. 2006; 14(1):Online.

133 Hawk C, Pfefer M, Strunk R, Ramcharan M, Uhl NL. Feasibility study of short-term effects of chiropractic manipulation on older adults with impaired balance. J Chiro Med. 2007 December; 6(4):121–31.

134 Noll DR, Degenhardt BF, Fossum C, Hensel K. Clinical and research protocol for osteopathic manipulative treatment of elderly patients with pneumonia. J Am Osteopath Assoc. 2008 September; 108(9):508–16.

135 Uthaikhup S, Jull G. Performance in the cranio-cervical flexion test is altered in elderly subjects. Man Ther. 2009 October; 14(5):475–9.

136 Champagne A, Descarreaux M, Lafond D. Comparison between elderly and young males' lumbopelvic extensor muscle endurance assessed during a clinical isometric back extension test. J Manipulative Physiol Ther. 2009 September; 32(7):521–6.

137 Haas M, Attwood M, Groupp E et al. Chronic disease self-management program for low back pain in the elderly. J Manipulative Physiol Ther. 2005 May; 28(4):228–37.

138 Lorig KR, Ritter PL, Laurent DD, Plant K. The internet-based arthritis self-management program: a one-year randomized trial for patients with arthritis or fibromyalgia. Arthritis Rheum. 2008 July 15; 59(7): 1009–17.

139 Hess JA, Woollacott M. Effect of high-intensity strength-training on functional measures of balance ability in balance-impaired older adults. J Manipulative Physiol Ther. 2005 October; 28(8):582–90.

140 Bautmans I, Demarteau J, Cruts B, Lemper JC, Mets T. Dysphagia in elderly nursing home residents with severe cognitive impairment can be attenuated by cervical spine mobilization. J Rehabil Med. 2008 October; 40(9):755–60.

141. Hawk C, Rupert RL, Hall S, Colonvega M, Boyd J. Comparison of Bioenergetic Synchronization Technique and customary chiropractic care for older adults with chronic musculoskeletal pain. J Manipulative Physiol Ther. 2006 September; 29(7):540–9.

142. Hawk C, Cambron JA, Pfefer MT. Pilot study of the effect of a limited and extended course of chiropractic care on balance, chronic pain, and dizziness in older adults. J Manipulative Physiol Ther. 2009 July; 32(6):438–47.

143. Hawk C, Cambron J. Chiropractic care for older adults: Effects on balance, dizziness, and chronic pain. J Manipulative Physiol Ther. 2009 July; 32(6):431–7.

144 Hondras MA, Long CR, Cao Y, Rowell RM, Meeker WC. A randomized controlled trial comparing 2 types of spinal manipulation and minimal conservative medical care for adults 55 years and older with subacute or chronic low back pain. J Manipulative Physiol Ther. 2009 June; 32(5):330–43.

145 Noll DR, Degenhardt BF, Stuart MK et al. The effect of osteopathic manipulative treatment on immune response to the influenza vaccine in nursing homes residents: a pilot study. Altern Ther Health Med. 2004 July; 10(4):74–6.

146 Noll DR, Degenhardt BF, Stuart M, McGovern R, Matteson M. Effectiveness of a sham protocol and adverse effects in a clinical trial of osteopathic manipulative treatment in nursing home patients. J Am Osteopath Assoc. 2004 March; 104(3):107–13.

147 Noll DR, Degenhardt BF, Johnson JC, Burt SA. Immediate effects of osteopathic manipulative treatment in elderly patients with chronic obstructive pulmonary disease. J Am Osteopath Assoc. 2008 May; 108(5):251–9, 541–2.

148 Bronfort G, Haas M, Evans R et al. Effectiveness of manual therapies: the UK evidence report. Chiro and Osteop. 2010; 18:3.

149 Schneider J, Gilfort S. The chiropractor's role in pain management for oncology patients. J Manipulative Physio Ther .2001; 24(1):52–57 (two cases).

150 Morley JE, Thomas DR. Back to basics ... Recent advances in geriatrics. Top Clin Chiropr. 2002 June; 9(2):1–6.

151 Morley JE, Thomas DR. Nutritional considerations in older people. Top Clin Chiropr. 2002 June; 9(2):7–24.

152 Stump JL. The neuroarticular lesion in the elderly: A condensed literature review. J Manipulative Physio Ther. 2004; 27(7):478.

153 Dishman JD, Katz P. Establishment of chiropractic services for geriatric inpatient rehabilitation hospital: a pilot of one model of integration. J Chiro Ed. 2003; 17(1):6.

154 Kettner NW, Killinger LZ, Morley JE, Kauric E. Integrated care of the older patient. Top Clin Chiropr. 2001 June; 8(2):46–54.

155 Killinger LZ. Promoting health and wellness in the older patient: Chiropractors and the Healthy People 2010 objectives. Top Clin Chiropr. 2001 December; 8(4): 58–63.
156 McCarthy KA. A chiropractic clinical approach to aging, degeneration, and the subluxation. Top Clin Chiropr. 2001 March; 8(1):61–70.
157 Nicholson CV. Putting prevention into elder care as if wellness matters most. Top Clin Chiropr. 2002 June; 9(2):32–40.
158 Gleberzon BJ. Audio lectures. Chiropractic care of the older person: Challenges and solutions. DC Tracts. 2003; 15(4):2–3.
159 Azad A. Audio lectures. Health promotion and prevention in the elderly: A chiropractic perspective. DC Tracts. 2003; 15(4):3–6.
160 Russo R. Welcome seniors into your practice and watch it grow. ICA Rev. 2007 November; 63(3):39–42.
161 Maltby JK. Listening: The key to caring for the elderly patient. ICA Rev. 2008; 64(2):40–3.
162 Kirk R, Sullivan S. The center for seniors: A descriptive study of a wellness-based mature adult learning community. ACC-RAC 2009. Las Vegas NV. Mar 12–14, 2009
163 Austin WM. Discomfort and the ageing foot. J Am Chiropr Assoc. 2002; 39(6):56–65.
164 Danchik J. Rotator cuff connection in athletes and seniors. ICA Rev. 2002; 58(4):50–9.
165 Printon R, Osterbauer P, Davis PT. Chiropractic treatment of older people: protocol development for the upper extremities. J Chiropr Ed. 2003; 17(1):73–7.
166 Hulbert JR, Printon R, Osterbauer P et al. Chiropractic treatment of hand and wrist pain in older people: systematic protocol development. Part 1: informant interviews. J Chiropr Med. 2005; 4(3):144–51.
167 Hulbert JR, Osterbauer P, Davis PT, Printon R et al. Chiropractic treatment of hand and wrist pain in older people: systematic protocol development Part 2: cohort natural-history treatment trial. J Chiropr Med. 2007 March; 6(1):32–41.
168 Rorstrand-Viking H. Chiropractic management of osteoporotic vertebral compression fracture. Euro J Chiropr. 2003; 48(1):13–18.
169 Gleberzon BJ, Killinger LZ. Management considerations for patients with osteoarthritis and osteoporosis: A chiropractic perspective on what's working. Top Clin Chiropr. 2002 March; 9(1):48–61.
170 Doherty P, Lawrence D. Chiropractic management of musculoskeletal pain in the multiple sclerosis patient. Clin Chiropr. 2005; 8(2):57–65.
171 Leach RA. Patients with symptoms and signs of stroke presenting to a rural chiropractic practice. J Manipulative Physiol Ther. 2010 January; 33(1):62–9.
172 Feise R. Direction of the Evidence. Can physical activity provide a benefit to the very old? JACA Online. 2010 May; 47(4):Online-15.
173 Haneline MT. Chiropractic involvement in preventing falls among the elderly. J Am Chiropr Assoc. 2003 April; 40(4):24–9.
174 Polus BI, Walsh MJ, Webb MN. The role of the cervical spine in balance and risk of falling in the elderly. Chiropr J Aust. 2004 March; 34(1):19–22.
175 Kargus A. Preventing falls among older adults. J Am Chiro Assoc. 2005; 42(9):19–20.
176 Bougie JD. Audio lecture. Older adult balance disorders, assessment and rehabilitation. DC Tracts. 2006; 18(2): 2–5.
177 Larson L, Bergmann TF. Literature review. Taking on the fall: The etiology and prevention of falls in the elderly. Clin Chiropr. 2008 September; 11(3):148–54.
178 Neros C, Brauer S, Woollacott. Balance control in the elderly: do masters athletes show more efficient balance responses than healthy older adults? J Chiro Ed. 2009; 23(1):86.
179 Feise R. Direction of the evidence: Can you name an effective intervention (or two) that prevents falls in the elderly? JACA Online. 2009 September; 46(7):Online-17.
180 Kline CM. Fall prevention, part 1: Unique role for chiropractic? JACA Online. 2009 September; 46(7):Online-6.
181 Kline CM. Fall prevention, part II: Chiropractic keeps patients on their feet. JACA Online. 2009 November; 46(8):Online-6.
182 Kline CM, Gleberzon BJ, Rogers M. Fall prevention, Part III: Chiropractic keeps patients on their feet. JACA Online. 2009 December; 46(9):Online-6.
183 Kline CM, Enix D, Forcum T, Rogers M, Hyde T, Killinger L. Fall prevention, Part IV: Interventions. JACA Online. 2010 January; 47(1):Online-9.
184 Don't Let a Fall Get You Down. Available from the Canadian Chiropractic Association. www.ccachiro.org
185 Stuber K, Sajko S, Kristmanson K. Chiropractic treatment of lumbar spinal stenosis: a review of the literature. J Chiro Med. 2009; 8(2):77–85.
186 Kline CM. Chiropractic approach to lumbar spinal stenosis, Part 1. JACA online. April 2008: 2–6.
187 Kline CM. Chiropractic approach to lumbar spinal stenosis, Part II: Surgery and treatments. JACA Online. May-June 2008; 2–7.
188 Killinger LZ. Chiropractic adjusting and the "aging" patient. J Am Chiropr Assoc. 2003 November; 40(11): 26–8.
189 Cooperstein R. Mobilizing and manipulating the arthritic hip. J Am Chiro Assoc. 2009; 46(5):9–11.
190 McHenry Martin C. Complementary and alternative medicine practices to alleviate pain in the elderly. The Consultant Pharmacist. 2010; 25(5):284–290.
191 Hawk C, Schneider M, Doherty P. Best Practices

recommendations for chiropractic care for older adults: Results of a consensus process. J Manipulative Physio Ther. 2010; 33:464–473.
192 Byfield D. Adjustive care for seniors. WFC 6th biennial congress. Paris, France. May 21–26, 2001.
193 Byfield D. Adjusting seniors and osteoporotic patients. WFC 9th biennial congress/ ECU's 75th Anniversary Convention. Vilamoura, Portugal. May 17–19, 2007.
194 Byfield D. Diversified for older and osteoporotic patients: Assessment, imaging, management. WFC's 10the Biennial Congress Proceedings. Montreal, Qu. April 30–May 2, 2009.
195 Dougherty P, Wiese B, Osterbauer P. Second annual geriatric symposium. ACC-RAC 2009. Las Vegas NV. Mar 12–14, 2009.
196 Sportelli L, Dougherty P, Hawk C, Killinger L. Taking care of our geriatric population. ACC-RAC 2010. Las Vegas, NV. Mar 18–20, 2010.
197 Gleberzon BJ, Freedman A. Seniors quality of life. WFC's 10the Biennial Congress Proceedings. Montreal, Qu. April 30–May 2, 2009.
198 Gleberzon BJ. Quality of Life for seniors: Diet, fall prevention and wellness. WFC's 10the Biennial Congress Proceedings. Montreal, Que. April 30-May 2, 2009.
199 Freedman A. Quality of life for seniors: Collaborative care for musculoskeletal disorders. WFC's 10the Biennial Congress Proceedings. Montreal, Que. April 30–May 2, 2009.
200 Gleberzon BJ. Chiropractic Care of the older Patient. Oxford. Butterworth-Heinemann. 2001.
201 Bougie JD, Morgenthal AP. The Aging Body: Conservative management of common neuromusculoskeletal conditions. McGraw-Hill. 2001.
202 ACA Chiropractic and Geriatric: Care for the Aged. White House Conference on Aging. Sept 10, 2004. Washington DC.
203 Bougie J. Geriatric practice-specific issues. In: Haldeman S, editor. Principles and Practice of Chiropractic. 3rd ed. New York. McGraw-Hill: 2005.
204 Gleberzon BJ, Gengenbach MS, Montgomery P. Physical activity and the older person. In: Hyde TE, Genegenbach MS, editors. *Conservative Management of Sports Injuries*, Second Ed. Sudbury, MA: Jones and Bartlett Publishers; 2007. p953–969.
205 American Geriatric Society. Guidelines for the Prevention of falls in older persons. J Am Soc 2001; 49:664–72.
206 American Geriatric Society. Exercise prescription for older adults with osteoarthritis pain. Consensus practice recommendations. J Am Geriatr Soc. 2001; 49:808–823.
207 American Geriatric Society. The management of persistent pain in older persons. J Am Geriatr Soc. 2002; 50(6):S205–224.
208 Report on Senior's falls in Canada. Public Health Agency of Canada www.phac-aspc.gc.ca/seniors-aines/pubs/seniors_falls/index. Accessed Sept 11, 2008
209 Active Ageing: A Policy Framework. World Health Organization Madrid, Spain. April 2002: 12. http://whqlibdoc.who.int/hq/2002/WHO_NMH_NPH_02.8.pdf. Accessed Sept 11, 2008
210 WHO Global Report on Falls Prevention in Older Age. WHO 2007. http://whqlibdoc.who.int/publications/2008/9789241563536_eng.pdf. Accessed Sept 11, 2008
211 McClure R, Turner C, Peel N et al. Population-based interventions for the prevention of fall-related injuries in older people (review). The Cochrane Collaboration, 2008; Issue 3:2–3.
212 Forster A, Lambley R, Hardy J et al. Rehabilitation for older people in long-term care. Cochrane Database Syst Rev. 2009; CDOO4294.
213 Howe TE, Rochester L, Jackson A et al. Exercise for improving balance, physical function in older adults. Cochrane Database Syst Rev. 2007:CD004963.
214 Liu CJ, Lathan NK. Progressive resistance strength training for improving physical function in older adults. Cochrane Database Syst Rev. 2009; CD002759.
215 Sackett DL. Evidence-Based Medicine. Spine. 1999; 23(10):1085–1086 (Editorial).
216 Sackett DL. Testimony during the Inquest of Dana Dale Lewis. November 22, 2002. (As transcribed in the CCWG bulletin dated Nov 25, 2002).
217 Rosner AL. Fables or foibles: inherent problems with RCTs. J Manipulative Physio Ther .2003; 26(7):460–7.
218 Triano JJ. What constitutes evidence for Best Practices? J Manipulative Physio Ther. 2008; 31:637–643.
219 Mootz RD. The contextual nature of manual medicine: challenges of the paradigm. J Chiropractic Humanities. 1995:5(1):28–40.
220 Bolton JE. The evidence of evidence-based medicine. What counts and what doesn't count? J Manipulative Physiol Ther. 2001; 24(5):362–6.
221 Haynes B et al. Clinical expertise in the era of evidence-based medicine and patient choice. ACP Journal Club. 2002; Mar-Apr; 136-A11.
222 Cassidy JD, Boyle E, Cote P et al. Risk of vertebrobasilar stoke and chiropractic care. Results from a population-based case-control and case-crossover study. Spine. 2008; 33(4S):S176-S183.
223 Hurwitz EL, Morgenstern H, Vassilaki M. Frequency and clinical predictors of adverse reactions to chiropractic care in the UCLA neck pain study. Spine. 2005; 30: 1477–84.
224 Gouveia LO, Castanho P, Ferreira JJ. Safety of chiropractic interventions: a systematic review. Spine. 2009; 24:405–413.
225 Cooperstein R, Killinger LZ. Chiropractic techniques in the care of the geriatric patient. In: Gleberzon BJ, Editor.

Chiropractic care of the older patient First Ed. Oxford, UK. Butterworth-Heinemann. 2001; 359–383.
226 Cooperstein R, Gleberzon BJ editors. Technique Systems in Chiropractic. First Edition. Edinburgh, UK. Churchill-Livingstone 2004
227 Gleberzon BJ. Spinal adjusting and the older person. In: Byfield D. Techniques in Chiropractic. Churchill-Livingstone 2011. In press.
228 Gleberzon BJ, Ross K. Manual of Diversified Diagnostic and Therapeutic Procedures. Canadian Memorial Chiropractic College. Self-published. 2008.
229 Goodwin JS. Geriatrics and the limits of modern medicine. N Eng J of Med. 1999; 340(16):1283–1285.
230 World Health Organization: Health Promotion Glossary (1998). hppt://www.who.int/hpr/NPR/docs/hp_glossary_en.pdf
231 Meeker WC, Haldeman S. Chiropractic: A profession at the crossroads of mainstream and alternative medicine. Arch Intern Med. 2002; 136:216–227.
232 World Health Organization. The Ottawa Charter for Health Promotion (1986). http://www.who.int/htr/NPH/docs/ottawa_charter_hp.pdf

0008-3194/2011/96–106/$2.00/©JCCA 2011

Impairment assessment of lateral epicondylitis through electromyography and dynamometry

Marc-André Blanchette, DC, MSc*
Martin C. Normand, DC, PhD**

Objectives: *To investigate changes in muscular activity and strength of subjects diagnosed with lateral epicondylitis (LE). To assess the appropriateness of these measures in the patient's follow-up.*

Methods: *Twenty-four subjects (11 men and 13 women) with LE, were evaluated at baseline and after 5 weeks of an experimental treatment. Measurements included: the (1) pain-free grip (PFG), (2) maximal isometric strength, (3) surface electromyography (EMG) of forearm muscle (healthy and affected), (4) a visual analogue scale (VAS), and (5) the Patient Rated Tennis Elbow Evaluation (PRTEE) (Canadian-French version).*

Results: *All subjects showed improvement in VAS and PRTEE. The maximal isometric strength during flexion and extension of the wrist and the EMG analysis failed to discriminate the affected from the healthy elbow during the initial assessment. Only the PFG measured with the elbow in extension could discriminate elbows with LE from the healthy ones.*

Conclusions: *The use of the PFG with the elbow in extension seems to be the most indicated strength measurement to monitor the recovery of patients with LE. The EMG acquisition protocol used in this research was not adequate to monitor effectively the recovery of LE.*
(JCCA 2011; 55(2):96–106)

KEY WORDS: lateral epicondylitis, tennis elbow, pain-free grip, electromyography, measurements.

Objectifs : *Étudier les changements de force et d'activité musculaire de sujets avec un diagnostic d'épicondylite latérale (LE). Évaluer la pertinence de ces mesures dans le suivi de patients.*

Méthodes : *Vingt-quatre sujets (11 hommes et 13 femmes) avec LE, ont été évalués au départ et après 5 semaines d'un traitement expérimental. Les mesures comprenaient: (1) la préhension maximale sans douleur (PFG), (2) la force isométrique maximale, (3) l'électromyographie de surface (EMG) des muscles des avant-bras (sains et affectés), (4) une échelle visuelle analogue (VAS) et (5) le questionnaire Patient Rated Tennis Elbow Evaluation (PRTEE) (version française canadienne).*

Résultats : *Tous les sujets ont démontré une amélioration du VAS et du PRTEE. La force isométrique maximale lors de la flexion et l'extension du poignet et de l'analyse EMG n'ont pas permis de discriminer les coudes affectés des coudes sains lors de l'évaluation initiale. Seuls la PFG mesurée avec le coude en extension a réussi à discriminer les coudes avec LE des sains.*

Conclusions : *L'utilisation de la PFG avec le coude en extension semble être la mesure de force la plus indiquée pour effectuer le suivi de patient avec LE. Le protocole d'acquisition EMG utilisé dans cette recherche n'était pas adéquat pour effectuer le suivi de patients avec LE.*
(JCCA 2011; 55(2):96–106)

MOTS CLÉS : épicondylite latérale, préhension maximale sans douleur, électromyographie, évaluation.

* Public Health PhD Program. Department of Social and Preventive Medicine, Faculty of Medicine, University of Montreal, Montreal, QC, Canada. Private practice of Chiropractic, Centre Chiromédic, Laval, QC, Canada.
** Director of the Chiropractic department, Université du Québec à Trois-Rivières, Trois-Rivières, QC, Canada.
Corresponding author : Marc-André Blanchette DC, MSc, PhD candidate, Centre Chiromédic, 1545 boulevard de l'Avenir #300, Laval, QC, Canada H7S 2N5. E-mail: marc-andre.blanchette@umontreal.ca. Tel: (450) 967-0500, fax: (450) 967-8944.

Introduction

Lateral epicondylitis (LE) or "tennis elbow" is an injury at the insertion of the extensor carpi radialis brevis and the extensor digitorum. It is characterized by pain at the external aspect of the elbow exacerbated during extension of the elbow with the wrist in flexion or during resisted extension of the wrist with the elbow in extension.[1] Grip strength is affected and simple activities such as simply taking a cup of coffee may become painful. This is the most common condition diagnosed in the elbow and it affects between 1% and 3% of the population.[2–4] Smoking (Odds Ratio (OR) = 1,3),[4] forceful work (OR = 3,1)[5] and the combination of repetitive movements of the arm and forceful activities (OR = 5,6)[4] are associated with the occurrence of LE. LE naturally resolves over a period of 1 to 2 years in 80 to 90% of cases.[6] It is thought to be a self-limiting condition as pain limits the function of the elbow thus protecting the insertion of the extensor muscles of mechanical stresses during the healing process.[7] It should be noted that the term "tennis elbow" is inappropriate because tennis players represent only 5 to 10% of cases, however the practice of racket sports increases the risk of developing LE (OR = 2,8)[6] and 40 to 50% of players may develop this condition.[8] The term tendinitis is also inappropriate to describe the chronic presentation of this disease because no histological inflammatory reaction has been found in patients treated surgically for chronic LE.[9] The term tendinosis should be utilized preferentially since it refers to degenerative tendinopathy (angiofibroblastic hyperplasia)[10] as seen in this condition.

Recent literature reviews[7,11] have listed more than 40 different treatment methods for this condition. The majority of studies reported inconsistent results and no therapeutic modality seems to stand out or alter the natural history of the disease. Surprisingly, despite the multitude of studies, there is not enough evidence to currently recommend the use of one treatment modality over another. This can be explained by the limited usage (fewer than the half of the experimental studies) of assessment instruments, with adequate psychometric properties (valid, reliable, and sensitive to change), that limit the power and validity of studies on lateral epicondylitis.[12] The Patient-rated Tennis Elbow Evaluation (PRTEE) is a questionnaire that has demonstrated sufficient psychometric properties.[13–16] Since the PRTEE depends on the patient rating of 15 items, there is still a need to find measures that can objectively monitor the progress of patients with LE.

Grip strength is commonly measured to quantify the progression of LE. Several variations of grip strength testing are found in the literature. Healthy subjects demonstrate stronger maximal grip when measured with the elbow bent at 90 degrees than when measured with the elbow extended.[17] Patients with LE showed no difference between the elbow positions for the healthy arm, while the affected arm showed a significant lower strength when measured with the elbow in extension.[18] An 8% decrease of grip strength when measured with the elbow in flexion compared to extension was sufficient to distinguish the affected elbow from the healthy one. These variations have diagnostic implications for both researchers and clinicians. Although maximal grip has an adequate inter-observer reproducibility (ICC = 0.97)[19] many researchers prefer to quantify the progress of LE using the Pain-Free Grip (PFG).[19,20] In addition to the advantageous inter-observer reliability,[19] PFG shows a better correlation with common pain scales.[20] Since PFG is always measured with the elbow in extension, we decided to compare the two positions (flexion / extension) in order to identify the more appropriate position in which to monitor progress in patients with LE.

Electromyography (EMG) has also been used to investigate the function of forearm muscle in healthy and LE individuals. Rojas had identified muscle asymmetry characterized by a decrease of the activation of the extensor carpi radialis, a compensatory increase in the activation of extensor carpi ulnaris and higher muscle fatigue index in LE subjects compared to control subjects.[21] A similar study documented a reduction in the activation of the extensor carpi radialis, without increased activation of the extensor carpi ulnaris, or modification of the fatigue index.[22] They also have noted a weakness of the affected upper limb when compared to a control group. Another study was able to compare a group of healthy subjects, a LE group, and a group of recovered LE patients (no pain for 6 months).[23] The EMG results showed a decrease in the activation of the extensor carpi radialis in LE subjects and an increased activation in recovered subjects, despite persistent weakness of the upper limb. The decreased activation of the extensor carpi radialis is in accordance with the pain adaptation model[24] that predicts a reduced activity of agonist muscles in the presence of chronic pain.

Table 1 *Inclusion and exclusion criteria*

Inclusion criteria	Exclusion criteria
• Having a lateral epicondylitis confirmed by the chiropractor responsible for examination through the tests of Cozen and Mill.[1] • Being at least 18 years old.	• Bleeding disorders (hemophilia) • Taking anticoagulants (aspirin) • History of thrombosis or thrombophlebitis, • A condition than weaken the skin (e.g., hives) • Diabetes • Kidney disease • Uncontrolled hypertension, • The presence of an infection at the time of the evaluation • History of elbow surgery or diffuse pain syndrome (eg fibromyalgia), • Elbow osteoarthritis, rheumatoid arthritis, or other inflammatory arthritis affecting the wrist or the elbow, • Carpal tunnel syndrome, • Radiculopathy from the neck, • Fracture of the upper limb with residual deformity, • Pending litigation settlement (other than the Work Compensation Board) for the elbow problem, • Corticosteroid injections within 30 days preceding the study. • Bilateral lateral epicondylitis

Small increases in the level of activity of the antagonist could also be caused by pain. As a consequence of these changes, force production as well as the range and velocity of movement of the affected body part are often reduced. While this is not commonly used, we believe that the use of the co-activation percentage (ratio of : activity of a muscle acting as an antagonist/ activity when acting as an agonist) should show a modulation of motor activity in a context of chronic elbow pain. According to the pain adaptation model,[24] pain causes a reduction in the activity of agonist muscles and an increase in the antagonist activity which should lead to an increase in the percentage of co-activation. We compared the affected elbow to the unaffected elbow since we believe that this is preferable to between-subjects comparisons done in previous studies.

Since the number of adequate assessment instruments for LE is limited, the purpose of this study was to investigate change in EMG and dynamometry of subjects diagnosed with LE to assess the appropriateness of these measures in the patient initial functional assessment and follow-up.

Methodology

Subjects

This study was conducted at the biomechanics laboratory of the University. Subjects were recruited through an e-mail sent to University employees that were concurrently enrolled in a project comparing the effect of two treatments on LE. The recruitment period extended from February to April 2007. The subjects were accepted if they met the criteria for inclusions (Table 1). These criteria included those frequently used in studies on LE[25–27] and those recommended for the experimental treatment administered (augmented soft tissue mobilization). This study was approved by the Institutional Review Board of the University (number ERC-06-114-06.02). All potential subjects (n = 34) during the recruitment period were considered. Five did not meet the inclusion criteria, two refused to participate and three were lost to follow-up so their initial information was not utilized. Twenty-four subjects completed both the initial evaluation (week 1) and the final evaluation after 5 weeks of treatment (week

Figure 1 *The PFG with the elbow in extension and the elbow bent at 90 degrees*

Table 2 *Characteristics of subjects*

Age (years)	46 ± 10
Sex (male/female)	11 / 13
Affected elbow (Dominant / Non-dominant)	13 / 11
Onset of the LE (months)	29 ± 38

LE : lateral epicondylitis

6). Table 2 summarizes the clinical presentation of the subjects.

The initial evaluation included: the Patient Rated Tennis Elbow Evaluation (PRTEE) cross-culturally adapted to Canadian French,[28] a visual analogue scale (VAS), PFG, maximal isometric strength of the wrist and surface EMG. The first half of the group received ten treatments of augmented soft tissue mobilisation (a variation of deep friction massage) for a five week period, and the second received home exercises (stretching of the forearm). One week after the last treatment (week 6), all initial tests were repeated. All the analyses presented in this manuscript are for both treatment groups as a summary, they are not separated (this occurs in another manuscript).[29]

Dependant variables

The VAS was measured with a scaled line from zero to one hundred millimetres.[30] The question asked was: « Indiquez par un X l'endroit sur la ligne ci-dessous qui représente le mieux l'intensité de votre douleur aujourd'hui » which translates to: "Mark with an X the location on the line below which best represents the intensity of your pain today."

The PRTEE (cross-culturally adapted to Canadian French[28]) with a score from zero to one hundred[13–16] was used. This questionnaire provides a brief, uncomplicated, and standardised quantitative description of pain and functional disability.

PFG, commonly used to quantify the progression of LE,[19,30,31] was measured using a dynamometer JAMAR model 08940189 (Preston, Jackson, MI), whose dynamic range is 981 N. The test was performed with the subjects in two standard positions: the arm along the body with the elbow bent at 90 degrees[17] and the elbow in full extension along with the body (Figure 1). The subjects also received standardized instructions: they were to squeeze the dynamometer slowly until they began to feel discomfort. The PFG was measured 3 times, with a 20-second rest interval between each measurement. The results were averaged for better reproducibility.[19]

The surface EMG of the extensor carpi radialis, the extensor digitorum and the superficial flexor digitorum were recorded during maximum and sub-maximal isometric contractions of five seconds in flexion and extension of the wrist. During all EMG acquisition sessions, the sampling frequency was set at 1000 Hz. Disposable bipolar surface electrodes Ag-AgCl (BORTEC Biomedical, Calgary, Alberta, Canada) were applied bilaterally according

Figure 2 *Maximal isometric contraction during wrist extension (left picture) and wrist flexion (right picture).*

to literature recommendations.[32,33] The electrode placement site was first shaved and scrubbed with alcohol. The reference electrode (ground) was placed on the olecranon. The subjects were seated, with their elbow bent at 90°. With their hand initially in a prone position, they were asked to hold a U-shaped handle linked to a strain gauge to measure the maximal voluntary contraction (Figure 2). The subjects had their forearm fixed and were producing maximal flexion and extension of the wrist during verbal reinforcement. The sub-maximal EMG signals of muscles were collected during the hold against gravity of a 5 lbs dumbbell with the hand both in pronation and supination (Figure 3). Each contraction was followed by a two minute pause to reduce the risk of fatigue. Each measurement was made three times on both forearms for comparison. The signals were pre-amplified at the source (gain = 500), to eliminate motion artifacts, before a second amplification (AMT-8, BORTEC Biomedical). The EMG signals were filtered according to a seventh order Butterworth (bandwidth of 10 to 450 Hz), rectified in absolute values and smoothed (a moving average including 10 points was used to filter the data) to determine the maximal value of each curve. The average of three maximal values was calculated and used for each condition. In order to quantify the level of muscle activity, the average of sub-maximal values is expressed as a percentage of the average of the maximal values according to the following equation:

$$\% \text{ Activation} = (5 \text{ lb EMG} / \text{EMG max}) \times 100$$

The co-activation percentage was represented by the EMG activity of a muscle when acting as antagonist expressed as a percentage of when acting as agonist. These percentages were obtained using the mean of maximal isometric tasks as in the following example:

$$\% \text{ Co-activation} = (\text{EMG of one muscle acting as antagonist} / \text{EMG of the same muscle acting as an agonist}) \times 100$$

During maximum isometric contractions in flexion and extension of the wrist (Figure 2), the strength signals were collected using a strength gauge (NTEP-87-057A3 class III, Artech, Riverside, CA). For each test, the force was recorded at the same sampling frequency as the EMG (1000 Hz) and then filtered in a second-order Butterworth (cut-off frequency up to 8 Hz). The maximal strength was measured in each attempt and the average of the three trials was calculated.

Statistics

The paired t-test (a = 0.05) comparing the initial and the week 6 evaluation was performed for the VAS and the PRTEE. The two-way or three-way ANOVAs with repeated measures (a = 0.05) on all factors were used to determine whether statistically significant differences were present with the other variable. When appropriate, post hoc Fisher LSD test (a = 0.05) was performed. The status of the elbow (healthy or affected) was the independent variable while the PFG, EMG and isometric strength val-

Figure 3 *Sub-maximal isometric contraction during wrist extension (left picture) and wrist flexion (right picture).*

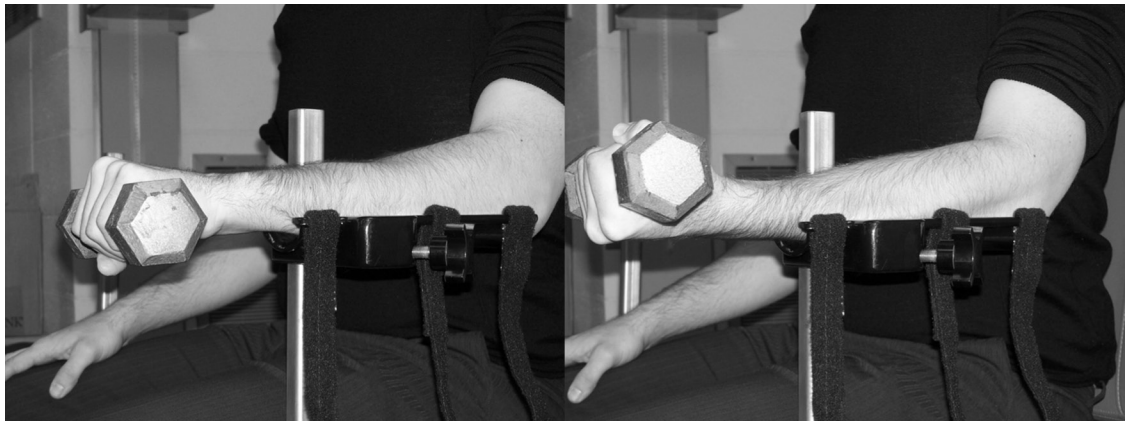


Table 3 *Patient rated outcomes*

	Baseline	Week 6	P value
PRTEE	35 ± 19	18* ± 14	< 0.001
VAS	46 ± 26	17* ± 12	< 0.001

Mean ± standard deviation
* Significant decrease of the score from baseline

ues were considered dependent variable. The experimental plan of analysis is represented by: A × Br for the results of EMG and isometric strength, and A × Br × C for PFG, where:

A has 2 levels represented by the healthy and affected elbow;

B has 2 levels respresented by the initial evaluation and the week 6 evaluation;

C has 2 levels represented by the position of the elbow during PFG in extension and flexion.

Results

Patient rated outcomes

Patient progress was evaluated using the PRTEE (Canadian-French version) and the VAS. Table 3 summarizes the results of these two scales. Both the PRTEE and the VAS showed a significant decrease of the score after 6 weeks (P < 0,001) which represents an improvement of the subject condition.

Strength

Isometric strength was measured in four specific conditions: flexion and extension of the wrist and PFG with the elbow in flexion and extension. Table 4 shows the average maximal obtained.

The maximal isometric *wrist flexion strength* revealed no main effect of elbow status or time.

The maximal isometric *wrist extension strength* during extension showed a main effect of time (P = 0,022), result of a significant increase of strength in both elbows after 6 weeks. This measure of strength showed no significant difference between the healthy and affected elbow.

The PFG showed main effects of time (P = 0,021) and elbow (P = 0,014) in addition to an interaction between the elbow and its position (P = 0,011). The post hoc analyses demonstrated:

1. A significant increase of the PFG after six weeks in both arms and both positions.
2. A significantly lower PFG in the affected elbows compared to healthy elbow when measured with the elbows in extension.
3. A significant lower PFG of the affected elbows measured in extension compared to flexion.

Surface EMG

Table 5 shows the percentages of muscle activation and co-activation. For the muscle activation, the statistical analysis demonstrated main effect of elbow status and/or time only for the percentage of activation during flexion

Table 4 *Isometric strength and PFG (kg)*

	Baseline		Week 6	
Elbow	Healthy	Affected	Healthy	Affected
Wrist strength in extension	12 ± 5	12 ± 5	13* ± 5	13* ± 5
Wrist strength in flexion	39 ± 17	37 ± 19	40 ± 22	40 ± 22
PFG (extension position)[a]	30 ± 11	26[a] ± 14	33[b] ± 11	28[ab] ± 13
PFG (flexion position)	31 ± 11	29 ± 13	34[b] ± 12	31[b] ± 14

Mean ± standard deviation

* Significant increase of the score from baseline (main effect of time, P = 0.022)

[a] PFG significantly lower than the measure with the elbow in flexion and the healthy elbows (interaction elbow status-position, P = 0.011)

[b] PFG significantly higher than the score from baseline (main effect of time, P = 0.021)

of the extensor digitorum and the superficial flexor digitorum.

The activation percentage of the extensor digitorum during flexion showed a main effect of time (P = 0.006), resulting from a significant decrease in the percentage of muscle activation of both forearms.

The activation percentage of the superficial flexor digitorum during flexion showed a main effect of time (P = 0.007), caused by a significant increase in muscle activation after 6 weeks in both forearms.

For muscle co-activation, the statistical analysis demonstrated main effect of elbow status and/or time only for the co-activation percentage of the extensor digitorum.

The co-activation percentage of the extensor digitorum showed a main effect of elbow status (P = 0.048) and time (P = 0.003), result of a significant increase of the co-activation percentage after 6 weeks in both forearms and a co-activation percentage significantly lower in affected elbows.

Discussion

Patient rated outcomes

Since both the VAS and the PRTEE showed significant improvement after six weeks, it is reasonable to consider that the subject's LE improved during that period of time. The Canadian French version of the PRTEE has demonstrated good acceptability, construct validity, internal consistency and responsiveness.[28] In 2005, the first English version of the PRTEE , the Patient-rated Forearm Evaluation Questionnaire (PRFEQ), was considered to be the most reliable (Interclass Correlation Coefficient (ICC) = 0.96; Standard error of measure (SEM) = 1.0) and *responsive* (Standardized response means (SRM) = 1.0) questionnaire utilized in patients suffering from lateral epicondylitis (compared to the Visual Analogue Scale (VAS), the Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH), the Medical Outcomes Study 36-item Short Form Health Survey and the Pain-Free Grip (PFG)).[13] In 2005, the PRFEQ was updated to the actual PRTEE to accommodate findings from different research groups and to improve its clarity.[15] In 2007, the comparison of this updated version with results of the VAS, the DASH Questionnaire, the Roles and Maudsley score, and the Upper Extremity Function Scale (UEFS), showed excellent reliability (r^2 = 0.87) and internal consistency (Cronbach's alpha = 0.94).[16] SRM was higher in the PRTEE (SRM = 2.1) than in the other outcome measures (1.5 – 1.7).[16] The questionnaire provides a brief, uncomplicated, and standardised quantitative description of pain and functional disability.[14] It can be completed in less than five minutes. The use of PRTEE as a standard outcome measure in research may help determine best practice approaches for lateral epicondylitis.

Strength

In order to quantify the functional capacity of subjects, several measures of strength involving the forearm muscles were used. Measuring the maximal isometric strength of the wrist during flexion and extension seemed

Table 5 *Percentages of muscle activation and co-activation*

	Baseline		Week 6	
Elbow	Affected	Healthy	Affected	Healthy
% activation during extension				
Extensor carpi radialis	27 ± 13	25 ± 12	25 ± 14	25 ± 10
Extensor digitorum	37 ± 23	37 ± 16	32 ± 17	31 ± 9
Superficial flexor digitorum	43 ± 24	45 ± 35	58 ± 37	45 ± 24
% activation during flexion				
Extensor carpi radialis	34 ± 22	34 ± 28	36 ± 27	27 ± 17
Extensor digitorum	36 ± 29	31 ± 23	22[a] ± 15	20[a] ± 10
Superficial flexor digitorum	16 ± 11	14 ± 8	21[b] ± 19	20[b] ± 17
% co-activation				
Extensor carpi radialis	13 ± 7	15 ± 6	15 ± 6	16 ± 5
Extensor digitorum[cd]	23[c] ± 10	30 ± 21	41[cd] ± 18	43[d] ± 18
Superficial flexor digitorum	63 ± 77	68 ± 56	45 ± 75	34 ± 19

Mean ± standard deviation

[a] The 6th week follow up percentage are significantly lower than the baseline week (main effect of time, P = 0.006)

[b] The 6th week follow up percentage are significantly higher than the baseline week (main effect of time, P = 0.007)

[c] The affected elbows percentage are significantly lower than the healthy one (main effect of elbow status, P = 0.048)

[d] The 6th week follow up percentage are significantly higher than the baseline week (main effect of time, P = 0.003)

logical, but our results showed no significant difference between the healthy and the affected elbows. Only an increase in the maximum isometric strength during extension of both elbows was observed after 6 weeks. Since an improvement of the affected elbow should demonstrate an interaction between time and elbow status, the increased strength of both elbows could be attributed to test-retest effects, because subjects often exert more force in a retest. The absence of difference between the affected and healthy elbows of LE subjects has been observed in the literature,[22] but the affected arm usually presented a lower strength when compared with a group of healthy subjects. LE typically affects the dominant arm and a decreased strength of the dominant arm could make the strength of both arms comparables. Hand dominance of the subject could be a confounding variable since 13 of our subjects had LE on the dominant arm and 11 on the non-dominant arm. Nevertheless, these measures cannot effectively discriminate the healthy and affected elbow (both arms showed comparable improvement even after a significant decrease in pain), they show little interest for initial assessment and follow-up in clinical practice.

Our results showed an increase of PFG for the two positions after 6 weeks. Similarly to the maximal isometric strength during wrist extension, the increase PFG of both elbows could be attributed to test-retest effects. But, the PFG was significantly lower among affected elbows when measured with the elbow in extension rather than in flexion. In addition, the PFG in the extension position was the only strength measure that could discriminate healthy elbows from the affected. The elbow extension, as in the provocation test of resisted wrist extension,[1] put greater stress on the extensor carpi radialis and produces pain at lower grip strength. This greater stress of the injured muscles allows better discrimination of affected and healthy elbows. According to this data, the PFG with the elbow in extension is the best measure of strength for the assessment of LE in research and practice.

Surface EMG

The only EMG measure that was able to discriminate the affected elbows from the healthy ones was the co-activation percentage of the extensor digitorum. These results are different from previous studies that described a decrease in the activation of extensor carpi radialis in LE subjects.[21,22,23] The fact that our results did not confirm this difference between healthy and affected elbows could indicate a methodological difference in the EMG acquisition. In previous studies, EMG data were acquired at 50% maximal voluntary isometric contraction during grip, and analysed using normalized median frequency slope as a fatigue index.[22,23,34] Our experimental task carried out during the acquisition of EMG signals during wrist extension combined the grip of a U-shape handle in addition to a resisted extension while previous research only included gripping[22,23,34] or a resisted wrist extension.[21] It has been suggested that the extensor carpi radialis brevis acts as a flexor muscle stabilizer for gripping during pronation.[35] Combining gripping in pronation and resisted extension could possibly cause an increase activation of extensor carpi radialis during our experiment. Another difference between our methodology and the one of previous studies is that our experimental design did not allow us to assess fatigue index. It is also possible that the lack of difference between healthy and affected elbows is due to the choice of non-affected elbows of the same subjects as a source of comparison. All previous studies used a group of healthy subjects.

Our experiment showed a decreased activation of the extensor digitorum of both forearms after six weeks. The co-activation percentage of that muscle is lower in the affected arm and increased in both arms after six weeks. These differences are opposite to those we expected under the pain adaptation model[24] since in the presence of a decrease of pain (VAS) a decreased percentage of muscle co-activation was expected. The pain adaptation model applies to the agonist-antagonist activity of different muscles, and not to the agonist-antagonist activity of the affected muscle. Once again, the increased co-activation percentage of both arms could be attributed to the test-retest effect. The same phenomenon was observed with the superficial flexor digitorum that showed an increase of activation in both arms after six week. One of the limitations of our research design is that we have not assessed the test-retest reliability of our EMG protocol. However, we have used a procedure that should increase test-retest reliability: using the average of 3 measures and expressing the level of muscle activity as a percentage of maximal values (standardisation). Even if Alizadehkhaiyat et al. claim that their EMG procedure is reliable for measuring muscle imbalance in the wrist-forearm-shoulder-chain,[33] they did not assess the test-retest reliability between two sessions.The discrepancy between our results and those found in previous studies[21–23] comes from changes in the EMG acquisition and analysis procedures.

According to our results and those from previous studies, the best way to monitor the recovery of LE in both clinical trials and clinical practice is to use the PRTEE[13–16,28] and the PFG with the elbow in extension.[19,30,31] Even if the method proposed by Alizadehkhaiyat et al. seems more promising than our's, future research using EMG data should assess the test-retest reliability of their protocol before it could be used in clinical trials. Since co-activation percentage of the extensor digitorum, was the only EMG measure that discriminated the affected elbows from the healthy ones in this study, more investigation should be done on co-activation of forearm muscle during other experimental tasks before it could be used as a clinical or research outcome.

Conclusion

The use of the PFG with the elbow in extension seems to be the most indicated strength measurement to monitor the recovery of patients with LE. The EMG acquisition protocol used in this research was not adequate to monitor effectively the recovery of LE patient. Future research should address the lack of significant difference between the affected and healthy elbows during EMG measurement.

Acknowledgement

The authors thank Dr. Chloé Moussaoui, MD and Dr. Julie-Marthe Grenier, DC for the revision of the manuscript, M. Pierre Black MSc for the technical support and the Foundation de recherche Chiropratique du Québec for their financial support.

References

1 Evans RC. Illustrated Orthopedic Physical Assessment second ed. St. Louis, Missouri, USA: Mosby; 2001.
2 Allander E. Prevalence, incidence, and remission rates of

some common rheumatic diseases or syndromes. Scand J Rheumatol. 1974; 3(3):145–153.
3 Verhaar JA. Tennis elbow. Anatomical, epidemiological and therapeutic aspects. Int Orthop. Oct 1994; 18(5): 263–267.
4 Shiri R, Viikari-Juntura E, Varonen H, Heliovaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. Am J Epidemiol. Dec 1 2006; 164(11):1065–1074.
5 Haahr JP, Andersen JH. Physical and psychosocial risk factors for lateral epicondylitis: a population based case-referent study. Occup Environ Med. May 2003; 60(5): 322–329.
6 Mens JM, Stoeckart R, Snijders CJ, Verhaar JA, Stam HJ. Tennis elbow, natural course and relationship with physical activities: an inquiry among physicians. J Sports Med Phys Fitness. Sep 1999; 39(3):244–248.
7 Boisaubert B, Brousse C, Zaoui A, Montigny JP. [Nonsurgical treatment of tennis elbow]. Ann Readapt Med Phys. Aug 2004; 47(6):346–355.
8 Gruchow HW, Pelletier D. An epidemiologic study of tennis elbow. Incidence, recurrence, and effectiveness of prevention strategies. Am J Sports Med. Jul–Aug 1979; 7(4):234–238.
9 Alfredson H, Ljung BO, Thorsen K, Lorentzon R. In vivo investigation of ECRB tendons with microdialysis technique--no signs of inflammation but high amounts of glutamate in tennis elbow. Acta Orthop Scand. Oct 2000; 71(5):475–479.
10 Kraushaar BS, Nirschl RP. Tendinosis of the elbow (tennis elbow). Clinical features and findings of histological, immunohistochemical, and electron microscopy studies. J Bone Joint Surg Am. Feb 1999; 81(2):259–278.
11 Goguin JP, Rush F. Lateral epicondylitis. What is it really? Current Orthopaedics. 2003; 17(5):386–389.
12 Hong QN, Durand MJ, Loisel P. Treatment of lateral epicondylitis: where is the evidence? Joint Bone Spine. Sep 2004; 71(5):369–373.
13 Newcomer KL, Martinez-Silvestrini JA, Schaefer MP, Gay RE, Arendt KW. Sensitivity of the Patient-rated Forearm Evaluation Questionnaire in lateral epicondylitis. J Hand Ther. Oct-Dec 2005; 18(4):400–406.
14 Overend TJ, Wuori-Fearn JL, Kramer JF, MacDermid JC. Reliability of a patient-rated forearm evaluation questionnaire for patients with lateral epicondylitis. J Hand Ther. Jan-Mar 1999; 12(1):31–37.
15 Macdermid J. Update: The Patient-rated Forearm Evaluation Questionnaire is now the Patient-rated Tennis Elbow Evaluation. J Hand Ther. Oct-Dec 2005; 18(4): 407–410.
16 Rompe JD, Overend TJ, MacDermid JC. Validation of the Patient-rated Tennis Elbow Evaluation Questionnaire. J Hand Ther. Jan-Mar 2007; 20(1):3–10; quiz 11.
17 Mathiowetz V, Rennells C, Donahoe L. Effect of elbow position on grip and key pinch strength. J Hand Surg [Am]. Sep 1985; 10(5):694–697.
18 Dorf ER, Chhabra AB, Golish SR, McGinty JL, Pannunzio ME. Effect of elbow position on grip strength in the evaluation of lateral epicondylitis. J Hand Surg [Am]. Jul–Aug 2007; 32(6):882–886.
19 Smidt N, van der Windt DA, Assendelft WJ, et al. Interobserver reproducibility of the assessment of severity of complaints, grip strength, and pressure pain threshold in patients with lateral epicondylitis. Arch Phys Med Rehabil. Aug 2002; 83(8):1145–1150.
20 Stratford PW, Levy DR. Assessing Valid Change over Time in Patients with Lateral Epicondylitis at the Elbow. [Article]. Clinical Journal of Sport Medicine. April 1994; 4(2):88–91.
21 Rojas M, Mananas MA, Muller B, Chaler J. Activation of forearm muscles for wrist extension in patients affected by lateral epicondylitis. Conf Proc IEEE Eng Med Biol Soc. 2007; 1:4858–4861.
22 Alizadehkhaiyat O, Fisher AC, Kemp GJ, Vishwanathan K, Frostick SP. Upper limb muscle imbalance in tennis elbow: a functional and electromyographic assessment. J Orthop Res. Dec 2007; 25(12):1651–1657.
23 Alizadehkhaiyat O, Fisher AC, Kemp GJ, Vishwanathan K, Frostick SP. Assessment of functional recovery in tennis elbow. J Electromyogr Kinesiol. Mar 13 2008.
24 Lund JP, Donga R, Widmer CG, Stohler CS. The pain-adaptation model: a discussion of the relationship between chronic musculoskeletal pain and motor activity. Can J Physiol Pharmacol. May 1991; 69(5):683–694.
25 Korthals-de Bos IB, Smidt N, van Tulder MW, et al. Cost effectiveness of interventions for lateral epicondylitis: results from a randomised controlled trial in primary care. Pharmacoeconomics. 2004; 22(3):185–195.
26 Martinez-Silvestrini JA, Newcomer KL, Gay RE, Schaefer MP, Kortebein P, Arendt KW. Chronic lateral epicondylitis: comparative effectiveness of a home exercise program including stretching alone versus stretching supplemented with eccentric or concentric strengthening. J Hand Ther. Oct-Dec 2005; 18(4):411–419, quiz 420.
27 Smidt N, van der Windt DA, Assendelft WJ, Deville WL, Korthals-de Bos IB, Bouter LM. Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomised controlled trial. Lancet. Feb 23 2002; 359(9307):657–662.
28 Blanchette MA, Normand MC. Cross-cultural Adaptation of the Patient-rated Tennis Elbow Evaluation to Canadian French. J Hand Ther. Apr 18.
29 Blanchette MA, Normand MC. Augmented soft tissue mobilisation vs natural history in the treatment of lateral epicondylitis: a pilot study. J Manip Physiol Ther. 2011; 34(2):123–130.
30 Stratford PW, Levy DR, Gauldie S, Levy K, Miseferi D. Extensor carpi radialis tendonitis: a validation of

selected outcome measures. Physiother Can. 1987; 39: 250–255.
31 Stratford PW, Levy DR, Gowland C. Evaluative properties of measures used to assess patients with lateral epicondylitis at the elbow. Physiother Can. 1993; 45: 160–164.
32 Hermens HJ, Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol. Oct 2000; 10(5):361–374.
33 Delagi EFP, Aldo. Anatomic guide for the electromyographer : the limbs. second ed. Springfield, Illinois, USA: Charles C. Thomas; 1980.
34 Alizadehkhaiyat O, Fisher AC, Kemp GJ, Frostick SP. Strength and fatigability of selected muscles in upper limb: assessing muscle imbalance relevant to tennis elbow. J Electromyogr Kinesiol. Aug 2007; 17(4):428–436.
35 O'Sullivan LW, Gallwey TJ. Upper-limb surface electromyography at maximum supination and pronation torques: the effect of elbow and forearm angle. J Electromyogr Kinesiol. Aug 2002; 12(4):275–285.

0008-3194/2011/107–119/$2.00/©JCCA 2011

Attitudes of clinicians at the Canadian Memorial Chiropractic College towards the chiropractic management of non-musculoskeletal conditions

Jodi Parkinson, BSc
Jennifer Lau, BSc (Hons)
Sandeep Kalirah, BHSc (Hons)
Brian J. Gleberzon, DC, BA, MHSc*

Objective: *The objective of this study was to determine the attitudes of clinical faculty during the 2009–2010 academic year at the Canadian Memorial Chiropractic College towards the treatment of various non-musculoskeletal disorders.*

Methods: *A confidential survey was distributed to the clinical faculty via email. It consisted of several questions polling the demographic of the respondent such as years in clinical practice, and a list of 29 non-musculoskeletal conditions. Clinicians were asked to indicate their opinions on each condition on rating scale ranging from strongly agree to strongly disagree.*

Results: *Twenty of 22 clinicians responded. The conditions garnering the greatest positive ratings include: asthma, constipation, chronic pelvic pain, dysmenorrhea, infantile colic, and vertigo. The options regarding vertigo and asthma, while demonstrating an overall positive attitude towards the benefits of chiropractic care, were stratified amongst clinicians with varying years in clinical practice.*

Conclusion: *This study suggests clinicians at this college are moderately open towards the chiropractic treatment of some non-musculoskeletal disorders.*
(JCCA 2011; 55(2):107–119)

KEY WORDS: non-musculoskeletal, chiropractic, treatment, CMCC

Objectif : *L'objectif de cette étude était de déterminer les comportements du corps professoral en clinique au cours de l'année scolaire 2009–2010 au Canadian Memorial Chiropractic College (CMCC) envers le traitement de divers troubles non-musculosquelettiques.*

Méthodes : *Un sondage confidentiel a été distribué au corps professoral en clinique par courriel. Il consistait en plusieurs questions interrogeant la population enquêtée comme, par exemple les années dans la pratique clinique, et une liste de 29 conditions non-musculosquelettiques. Les cliniciens étaient invités à donner leur opinion sur chaque condition à partir d'une échelle d'évaluation allant de fortement en accord à fortement en désaccord.*

Résultats : *Vingt des 22 cliniciens ont répondu. Les états pathologiques recueillant le plus grand nombre de cotes positives sont: l'asthme, la constipation, les douleurs pelviennes chroniques, la dysménorrhée, les coliques infantiles et le vertige. Les choix concernant le vertige et l'asthme, tout en démontrant un comportement globalement positif envers les bienfaits des soins chiropratiques, étaient stratifiés chez les cliniciens en fonction du nombre d'années en pratique clinique.*

Conclusion : *Cette étude suggère que les cliniciens de ce collège sont modérément ouverts à l'égard du traitement chiropratique de certains troubles non-musculosquelettiques.*
(JCCA 2011; 55(2):107–119)

MOTS CLÉS : non-musculosquelettique, chiropratique, traitement, CMCC

* Professor and Chair, Department of Applied Chiropractic, Canadian Memorial Chiropractic College, 6100 Leslie St. Toronto, ON M2H 3J1, E-mail: bgleberzon@cmcc.ca

Introduction

> "*I was deaf 17 years ago and expected to remain so, for I had doctored a great deal without any benefit … Last January, Dr. Palmer told me that my deafness came from an injury in my spine. This was new to me; but it is a fact that my back was injured at the time I went deaf. Dr. Palmer treated my spine; in two treatments I could hear quite well. That was eight months ago. My hearing remains good.*"(1p9)

The epochal event in the history of chiropractic occurred on September 18, 1895 when D.D. Palmer adjusted Harvey Lillard's spine with the intent of restoring his lost hearing and, what may be lesser known, is that Palmer's second patient presented with heart problems, a chief complaint that was also addressed using spinal adjusting directed to the patient's mid back.[1–3] Two features of this well-known story are especially relevant. One is that it was Palmer's intent to restore these patients functions via spinal adjusting of vertebrae that were "racked out of place,"[4,5] since it is the intention of the practitioner which is often of paramount importance to many chiropractors[6] and, secondly, the first two chiropractic patients did not present with the types of chief complaints that are typically associated with chiropractic care today. Rather than present with back pain, Palmer's first two patients sought out his help to cure their non-musculoskeletal (non-MSK) conditions. Palmer rationalized this therapeutic intention using the terms "tone" and "dis-ease" respectively, whereby "tone" referred to the intensity of an organ's function as a reflection of the purported vibratory frequency of its associated nerves and "dis-ease" referred to the loss of innate intelligence, meaning the loss of the body's ability to adapt to internal or external stressors.[7] Palmer posited that nerves supplying the organs were adversely affected when the nerves were impinged by subluxated spinal joints,[8] negatively influencing the body's innate recuperative ability to heal.[7] D.D.'s son B.J. Palmer continued with this ideological approach, eventually developing the Meric technique system that linked specific spinal segments (vertemeres) to their corresponding end organs or structures.[9] Eventually the Meric Technique system evolved into the Full Spine Specific Technique, a technique system taught principally at the two Cleveland Colleges of Chiropractic today.[9]

Over the next century, there has been something of a divergence in the profession with, on the one hand, groups of chiropractors advocating the profession exclusively championing a "spinal health care model"[10] to, on the other hand, groups of chiropractors who maintain the profession ought to pay homage to its vitalistic roots and continue with a more holistic, tonal-based worldview.[11–13] And of course there are chiropractors who bridge the gap between these two dichotomous poles, both in terms of practice activities and ideology.

Although the concept of chiropractic treatment for non-MSK conditions is controversial, students at the Canadian Memorial Chiropractic College (CMCC) are exposed to a variety of opinions on the subject. During their fourth and final year of studies students undergo their internship under the direct supervision of a licensed clinician at one of six clinics across the Greater Toronto Area. Clinicians, who are experienced Doctors of Chiropractic, have opinions based upon the accrual of their own education, clinical experience and personal ideology and it is possible they communicate these opinions to their interns during their rotation with them, not unlike how clinicians imprint their own personal preference on elements within the core curriculum taught to students during their undergraduate training.[14] In addition, since interns are providing chiropractic care under the direct supervision of the clinician, and technically are providing services under that clinician's certificate of registration/license, it is the clinician who will be the final arbiter as to whether or not care is provided for this or that diagnosed condition at all.

Bearing all this in mind, the purpose of this study was to determine the attitudes of the supervising clinicians at CMCC towards the chiropractic management of various non-musculoskeletal conditions.

Methods

The study was approved by the Research and Ethics Board at CMCC.

Survey

An online survey using SurveyMonkey™ was conducted on 22 CMCC clinicians, instructing at any one of the six affiliated clinics during the 2009–2010 academic year. Using a 5-point rating scale ("strongly agree," "agree," "neutral," "disagree," and "strongly disagree") clinicians were instructed to indicate their opinion on the efficacy of

chiropractic treatment for specified non-musculoskeletal complaints. Each question required a response before the participant could proceed to the next question. (Appendix A)

SurveyMonkey™ is a web-based software program that enables users to create their own web-based surveys and/or questionnaires. An enhanced paid account was made available through the existing license purchased by CMCC. Clinician emails were obtained through requesting a directory from the human resources department at CMCC. The emails were uploaded into the survey tool (SurveyMonkey™). Emails consisting of a description of the study, as well as informed consent, were sent to the clinicians along with the survey URL. Clinicians were asked to read the description and informed consent form and given an option to proceed with the study, (implying agreement,) or to decline from participation.

Clinicians were not asked to input any personal identifiers on the survey. Survey responses were collected using the "Email Invitation Collector" (EIC) option provided by SurveyMonkey™. EIC allowed the survey tool system to automatically generate unique links tied to a specific email address. Only the recipient knew his/her link. Survey authors and data collectors were not able to see the assigned link inside the collector. As a person responds, only the email was tracked as a status – as having responded/completed the survey. No personal identifiers were linked to any particular survey. Data collection was handled by the authors of the survey who held the license to the "pro" account.

Confidentiality

Clinicians were not required to identify themselves in any way on the survey. Electronic identifiers only included email addresses which were removed from the raw data before analysis by the principal investigators.

Selecting conditions

The outcome measure was the ranking of effectiveness of chiropractic care for the following list of non-MSK conditions: ADHD/learning disabilities, arrhythmias/ECG abnormalities, asthma, autism, bowel/bladder dysfunction, cerebral palsy, chronic obstructive pulmonary disorder, chronic pelvic pain, constipation, Crohn's Disease, depression, dysfunction of nursing, dysmenorrhea/PMS, eczema/psoriasis, hearing loss/tinnitus, hypertension, infantile colic, infertility/amenorrhea, multiple sclerosis, nocturnal enuresis, otitis media, Parkinson's disease, pneumonia, seizures, ulcers, upper respiratory infection, urinary tract infection, vertigo, and visual disturbances.[15] This list was compiled from the 2001 literature review by Cheryl Hawk *et al*,[15] which in turn was based on their analysis of the most prevalent non-MSK complaints seen in chiropractic practice.

Data Analysis

This survey was intended to be a descriptive study based on overall trends, means, and proportions with groups stratified by years in practice. Using Microsoft Excel, responses were sorted by years in practice (<10, 10–20 and >20) and analyzed by the number of positive (strongly agree and agree), neutral and negative (strongly disagree and disagree) responses. By graphically examining the data, any observable trends were noted and that data was then analyzed again, calculating the percentage response of each tier. The percentage response allowed for comparison by proportions.

Results

Response Rate

All 22 clinicians were surveyed and 20 responded, yielding a response rate of 90.9%. All returned surveys were sufficiently completed to be used in the data analysis.

Clinicians were asked to indicate their year of graduation, how many years they have been in practice, as well as to which ideologies they subscribe. Table 1 is a summary of the population demographics. It was observed that all clinicians surveyed had been educated at CMCC either for their doctor of chiropractic degree or for their post-graduate studies. Of the possible 22 respondents, it is observed that there is a disproportionate ratio of men (15) to women (7). Five clinicians had been in practice less than 10 years, nine had been in practice less than 20 years, and six had been in practice more than 30 years (Table 1). With respect to technique systems, most clinicians reported to use Diversified technique.[16]

When asked, the majority of respondents subscribed to more than one ideology (which accounts for this total response rate exceeding 100%), with the majority indicating they were functional based (n = 19), pain based (n = 17) and structural based practitioners (n = 11). Of the

Table 1 *Demographic characteristics of respondent clinicians.*

Characteristic	Number of Respondents (n = 20)
Graduation Year (before 1995)	10
Graduation Year (after 1995)	10
Years in Practice (1–10 years)	5
Years in Practice (11–20 years)	9
Years in Practice (>21)	6
Philosophies subscribed to/practiced	
Subluxation-based	2
Pain-based	17
Functional-based	19
Structural-based	11
Tonal-based	0
Other	
Patient-centered	1
Biomechanical	1
Outcome based	1

20 respondents, two reported they were subluxation based (Table 1).

Table 2 depicts the percentage of CMCC clinicians that strongly agree, agree, are neutral to, disagree, or strongly disagree to chiropractic treatment being beneficial to the conditions listed above. More than 50% of the clinicians agreed or strongly agreed that chiropractic could be effective for the treatment of asthma, chronic pelvic pain, constipation, dysmennorhea, infantile colic and vertigo (Table 2). Similarly, strong negative responses (disagree or strongly disagree) were noted for ADHD/learning disabilities, arrhythmias/ECG abnormalities, autism, Crohn's disease, eczema/psoriasis, infertility/amenorrhea, Parkinson's disease, pneumonia, seizures, upper respiratory infection, urinary tract infection and vision problems (Table 2). It is also observed that no one condition had a neutral response higher than 45% (Table 2).

After analysis of the raw data, Figure 1 represents the conditions listed above that showed high favorable responses toward the benefit of chiropractic treatment. For the sake of simplicity, a positive response was considered whenever the chosen answer was either strongly agree or agree. The number of clinicians that indicated a positive response are depicted, divided into categories by number of years in practice (<10, 10–20 or >20).

Because the population surveyed was limited in size, the results were analyzed by percentage proportions only for the purposes of comparison; high percentages are not an indication of statistically significant responses (Table 3 and Figure 2).

Using the data from Table 3, Figure 2 graphically displays significant differences in opinion between the "years in practice" groups for conditions such as asthma, chronic pelvic pain and vertigo. Positive responses for treatment of asthma totaled 12 out of 15 clinicians who have been in practice longer than ten years, whereas only 2 out of 5 clinicians in the under 10 year bracket gave a positive response. This demonstrates a proportional difference of 40%. In the case of chronic pelvic pain, 4 out of 5 clinicians in the <10 year bracket had a positive response, compared to 5 out of 9 in the 10-20 bracket and 3 out of 6 in the >20 year bracket. Positive responses for vertigo showed the opposite; only 1 out of 5 in the <10 year bracket but 7 out of 9 (10–20) and 5 out of 6 (>20) in the other two brackets; a proportional difference of 58% and 63% respectively (Table 3 and Figure 2).

Similarly, conditions listed from Table 2 with a largely negative response (disagree and strongly disagree) were analyzed; however no clear trends or differences were seen in regards to years in practice.

Discussion

As demonstrated by this study, opinion on chiropractic treatment for certain non-musculoskeletal conditions differs greatly between individual CMCC clinicians with some congruence due to years in practice and condition. A fourth year intern may formulate their own opinion on chiropractic treatment of a non-musculoskeletal condition, or, depending on the clinicians they are assigned to during their clinical rotations, may be influenced by their clinician's opinions and experiences. Some chiropractors, especially more recent graduates, shy away from treating non-musculoskeletal disorders and instead approach patient care from a musculoskeletal perspective only.

Initially the study attempted to correlate clinician ideology with the clinician's attitude toward the appro-

Table 2 *Clinician responses to chiropractic care for non-musculoskeletal conditions.*

Non-musculoskeletal Condition	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
ADHD/Learning Disabilities	5	0	40	25	30
Arrhythmias/ ECG abnormalities	5	0	40	25	30
Asthma	10	60	10	5	15
Autism	5	0	40	25	30
Bowel/Bladder Dysfunction	0	30	35	15	20
Cerebral Palsy	0	30	35	10	25
Chronic Obstructive Pulmonary Disorder	0	25	30	20	25
Chronic Pelvic Pain	20	40	30	0	10
Constipation	5	55	25	5	10
Crohn's Disease	0	10	35	20	35
Depression	15	15	25	15	30
Dysfunction of nursing	0	20	35	15	30
Dysmenorrhea/PMS	20	45	20	0	15
Eczema/Psoriasis	0	15	25	25	35
Hearing Loss/Tinnitus	0	15	45	20	20
Hypertension	0	40	35	10	15
Infantile Colic	10	65	15	0	10
Infertility/Amenorrhea	0	5	35	35	25
Multiple Sclerosis	0	25	40	10	25
Nocturnal enuresis	5	30	20	25	20
Otitis Media	5	25	45	0	25
Parkinson's Disease	5	20	25	25	25
Pneumonia	0	10	20	45	25
Seizures	0	0	35	30	35
Ulcers	5	5	45	20	25
Upper Respiratory Infection	0	10	40	25	25
Urinary Tract Infection	0	10	20	40	30
Vertigo	15	50	20	5	10
Vision Problems	0	5	35	30	30

priateness of treating of non-musculoskeletal conditions. However, as the sample size was very limited, the data collected was not sufficiently robust to draw any conclusions with respect to ideology. Perhaps not surprisingly, conditions that garnered greater than 50% or higher positive response with respect to appropriateness of chiropractic management are the conditions that generally have the most supportive retrievable research available for them. For the conditions where 50% or higher negative responses were ascertained, the opposite is generally

Figure 1 *Selected conditions with majority positive responses.*

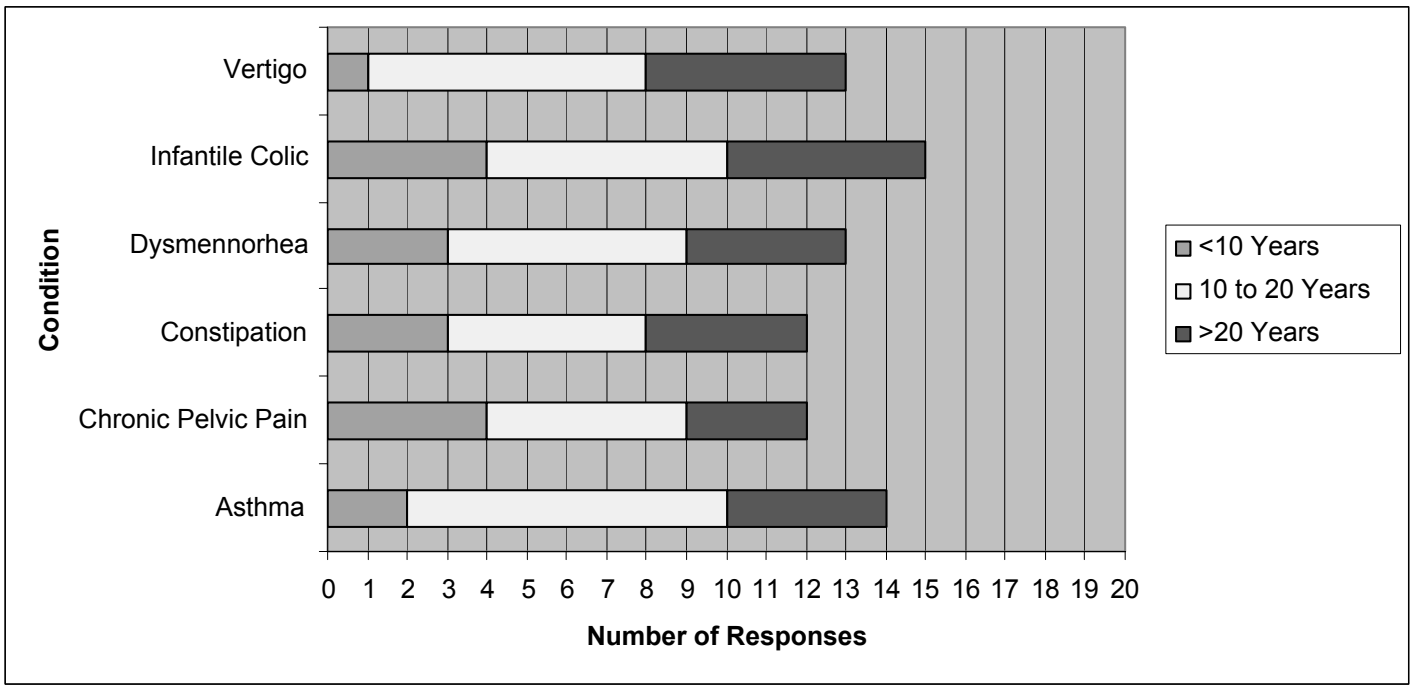


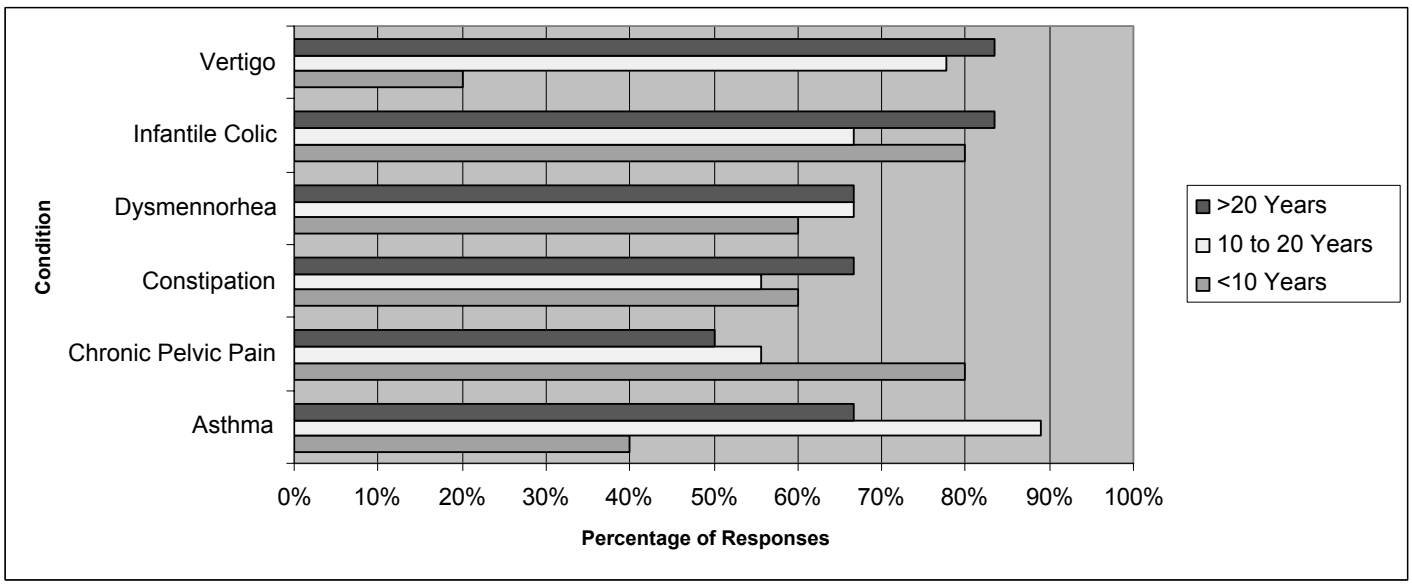
Table 3 *Proportion of clinicians by years in practice reporting positive responses to selected conditions.*

Years in Practice	Response	Asthma	Chronic Pelvic Pain	Constipation	Dysmennorhea	Infantile Colic	Vertigo
<10	Positive	40%	80%	60%	60%	80%	20%
10 to 20	Positive	89%	56%	56%	67%	67%	78%
>20	Positive	67%	50%	67%	67%	83%	83%

demonstrated through a paucity of peer-reviewed evidence in the literature.

Further analysis of five conditions (asthma, chronic pelvic pain, vertigo, infantile colic, constipation) was done to observe any trends with respect to years in practice to see if opinions were related to clinical experience. Three conditions demonstrated clear differences between decades in practice: asthma, chronic pelvic pain, and vertigo. From these results, a percentage proportion was calculated. It was noted that asthma and vertigo showed the most significant difference within the stratification of years in practice. Specifically, a high proportion of CMCC clinicians with greater than 10 years experience indicated a favorable response toward the chiropractic treatment of both asthma and vertigo. Conversely, very few clinicians with less than 10 years experience concurred with their more experienced colleagues. Considering that the literature regarding the efficacy of chiropractic treatment for asthma is equivocal, it is possible that clinicians with less clinical experience rely more heavily on evidence-based literature thus accounting for their low favorable response rate. That said, since the research on vertigo is generally more favorable towards the effectiveness of manual therapies (see further discussion below), it was expected there would be a higher congruence amongst all three tiers of experience. Although more experienced clinicians (>20

Figure 2 *Positive responses grouped by years in practice.*



years) did report their belief that chiropractic care was effect for vertigo (83% in favor), it is noteworthy that relatively few chiropractors with less than 10 years experience mirrored this sentiment (20%). Overall, asthma, chronic pelvic pain, constipation, dysmennorhea, infantile colic and vertigo showed the strongest positive clinician response for chiropractic treatment. Though research exists for each one of these conditions, the quality of the literature is varied and the strength is debatable.

Brontfort *et al* have recently published a systematic review of the literature on the effectiveness of manual therapies for a variety of musculoskeletal and non-musculoskeletal conditions.[17] In it, the authors stated that, overall, there is moderate quality evidence that spinal manipulation is effective for cervicogenic dizziness (short term), is not effective (similar to sham manipulation) for the treatment of asthma, infantile colic and primary dysmenorrhea, and inconclusive evidence exists regarding the effectiveness of manipulation for otitis media, hypertension, premenstrual syndrome.[17]

Asthma is one of the most common chronic diseases amongst children causing increased mucous production and airway hypersensitivity resulting in decreased airflow.[18,19] Chiropractic treatment has been thought to be beneficial in the treatment of this condition as it posited that it may modify the autonomic system and elicit viscerosomatic reactions to it.[18–20] Additionally, it has been hypothesized that misalignments at the levels of the upper C-spine create spinal reflexes that can induce asthma and correcting the misalignments could potentially alleviate the symptoms.[19,21,22] In addition, a more recent review by Kaminskyj *et al*[23] reported in their systematic review of the literature that chiropractic care should be used as an adjunct, not a replacement to traditional medical therapy. It is interesting to note that there exists a large positive response (70%) amongst CMCC clinicians with respect to this condition, even though the literature is extremely polar and generally equivocal (Table 2). This incongruence may suggest that clinicians consider their treatment to be beneficial for the musculoskeletal symptoms associated with asthma rather than the condition itself.

Chronic pelvic pain is described as non-cyclic pelvic pain persisting longer than three months and distinct from dysmenorrhea (a fairly common syndrome causing pain and disability in women).[24] The etiology is considered to be multi-factorial, attributed to anatomical, neurological, hormonal, musculoskeletal and psychosocial factors.[24] There has been very little research conducted on the effect of chiropractic care on chronic pelvic pain. One study by Hawk *et al* concluded that chronic pelvic pain

is best treated using a multi-disciplinary approach including spinal manipulative therapy which showed positive short-term effects compared with sham adjustments.[24] This conclusion is supported by the data from this study as 60% of CMCC clinicians responded positively toward the benefit of chiropractic treatment for chronic pelvic pain (Table 2).

Constipation is a common condition amongst the young and the elderly. Difficulty and infrequency in the elimination of feces is often accompanied with pain, fear, and discomfort.[25] In a study conducted by Alcantara and Mayer on three pediatric patients, they found successful resolution of the condition after a regiment of spinal manipulative therapy by observing an increased frequency in bowel movements, with less straining and pain.[25] Similarly, a case study done on a 64 year old Caucasian female demonstrated a positive resolution to chronic constipation after ten treatments of spinal manipulative therapy.[26] While there is no extensive, high quality research on this issue, CMCC clinicians responded favorably (60%) toward the use of chiropractic treatment for constipation. This may be explained by personal experience as referenced by the above case studies.

Dysmenorrhea, painful menstrual cramps of uterine origin, is differentiated from chronic pelvic pain by its cyclic nature and is grouped into two categories, primary and secondary.[17] Primary dysmenorrhea is not associated with pelvic disease while secondary dysmenorrhea is associated with underlying pelvic pathology such as endometriosis.[17,24] Hondras *et al* conducted a randomized, blinded clinical trial concluding that there was no significant difference between spinal manipulative therapy and sham treatment on the symptoms of primary dysmenorrheal.[27,28] In a narrative review conducted by Spears, the author concluded that dysmenorrhea is best treated by a multi-modal approach including nutrition, chiropractic, medication and other alternative healthcare practices.[29] Sixty-five percent of the respondents in this study indicated a positive opinion; while this may not be reflected in research studies, clinicians may have approached this question with a multi-modal treatment plan in mind.

Infantile colic is an easily identified condition in infancy; however its etiology is relatively unknown.[30] Originally defined by Wessel *et al* infantile colic must meet three criteria: crying for three hours a day, for at least three days a week, for at least three weeks.[31] Many infants suffering from colic were observed to have cranial and spinal dysfunction as a result from a traumatic birth process and it has also been theorized that colic may be associated with gastrointestinal dysfunction.[32,33] Some chiropractors opine that manipulative therapy could effectively treat infantile colic because misalignments in the spine may be inhibiting sympathetic output. Since an "adjustment" theoretically causes sympathetic stimulation which, based on physiology, in turn relaxes the smooth muscle of the gastrointestinal tract, reduces peristalsis, and inhibits bowel function, infantile colic could be effectively treated through manual therapy[32] A random controlled study conducted in Denmark showed a 67% reduction in daily crying with spinal manipulation, another study conducted in South Africa showed complete resolution of symptoms in 93% of infants in the manipulation group.[33] On the other hand, Olafsdottir *et al* conducted a blinded, randomized, and placebo controlled clinical trial on the effectiveness of chiropractic treatment on infantile colic and found it was no more effective than placebo.[34] Despite the extremes of opinion demonstrated by the research, 75% of CMCC clinicians responded favorably toward the chiropractic treatment of infantile colic. This may attributed to personal clinical experience and/or their choice of what research they have read.

Vertigo is a fairly common condition described as a false sensation of movement of self or the environment.[17] Underlying pathologies vary from trauma to infection in the inner ear, or pathological disorders such as vertebrobasilar insufficiency or central nervous system lesions.[17,27] In some patients, the cause of the dizziness may not fall in the above categories, and it is suspected that the cause may originate from the cervical spine, termed cervicogenic dizziness.[35] Cervicogenic dizziness is defined as vertigo induced by changes in position of the neck or originating from the cervical region.[36]

A retrospective study conducted by Elster showed 100% positive response with either symptoms having improved or completely reversed within one to six months of care using a treatment plan of upper cervical adjustments.[37] In contrast, a review study conducted by Reid and Rivett cited a lack of randomized clinical trials and insufficient clinical research fails to prove the efficacy of manual therapy in treating vertigo.[36] Similarly, Bracher et al observed that a conservative treatment protocol in-

cluding spinal manipulative therapy, soft tissue therapy, analgesic electrotherapy and exercise demonstrated a consistent improvement for patients experiencing cervicogenic vertigo.[37] However, they also concluded that further studies are needed to assess the treatment validity.[37] Considering that most of the research regarding this condition is positive for chiropractic treatment the results from this study (65%) concur with the literature (Table 2).

Limitations

This study had several limitations. The clinicians could have misinterpreted the questions regarding each condition to mean whether or not chiropractic care was effective in treating the condition itself or the musculoskeletal symptoms associated with them. For example, conditions such as asthma and chronic pelvic pain have been associated with higher incidences of thoracic and lower back pain respectively.[19,24] Moreover, several clinicians did suggest that those individuals exhibiting any of the above listed conditions may have co-morbidities or dysfunction in their musculoskeletal systems, making chiropractic treatment both practical and beneficial. Although clarifications were made about the question to those who asked, it cannot be assumed that all respondents were accurate in their interpretation of each question in the survey. Future studies ought to take greater care in differentiating whether a respondent believes that chiropractic care can effectively manage a condition listed, the musculoskeletal effects associated with it or a combination of the two.

Including the option of "neutral" as a possible response was also open to respondent interpretation. Since the survey required an answer for each question, respondents may have chosen the answer "neutral" not because they genuinely had no positive or negative position on the matter, but rather because they were required to select an answer in order to continue with the survey. Furthermore, a neutral response could be translated as a mixed opinion; in that personal clinical experience has shown some positive and some negative responses in treating the above listed conditions, again not a "true" neutral response. It can also be argued that, by responding "agree," "neutral" or "disagree," a respondent does not have a strong opinion at all. That said, surveys such as the one used in this study conventionally collapse "strongly agree" and "agree together and "strongly disagree" and "disagree" together. In the future, this study may be replicated with the inclusion of an interview component that would clarify reasons for a neutral, "agree" or "disagree" response.

Finally, as this survey study was restricted to the 22 CMCC clinicians of the 2009–2010 academic school year, the sample size was very small, and not all clinicians participated. Had all clinicians responded, the response frequencies would have been different. Bearing in mind the above limitations of the study, the small sample size may have created a skew in the distribution of the results and the attitudes of CMCC clinicians towards the management of non-MSK conditions may not be representative of the attitudes of field practitioners in general.

Lastly, it might be interesting to conduct similar surveys of clinicians at other accredited chiropractic college and compare their attitudes towards the effectiveness of chiropractic care of non-MSK from those institutions to the ones discussed here.

Conclusion

Overall, there appears to be a positive response toward the chiropractic treatment of non-MSK conditions such as asthma, constipation, chronic pelvic pain, dysmenorrhea, infantile colic, and vertigo amongst CMCC clinicians. It was noted that, regardless of number of years in clinical practice, most opinions amongst CMCC clinicians were congruent with the exception of asthma and vertigo. However, a majority of the more experienced clinicians posited that chiropractic care would be of benefit to patients affected by these two conditions. Both conditions are fairly prevalent in the population and many patients with these conditions seek chiropractic care, not necessarily for the condition itself, but for related/associated MSK symptoms.

The unexpected result regarding vertigo indicates that research may not play as significant a role as predicted since clinicians with less than 10 years of clinical experience had a low positive response result compared to their more experienced colleagues despite the availability of literature indicating there is evidence of moderate strength supporting the use of chiropractic in treating this condition.

Future studies should be conducted to reveal any influences clinicians may have on their interns. Similarly, CMCC students in years one through three receive a var-

iety of theoretical knowledge and opinions pertaining to the non-musculoskeletal conditions discussed. A study should be conducted to gather similar data to determine if there is any vertical integration/continuity between the theory taught in class in the undergraduate program, and the opinions formed by fourth year interns.

Appendix A

Attitudes towards Non-Musculoskeletal Survey

This study is designed to determine the attitudes of the clinicians, specifically towards the chiropractic management of a set of non-musculoskeletal conditions. From the results of this study, we will discuss the influence of the clinicians on year 4 chiropractic students and how well that integrates with the first three years of study at the Canadian Memorial Chiropractic College.

1. Please indicate your year of graduation from an accredited chiropractic college

2. Please indicate the number of years in practice

- ❑ 0–5
- ❑ 6–10
- ❑ 11–15
- ❑ 16–20
- ❑ 21–25
- ❑ 26–30
- ❑ >30

4. Please indicate which philosophies you subscribe to and/or practice. Please check all that apply.

- ❑ Subluxation-based
- ❑ Pain-based
- ❑ Functional-based
- ❑ Structural-based
- ❑ Tonal-based
- ❑ Other (please specify) _____

5. Please indicate whether you think chiropractic is beneficial in treating the following conditions:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
ADHD/Learning Disabilities					
Arrhythmias/ ECG abnormalities					
Asthma					
Autism					
Bowel/Bladder Dysfunction					
Cerebral Palsy					
Chronic Obstructive Pulmonary Disorder					
Chronic Pelvic Pain					
Constipation					
Crohn's Disease					
Depression					
Dysfunction of nursing					
Dysmenorrhoea/PMS					
Eczema/Psoriasis					
Hearing Loss/Tinnitus					
Hypertension					
Infantile Colic					
Infertility/Amenorrhea					
Multiple Sclerosis					
Nocturnal enuresis					
Otitis Media					
Parkinson's Disease					
Pneumonia					
Seizures					
Ulcers					
Upper Respiratory Infection					
Urinary Tract Infection					
Vertigo					
Vision					

Thank you for your participation in our survey.

References

1 Keating JC Jr, Cleveland CS, Menke M. Chiropractic History: A Primer. Association for the History of Chiropractic, Davenport, Io. 2004.
2 Montgomery PD, Nelson MJ. Evolution of chiropractic theories of practice and spinal adjustment, 1900–1950. Chiro Hist. 1985; 5:71–77.
3 Kaptchuk TJ, Eisenberg DM. Chiropractic. origins, controversies and contributions. Arch Intern Med. 1998; 158:2215–2224.
4 Keating JC Jr. Several pathways in the evolution of chiropractic manipulation. J Manipulative Physio Ther. 2003; 26(5):300–321.
5 Paget J. Cases that bonesetters cure. BMJ. 1867; 1:1–4.
6 Meeker WC, Haldeman S. Chiropractic: A profession at the crossroads of mainstream and alternative medicine. Ann Intern Med. 2002; 136:216–227.
7 Masarsky CS, Todres-Masarsky M. Somatovisceral Aspects of Chiropractic: An Evidence-Based Approach, 2001. Churchhill Livingstone USA.
8 Owens E. Theoretical constructs of vertebral subluxation as applied to chiropractic practitioners and researchers. T Clin Chiropr. 2000; 7(1):74–79.
9 Cooperstein R, Gleberzon BJ. Full-Spine Specific (FSS) Technique (Meric Technique, Meric Recoil Technique). In: Technique Systems in Chiropractic. Churchill-Livingstone, 2004:155–159
10 Nelson C, Lawrence D, Triano J et al. Chiropractic as spine care: A model for the profession. Chiropractic & Osteopathy. 2005;13(9). www.chiroandosteo.com/content/13/1/9
11 Hawk C. Should chiropractic be a wellness profession? Top Clin Chiropr. 2000; 7:23–26.
12 Hawk C. When worldviews collide: maintaining a vitalistic perspective in chiropractic in the postmodern era. J Chiropr Humanit. 2005; 12:2–7.
13 Coopestein R, Gleberzon BJ. Towards a taxonomy of subluxation-equivalents. Top Clin Chiropr. 2000; 8(1):49–60.
14 Vermet S, McGinnis K, Boodham M, Gleberzon BJ. Degree of vertical integration between the undergraduate program and clinical internship with respect to lumbopelvic diagnostic and therapeutic procedures at a chiropractic college. J Chiro Ed 2010; 24(1):46–56.
15 Hawk C, Long CR, and Boulanger KT. Prevalence of nonmusculoskeletal complaints in chiropractic practice: Report from a practice-based research program. J Manipulative Physiol Ther. 2001*;* 24(3):157–169.
16 Cooperstein R, Gleberzon BJ. Diversified Technique. In: Technique Systems in Chiropractic. Churchill-Livingstone, 2004:
17 Bronfort G, Haas M, Evans R, Leininger B, Triano J. Effectiveness of manual therapies: The UK evidence report. Chiropractic & Osteopathy. 2010; 18:3.
18 Balon JW, Mior SA. Chiropractic care in asthma and allergy. Ann Allergy Asthma Immunol. 2004; 93(Suppl 1):S55–60.
19 Bronfort G. Childhood and adolescent asthma: the scientific basis for chiropractic management. European J Chiropr. 2002; 49: 8–12.
20 Balon J et al. A comparison of active and simulated chiropractic manipulation as adjustive treatment for childhood asthma. N Engl J Med. 1999; 339:1013–1020.
21 Bronfort G et al. Chronic pediatric asthma and chiropractic spinal manipulation: a prospective clinical series and randomized clinical pilot study. J Manipulative Physiol Ther. 2001; 24:3639–3677.
22 Gibbs A. Chiropractic co-management of medically treated asthma. Clinical Chiropractic. 2005; 8:140–144.
23 Kaminskyj A, Frazier M, Johnstone K, Gleberzon B. Chiropractic care for patients with asthma: A systematic review of the literature. J Can Chiropr Assoc. 2010; 54(1):24–32.
24 Hawk C, Long C, Azad A. Chiropractic care for women with chronic pelvic pain: a prospective single-group intervention study. J Manipulative Physiol Ther. 1997; 20(2):73–79.
25 Alcantara J, Mayer D. The successful resolution of chronic constipation in three pediatric patients following chiropractic spinal manipulative therapy. European J Integrative Med. 2008; 1: 25–26.
26 Redly M. The effects of chiropractic care on a patient with chronic constipation. JCCA. 2001; 45(3):185–191.
27 Ernst E. Chiropractic manipulation for non-spinal pain – a systematic review. NZMJ. 2003; 116:1179.
28 Hondras MA, Long CR, Brennan PC. Spinal manipulative therapy versus a low force mimic maneuver for women with primary dysmenorrheal: a randomized, observer-blinded, clinical trial. Pain. 1999; 81:105–114.
29 Spears LG. A narrative review of medical, chiropractic, and alternative health practices in the treatment of primary dysmenorrhea. J Chiropr Med. 2005; 4(2):76–88.
30 Cohen-Silver J, Ratnapalan S. Management of infantile colic: a review. Clinical Pediatrics. 2009; 48(1):14–17.
31 Wessel MA, Cobb JC, Jackson EB, Harris GS, Detwiler AC. Paroxysmal fussing infancy, sometimes called 'colic'. Pediatrics. 1954; 14:421–434.
32 Hipperson AJ. Chiropractic management of infantile colic. Clinical Chiropractic. 2004; 7:180–186.
33 Wiberg JMM. Infantile colic: the scientific evidence for chiropractic management. European J Chiropr. 2002; 48:3–7.
34 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.
35 Elster E. Sixty patients with chronic vertigo undergoing upper cervical chiropractic care to correct vertebral

subluxation: A retrospective analysis. J Vertebral Subluxation Res. 2006; (Nov 8); 1–9.
36 Reid SA, Rivett DA. Manual therapy treatment of cervicogenic dizziness: a systematic review. Manual Therapy. 2005; 10:4–13.
37 Bracher ES, Almeida C, Almeida R, Duprat A, Bracher C. A combined approach for the treatment of cervical vertigo. J Manip Physiol Thera. 2000; 23(2):96–100.

0008-3194/2011/120–127/$2.00/©JCCA 2011

Two cases of medial knee pain involving the medial coronary ligament in adolescents treated with conservative rehabilitation therapy

Karen Hudes, BSc, BS, DC*

Objective: *This case study chronicled the assessment, treatment and management of two adolescent patients presenting with acute knee pain, diagnosed as medial meniscus tear, with or without a medial collateral ligament sprain, with coronary ligament involvement.*
Cases: *Patient 1: A 16 year old male football player presented with right medial knee pain of 2 days duration after having been tackled during practice from the left side. Patient 2: A 16 year old female presented with right medial knee pain that began 1 week prior to presentation after a fall down the stairs.*

Treatment: *Treatment was initiated in both cases using inflammatory control techniques of icing and fascial stripping and progressed to rehabilitative exercises including VMO (vastus medialis oblique) exercises and squatting exercises to strengthen the quadriceps femoris musculature and proprioceptive exercise. Rehabilitation occurred over a four week duration in both cases with progression of exercises on an individual basis. Both cases resolved within four weeks and return to normal activities resumed at the three week mark including a return to play in patient 1. Both patients reported complete resolution of symptoms at the four week mark with no recurrence on follow up a number of months later.*

Summary: *Conservative management, including icing, fascial stripping, and rehabilitative exercises may be*

Objectif : *Cette étude de cas décrivait l'évaluation, le traitement et la prise en charge de deux patients adolescents présentant une douleur aiguë au genou, diagnostiquée comme étant une déchirure du ménisque interne, avec ou sans entorse du ligament latéral interne, et impliquant le ligament coronaire.*

Les cas : *Patient 1 : Un joueur de football de 16 ans s'est présenté avec des douleurs au genou droit interne 2 jours après avoir plaqué du côté gauche durant une pratique. Patient 2 : Une jeune femme de 16 ans s'est présentée avec une douleur au genou droit interne qui a commencé une semaine après une chute dans les escaliers.*

Traitement : *Le traitement a été entrepris dans les deux cas en utilisant des techniques de contrôle inflammatoire d'application de glace et d'éveinage des fascias, et cheminait graduellement vers des exercices de réadaptation, notamment des exercices du muscle vaste interne du membre inférieur oblique et des exercices d'accroupissement pour renforcer les quadriceps et l'exercice proprioceptive. La réadaptation s'est étalée sur une période de quatre semaines dans les deux cas avec l'ajout graduel des exercices sur une base individuelle. Les deux cas ont été résolus dans un délai de quatre semaines, et le retour aux activités a eu lieu au bout de trois semaines, y compris un retour au jeu pour le patient 1. Les deux patients ont signalé une guérison complète des symptômes au bout de quatre semaines sans rechute lors du suivi quelques mois plus tard.*

Sommaire : *Un traitement prudent, incluant l'application de glace, l'éveinage des fascias et des*

* Private practice, 168 Sheppard Avenue West, Toronto, Ontario M2N 1M8; E-mail: karenchiro@hotmail.com

beneficial in the treatment of medial meniscus tears with coronary ligament involvement in adolescents.
(JCCA 2011; 55(2):120–127)

KEY WORDS: pain, adolescent, chiropractic, rehabilitation

exercices de réadaptation, peut être bénéfique pour les déchirures du ménisque interne impliquant le ligament coronaire chez les adolescents.
(JCCA 2011; 55(2):120–127)

MOTS CLÉS : genou, douleur, adolescent, chiropratique, réadaptation

Introduction

According to the National Board of Chiropractic Examiners 2005 Job Analysis of Chiropractic, the chief presenting complaint on an initial visit of 8.9% of chiropractic patients in 2003 was a lower extremity complaint. It was reported on a scale of 0 to 4, where 0 meant the practitioners never treated the condition and 4 meant that the practitioners routinely treated the condition, that extremity joint dysfunction earned a rating of 3.2. Additionally the respondents indicated that 89.3 % of the respondents were the sole managers of the condition and 9.4% of the respondents co-managed the condition.[1] There was no specific data listed for knee disorders in the NBCE 2005 job analysis. Although the specific incidence and prevalence of knee injuries in adolescents that is not sport specific was not specifically reported in the research, it was reported that overall 5% of meniscal injuries involve patients under the age of 15.[2] Currently, there are few published case reports regarding knee injuries in adolescents as well as little information regarding the involvement of the coronary ligaments in knee injuries. The purpose of this article is to report two cases of knee injuries in adolescents and their management using conservative treatment and rehabilitation methods.

Case Reports

Case 1

A 16 year old male football player presented with right medial knee pain of two days duration after having been tackled during practice from the left side at the level of his lower thighs and knees. He reported that the force of the tackle was directed at his lower legs and that his feet were planted on the ground at the time of the tackle. He reported that following the tackle he was unable to get off the field due to knee pain. He attended his medical doctor the day after the injury and was told he had a medial collateral ligament sprain and was advised to seek physiotherapy, ice, and elevate the leg.

He presented to the chiropractic clinic the following day favouring his right leg due to pain and unable to bend or straighten his right knee fully. He reported that his mother gave him oral arnica on the evening prior to the assessment and that he iced several times over the course of the evening, both of which he felt helped his pain and inflammation. The specific dosage of arnica was not known. He reported that putting pressure over the outside of his knee and walking tended to increase the pain. He described the pain as being dull with occasional sharpness associated with certain movements such as walking or pivoting, ascending and descending stairs, as well as quick movements. He denied referred pain or any parathesias and rated the pain as 3/10 in the office and 7/10 at its worst on a Verbal Rating Scale where 0 is no pain and 10 is the worst pain he had ever experienced. Past medical history was unremarkable.

The examination revealed limitations in right knee flexion which was absent for the last ten degrees of flexion and found to be full in extension with pain reported at the end range of both motions. The neurological screening of the upper and lower extremities was found to be unremarkable bilaterally. A focused examination of the right knee revealed no edema or bruising when compared to the left knee. Varus stress testing at zero and thirty degrees of flexion was negative bilaterally. Valgus stress testing of the right knee at zero and thirty degrees was reportedly painful and revealed a slight laxity when compared to the left knee which was considered a weak positive test for a medial collateral ligament injury. Anterior and posterior drawer testing was found to be negative bilaterally. Apley's compression and distraction test of the right knee produced pain in both compression and distraction (compression portion of test: with the patient prone with knee flexed to 90 degrees clinician grasps calcaneus

and applies a downward force while rotating the tibia internally and externally to test for meniscal tear; distraction portion: with the patient prone with knee flexed to 90 degrees, clinician stabilizes upper leg above knee and distracts the lower leg grasping the ankle and rotates the tibia internally and externally to assess collateral ligaments and for meniscal tears).[3] McMurray's test (with the patient supine, the clinician places one hand at knee joint line and other hand grasping distal tibia. With the knee maximally flexed to begin, extend knee with external rotation of the tibia; pain or snapping indicates a possible medial meniscus tear)[3] was positive when performed on the right knee. Palpation of the medial coronary ligament of the right knee elicited pain. Based on the orthopaedic testing and history, the patient was diagnosed with a right knee medial collateral ligament sprain, likely a grade 1, and possible medial meniscus tear with medial coronary ligament involvement.

A course of therapy consisting of two visits per week for four weeks was initiated and consisted of Transcutaneous Electrical Nerve Stimulation (TENS) and laser therapy to the right medial knee to control inflammation with instructions to ice four times per day for ten minutes. An in clinic and home rehabilitation exercise program was also initiated. The rehabilitation exercises consisted of VMO exercises to strengthen the quadriceps femoris muscle, wobble board exercises including double and single leg balancing and double leg squats, squats, squats with adduction using a ball for resistance, resisted side stepping and the subsequent progression of these exercises. For the VMO exercises the patient was instructed to sit with his knee bent and approximately 4 inches from the floor and then to slowly straighten his lower leg without moving the thigh (Figure A i and ii). He was instructed to do ten to fifteen repetitions three times per day. During the first week, the rehabilitation focused on VMO exercises, wobble board exercises and simple squat exercises with the other exercises and progressions being added in the second week of treatment. VMO exercises were given with the intention of ensuring the maintenance of strength of the quadriceps muscle rather than specifically treating the injured tissue. After two weeks of therapy, the patient reported that he no longer had any pain unless he was running at full speed doing sprints in practice. By the middle of the third week of care, he no longer had any pain during practice and was cleared to return to play by the team doctor. He was at this time provided instruction for advanced wobble board training (one legged squats) at home. He was discharged after the fourth week of care and reported no return of pain and no difficulty playing football. On a three month and 4 month follow up of the patient, he did not report any return of pain or disability in his right knee.

Figure A i *VMO style exercise start position.*

Figure A ii *VMO style finish position.*

Case 2

A 16 year old female presented with right medial knee pain that began 1 week prior to presentation after a fall down the stairs. The patient reported that she "missed a stair" approximately 1 month prior and fell down the

stairs which at the time caused a small amount of pain in the right knee, but reports that she ignored this pain assuming that it would disappear in time. She reported that approximately two weeks prior to her visit to the chiropractic office, she once again "missed a stair" and fell but did not have any increased pain immediately. She was unable to report specifically how she landed on her knee. She reported that the pain began in her right knee one week prior to her visit and could not identify a specific cause for the pain other than the two prior falls. She reported that she had attended the emergency room a few days prior and that x-rays were taken of her right knee and found to be unremarkable. She reported that she was referred to an orthopaedic surgeon but that the appointment was not for two weeks. She reported that she then went to see a naturopath one day prior who prescribed topical arnica to control the inflammation and performed acupuncture therapy which the patient reported did not change the pain. She reported that nothing seemed to ease the pain and that walking aggravated the pain to such a degree that she missed a few days of school. She rated the pain as a 10/10 on the Verbal Rating Scale where 0 is no pain and 10 is the worst pain she has ever experienced and reported that the pain was very sharp in nature. Her past medical history was unremarkable.

She presented for the examination being carried in to the clinic by her boyfriend and when asked to weight-bear during the examination, required support on both her right and left side. Inspection of the right knee did not reveal any edema or bruising. Range of motion of the right knee was found to be full in extension and limited to 90 degrees of flexion with pain reported at the end range of both motions. There was pain reported on light palpation of the medial joint line of the knee and the medial coronary ligament of the right knee. Neurological testing of the upper and lower extremities was found to be unremarkable bilaterally. The following orthopaedic tests were found to be positive for the right knee: Apley's compression/distraction, and McMurray's test. The anterior and posterior drawer test, as well as valgus and varus stress testing at zero and thirty degrees were found to be negative. The patient was diagnosed with a right knee medial meniscus tear with medial coronary ligament involvement and started on a one month course of therapy consisting of edema control methods, rehabilitation in clinic twice per week as well as a home exercise program.

During the first visit, the patient was treated with instrument assisted fascial stripping using Gua Sha tools over the right medial knee and coronary ligament as well as laser therapy. She was instructed with VMO exercises as described above. After the pain and edema control methods were completed on the first visit, the patient was able to get off of the table on her own and ambulate unassisted, though with a slight limp favouring her right knee. She was given instructions to ice four times per day for 10 minutes each as well as do 10–15 repetitions of the VMO exercises three times daily to ensure the maintenance of quadriceps strength. During the first week of care she was also given simple squatting exercises as well as wobble board exercises to perform in the clinic as well as at home. After the first week of care, she presented to the clinic reporting that her pain levels had dropped to 0/10 and reported that she continued her exercises daily. She was given further advanced squatting exercises including squats with adduction and one legged squats during her second week of care. At the end of two weeks of her four week rehabilitation program, the patient and her mother elected to drop out of care, despite the advice of the doctor to the contrary, as she reported that her pain had not returned. On a three month and 6 month follow up with the patient's mother it was reported that the patient's pain had not returned.

Discussion

Knee problems and injuries are extremely common in sports and falls. Other disease processes regarding the knee joint such as osteoarthritis are also very common but usually not seen in the adolescent population.[4] One article reported that 30 million children in the US participate in sports and that the incidence of overuse and acute injuries of children has been increasing as the number of children participating in sports grows.[5] The ankle and knee joints were reported to be the most commonly injured joints of the body, with non-traumatic knee pain being one of the most common complaints of the young athlete.[5]

Meniscal injury rates have been reported to be 60 per 100,000 with the medial meniscus being injured more frequently than the lateral meniscus.[6] In fact, one study reported the annual incidence of medial meniscal injuries specifically as 60 to 70 per 100,000 people and the male to female ratio is reported to be 2.5–4:1.[6] Another study reported that "medial meniscus disorders made up 37% of overall cartilage lesions found after analyzing 25,124

knee arthroscopies."[6] The menisci are firmly attached to the tibial plateau by the strong meniscotibial or coronary ligaments.[7] Hammer reports that typically these ligaments are anatomically separate structures although they are seen to blend with the joint capsule, and medial collateral ligament.[7] It is likely that since the coronary ligaments are so closely married to both the collateral ligaments and the menisci, they suffer sprain injuries when damage to either structure occurs.[7] When treating medial knee injuries it should be recalled that the deep fibers of the medial collateral ligament attach to the medial meniscus which is why these two structures are often injured in conjunction.[8] In contrast, the lateral collateral ligament does not attach to the lateral meniscus.[8] It is suggested that a conservative approach for meniscal injuries be attempted prior to surgical intervention.[9] The natural history of a meniscal injury is dependant on the type and location of the tear.[10] It was reported by one source that vertical tears in the menisci that are located in the well vascularized periphery should not be surgically repaired as they have good healing potential if left alone.[10]

Knee pain of acute and chronic nature is very commonly seen in a chiropractic practice. Diagnosis of knee injuries can be challenging as the knee articulation is complex and contains several structures vulnerable to injury due to the nature of the joint as well as the fact that the large muscles surrounding the knee, specifically the quadriceps, are capable of splinting the knee and thus masking symptoms in some cases.[11] Ligamentous knee anatomy is illustrated in Figure B and C (reprinted with permission).[12] It should be remembered that as there are physical and physiological differences between adults and children, these factors may predispose the younger population to injury, or alter the types of injuries seen in the two populations following similar mechanisms of injury.[5,13] Patellofemoral pain syndrome, anterior cruciate ligament tear, collateral ligament tear, meniscus tear, iliotibial band syndrome, Osgood-Schlatter's disease, meniscotibial sprain, bursitis and muscle strains are all common problems that may affect the adolescent knee.[5,7,14,15,16] In addition, care should be taken to rule out more distant sources of knee pain including referred pain from other origins such as would be seen in a slipped capital femoral epiphysis and/or other structures including trigger points or nerve root compression.[5,14]

Acute medial meniscus injuries often present with a patient history of a twisting injury about the loaded knee joint while the knee was in flexion.[5,14] This may be combined with a trauma directed across the knee.[1] Symptoms may include joint line pain, swelling, antalgic gait, locking or a feeling of instability, buckling or "giving way" and a feeling of being unable to fully extend the knee.[13,16] The swelling or effusion noted is generally of delayed onset and may not be visible until one to three days post injury.[16] In contrast an anterior cruciate ligament injury generally has immediate swelling as it is vascularized to a much greater degree than the menisci.[13,16] It is interesting to note that the menisci of children under the age of 10 years are resistant to tears as the meniscus is composed of dense collagen bundles arranged in an interlacing pattern

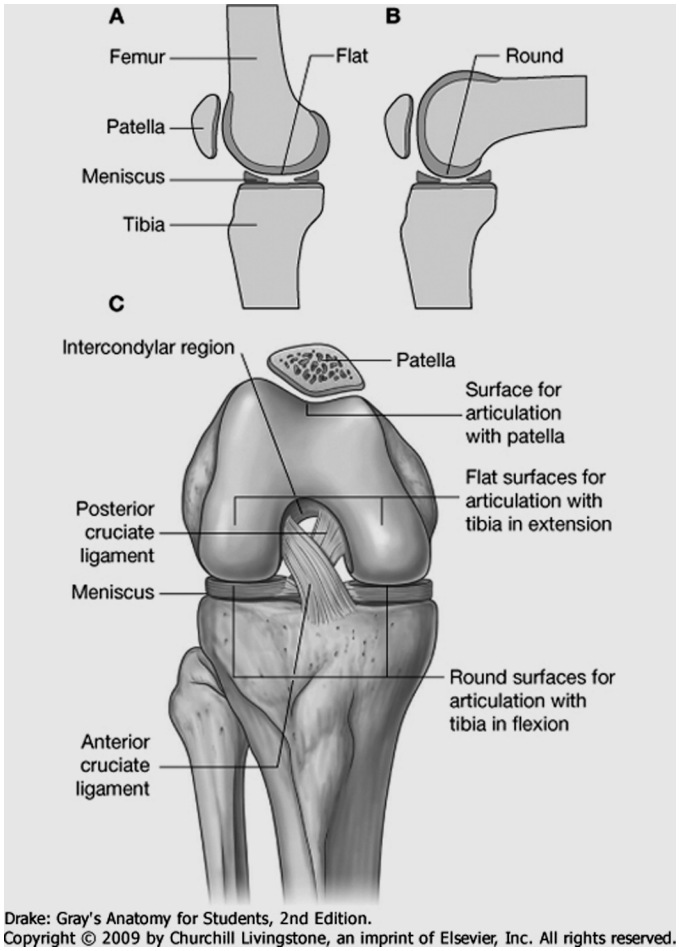


Figure B *Articular surfaces of the knee joint. A. Extended. B. Flexed. C. Anterior view (flexed)*

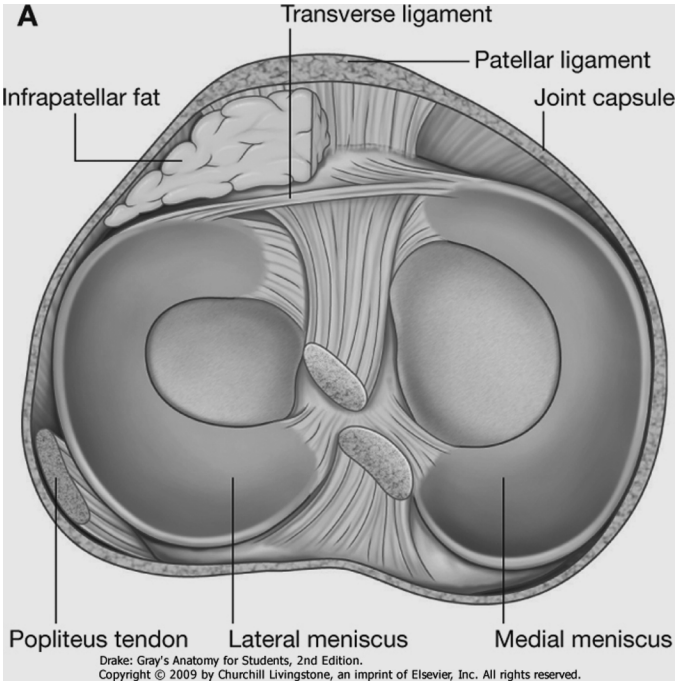


Figure C *Menisci of the knee joint. A. Superior view.*

that are well vascularized, which promotes "moist and pliable tissue."[12]

The role of the menisci in the knee joint is to assist in load transmission as well as joint stability.[4] In fact, "the menisci bear between 40 and 70% of the load across the knee; the remainder of that load is transmitted by the direct contact of articular cartilage."[18] It has been shown that "complete meniscotomy leads to tibiofemoral joint space narrowing, condyle flattening, and osteophyte formation" and one study reports that removal of the medial meniscus decreases the tibiofemoral contact area by as much as 50 to 70%.[4] Contact stresses in the articular areas are thereby doubled as contact area is inversely proportional to contact stress.[3]

Commonly, medial meniscus damage does not occur in isolation as it is much more firmly attached to the tibial condyles than the lateral meniscus.[7,18] This is also the reason that the medial meniscus is more commonly injured that the lateral meniscus.[17] Approximately 33% of meniscal tears are associated with ACL injuries.[17] Some meniscal tears are asymptomatic and may remain that way or heal spontaneously.[19] Meniscal injuries are typically diagnosed by history and physical including joint line tenderness, Apley's test and McMurray's test.[14,19] However, one study reported that the aforementioned orthopaedic tests are insensitive and non specific for detecting meniscal tears in ACL-intact knees.[19] In a recent review, McMurray's test is described as being the "primary test for the examination of knee menisci" and reports a sensitivity range between 16–70% and a specificity range of 59-98% based on all of the historical research data.[3] This review reported the sensitivity range for Apley's test at 13–41% and a specificity range of 80–93%.[3] The review also presented information on Thessaly's test which had a sensitivity range of 65–95% and specificity range of 80–97%.[3] Thessaly's test "performed better than all other tests evaluated" in the review.[3] As this information was found during the research stages of this case study, this test was not conducted on the patients outlined in this report. Thessaly's test is performed by the patient rotating his knee and body internally and externally three times each while weight bearing on the leg being tested at 5 degrees and then again at 20 degrees.[3] The following indicate positive test results: discomfort at the joint line, locking or catching.[3] These tests may also be present in a knee with injured coronary ligaments.[7] In contrast, coronary ligament injury may be present, and the primary injury, if the meniscal and collateral ligament tests are negative and rotational stresses of the tibia are positive.[7] Pain with lateral rotation of the tibia incriminates the medial coronary ligament whereas pain with medial rotation of the tibia incriminates the lateral coronary ligament.[7] The gold standard in diagnosing a meniscal tear is arthroscopy, however, this procedure is invasive and MRI is becoming "the imaging modality of choice to evaluate intra-articular tissues of the knee, including the menisci."[11] Meniscal injuries usually have limited findings on plain film radiography.[13] An MRI of the knee in most cases will reveal an area of increased signal intensity extending to one or more articular surfaces.[13,15] Accuracy rates for diagnosing meniscal tears with MRI have been reported as 90%.[11] As waiting times for MRI can be lengthy, not every case of suspected meniscal tear necessitate referral for MRI and treatment should be initiated prior to obtaining MRI results.

Cases where locking of the joint occurs should be immediately referred for an orthopaedic consultation if the locking cannot be resolved quickly or if locking recurs. Symptoms of medial meniscus tears not complicated by locking can be managed conservatively. Treatment may

include: reassurance, custom orthotics, taping, rehabilitative exercises, icing, soft tissue manipulation, chiropractic adjustments, massage, fascial stripping, non steroidal anti-inflammatory medication, corticosteroid injection, and analgesic medication.[6,7,9,14,20,21,22,23] If conservative intervention fails to relieve symptoms, surgical approaches may be explored, such as a partial or full meniscotomy or meniscus repair.[4,9]

As with other acute inflammatory conditions, beneficial effects of icing, NSAIDs, manipulation, and soft tissue treatment including massage and myofascial stripping with the intent to restore normal movement have been noted for both meniscal and coronary ligament injuries.[6,7,14,20,21,24] One study outlined the efficiency of both instrument assisted techniques as well as soft tissue mobilization done with the clinician's hands noting that while the clinical improvements were not different between the therapy groups, improvement in both groups was maintained on a 3 month follow up.[24]

While the symptom presentation and history in these cases ruled out patellofemoral pain syndrome, Osgood Schlatters disease, slipped capital femoral epiphysis and delayed onset effusion, and the negative anterior drawer tests ruled out anterior cruciate ligament tear, the remaining six conditions stayed on the differential list. No evidence of remote trigger points, nerve compression or involvement of the iliotibial band were noted in either case. Instability was not noted in either case on valgus or varus testing of the knee, although these tests were painful. On initial examination in both cases immediate ruling out of bursitis and muscle strain were not possible due to the exquisite nature of the pain. In addition, it was thought likely that some muscle strain about the knee was to be present as it is uncommon for only one structure to be damaged during an acute knee injury. With the symptom presentation in both cases of either antalgic gait or inability to weight bear, delayed onset effusion, inability to fully extend the knee, and in case 1 the typical history of a twisting injury about the loaded knee joint while the knee was in flexion accompanied by direct trauma across the knee, it was suspected that the menisci and coronary ligaments were involved. Positive orthopaedic tests including Apley's test, McMurray's test, and medial joint line tenderness were conducted to confirm this diagnosis as advanced imaging was not immediately available.

Previous studies have recommended a course of conservative treatment prior to surgical referral including icing, manipulation, and soft tissue treatment including massage and myofascial stripping.[6,7,14,20,21,22,23] The patients in these cases were initially treated with either instrument assisted or non instrument assisted friction massage at the medial joint line and over the coronary ligaments as well as icing and rehabilitation exercises over the course of four weeks. Rehabilitation exercises included exercises to target the VMO and thereby strengthen the quadriceps muscle, squatting exercises, stability exercises on the wobble board and exercise ball which were progressed to more advanced versions of these exercises to meet the individual patient's needs. Improvement was noted by both patients within the first week of care and return to play was initiated after week 3 for patient 1. No pain remained for either patient after week 4 of care and active therapy was halted for both patients at this time.

There are several factors that may have influenced the favourable outcome of these cases. The rehabilitation exercises were attempted due to the success of such programs seen for meniscal injuries in the literature. Soft tissue techniques including fascial stripping were used to attempt to break down scar tissue that may have accumulated in the area, promote the laying down of more organized scar tissue and decrease edema.[25] With the onset of manual therapy, the patients seemed to have a rapid reduction of subjective symptoms, but it is important to note other factors that may have produced a favourable outcome in this case such as the cessation of playing football in patient 1 and therefore rest to the affected knee.

Further study is needed to identify other possible treatment avenues such as specific rehabilitative exercises for injured menisci and coronary ligaments. This research might take the form of other case reports or a small scale clinical trial (RCT)[4] to compare the effectiveness of treatment with and without specific exercise prescription or treatment with rehabilitation with and without soft tissue treatment. Additionally, the use of other outcome measures for knee injuries such as the Knee injury and Osteoarthritis Outcome Score (KOOS) would be a simple addition that could better quantify the measurement of improvement for future cases or research.

Summary

Although favourable results were obtained, it is important to remember that the nature of this investigation was

that of a case study, and therefore no inferences can be made with respect to effectiveness of the care administered in general. The patients in this manuscript may have improved by virtue of the natural healing of their injuries, the rest, ice or perhaps the arnica helped as well. Case studies, while a starting point in the research, are by their nature limited as the protocols were carried out on one, or in this case two, patients. Limited as it may be, this case does suggests that conservative management using rehabilitative exercise, icing, and fascial stripping of two cases of medial meniscus injury with associated coronary ligament injury may be helpful. Conservative management of meniscal injuries should be explored prior to more invasive procedures such as injection of corticosteroids or surgery.

Acknowledgements

I would like to thank Anne Taylor-Vaisey, CMCC Reference Librarian, for her assistance with searching the literature. I would also like to thank Dr. Emily Howell, Mr. Kenneth Clasper and Mrs. Andrea Murray for their assistance with editing.

References

1 NBCE 2005 Job Analysis of Chiropractic (homepage on the internet).Greeley, CO: National Board of Chiropractic Examiners. Available from: http://ibce.org/publication/job-analysis.html
2 Odgers C, Galinat B. Meniscal Injuries in Children and Adolescents. Clinical Case presentation, Orthopaedic Department The Alfred I. Dupont Institute, May 8, 1996. Available at http://gait.adi.udel.edu/educate/menisc.htm.
3 Chivers M, Howitt S. Anatomy and physical examination of the knee menisci: a narrative review of the orthopedic literature. JCCA. 2009; 53(4):319–333.
4 Fazalare J, McCormick K, Babins D. Meniscal repair of the knee. Orthopaedics. March 2009; 32(3):199–206.
5 Adirim J, Cheng T. Overview of injuries in the young athlete. Sports Med. 2003; 33(1):75–81.
6 Brantingham H, Globe G, Tong V, Bates C, Jukes G, VanHouten C, Doorly K. Diversified chiropractic adjusting and management of five clinically diagnosed meniscus injury patients with MRI imaging in four cases. J Am Chiropr Assoc. July 2008; 11–24.
7 Hammer W. Meniscotibial (coronary) ligament sprain: diagnosis and treatment. Chiropractic Sports Medicine. 1988; 2(2):48–50.
8 Standring S. Gray's Anatomy; The Antatomical Basis of Clinical Pratice. Fortieth Edition. Elsevier Limited 2008.
9 Rimington T, Mallik K, Evans D, Mriczek K, Reider B. A prospective study of the nonoperative treatment of degenerative meniscus tears. Orthopaedics. August 2009; 32(8):558.
10 McCarty E, Marx R, Wickiewicz T. Meniscal tears in the athelete: operative and non operative management. Phys Med Rehabil Clinics of North America. Nov. 2000; 11(4):867–879.
11 Pollard H, McHardy A, Hoskins W, Windsham R, Onley R. Chiropractic treatment of lower extremity conditions: a literature review. JMPT. 2006 Oct; 29(8):658–671.
12 Drake R, Vogl W, Mitchell A, editors. Gray's Anatomy for Students Second Edition. Churchill Livingstone 2010/2005. figures 6.69 and 6.70 Copyright Elsevier. (Reprinted with permission).
13 Yomtob C. Meniscal injury in the juvenile knee: an MRI case study. Topics in Diagnostic Radiology and Advanced Imaging. Fall 1995; 12–15.
14 Souza T. Treatment of common knee disorders: Part II – specific conditions. Chiropractic Sports Medicine. 1990; 4(2):119–127.
15 Grenier J, Wessely M. Knee MRI Part II: MR imaging of common internal derangements affecting the knee. Clinical Chiropractic. 2004; 7:131–140.
16 Hunter R, Hunter J. The Young Athelete: Special Consderations. In: Hyde T et al. Conservative Management of Sports Injuries. Second Edition. Lippincott 2007.
17 Goldblatt J, Smith JS. Managing meniscal injuries: the diagnosis. J Musculoskeletal Med. March 2005; 146–142.
18 Ozkc G, Circi E, Gonc U, Irgit K, Pourbagher A, Tandogan R. Radial tears in the root of the posterior horn of the medial meniscus. Knee Surgery Sports Traumatology Arthrosc. 2008; 16:849–854.
19 Shelbourne KD, Benner R. Correlation of joint line tenderness and meniscus pathology in patients with subacute and chronic anterior cruciate ligament injuries. J Knee Surg. 2009; 22:187–190.
20 Seplow W. Management of lateral meniscus injury. Sports Chiropractic & Rehabilitation. 1996; 10(2):86–88.
21 Polkinghorn B. Conservative treatment of torn medial meniscus via mechanical force, manually assisted short lever chiropractic adjusting procedures. J Manip Physiol Thera. September 1994; 17(7):474–484.
22 Souza T, Hyde T. The Knee. In: Hyde T et al. Conservative Management of Sports Injuries. Second Edition. Lippincott 2007.
23 Palo J. "Knee Needs" – the problems that plague our largest joint. J Am Chiropr Assoc. September 1998; 42–44.
24 Burke J, Buchberger D, Carey-Loghmani T, Dougherty P, Greco D, Dishman J. A pilot study comparing two manual therapy interventions for carpal tunnel syndrome. J Manip Physiol Thera. 2007; 30(1):50–61.
25 Pajaczkowski J. Mimicking turf-toe: myofasopathy of the first dorsal interosseous muscle treated with ART. J Can Chiropr Assoc. 2003; 47(1):28–32.

0008-3194/2011/128–139/$2.00/©JCCA 2011

The West family chiropractic dynasty: celebrating a century of accomplishment in Canada Part II: Samson J. West, David I. West, Neil A. West, Megan L. West, R. Ian Buchanan and James L. West

Douglas M. Brown DC*

This historical paper documents the unbroken legacy of the West family of chiropractors which has flourished in Canada for over 100 years. Part I, unearthed the origins, development and careers of Archibald West, the founder of this dynasty, his son Samuel and grandson Stephen. Part II, delves into the life of Archie's brother Samson, and Samson's chiropractic progeny: grandsons David and Neil, and great granddaughter Megan. Then it goes back to look at Stephen West's nephew, R. Ian Buchanan and ends with a descendant of another branch of the family tree, James L. West.
(JCCA 2011; 55(2):128–139)

KEY WORDS: history, chiropractic, West

Ce document historique rassemble l'héritage ininterrompu des chiropraticiens de la famille West qui a prospéré au Canada depuis plus de 100 ans. Partie I, la découverte des origines, le développement et la carrière d'Archibald West, le fondateur de cette dynastie, son fils Samuel et petit-fils Stephen. Partie II, plonge dans la vie de Samson, le frère d'Archie, et la descendance chiropratique de Samson : petits-fils David et Neil, et arrière petite-fille Megan. Ensuite, il fait un retour en arrière pour observer le neveu de Stephen West, R. Ian Buchanan et se termine par un descendant d'une autre branche de l'arbre de la famille, James L. West.
(JCCA 2011; 55(2):128–139)

MOTS CLÉS : histoire, chiropratique, West

Introduction

This historical paper documents the unbroken legacy of the West family of chiropractors which has flourished in Canada for over 100 years. Part I, unearthed the origins, development and careers of Archibald West, the founder of this dynasty, his son Samuel and grandson Stephen.[1] Part II, delves into the life of Archie's brother Samson, and Samson's chiropractic progeny: grandsons David and Neil, and great granddaughter Megan. Then it goes back to look at Stephen West's nephew, R. Ian Buchanan and ends with a descendant of another branch of the family tree, James L. West.

Samson J. West DC: Archibald's Brother

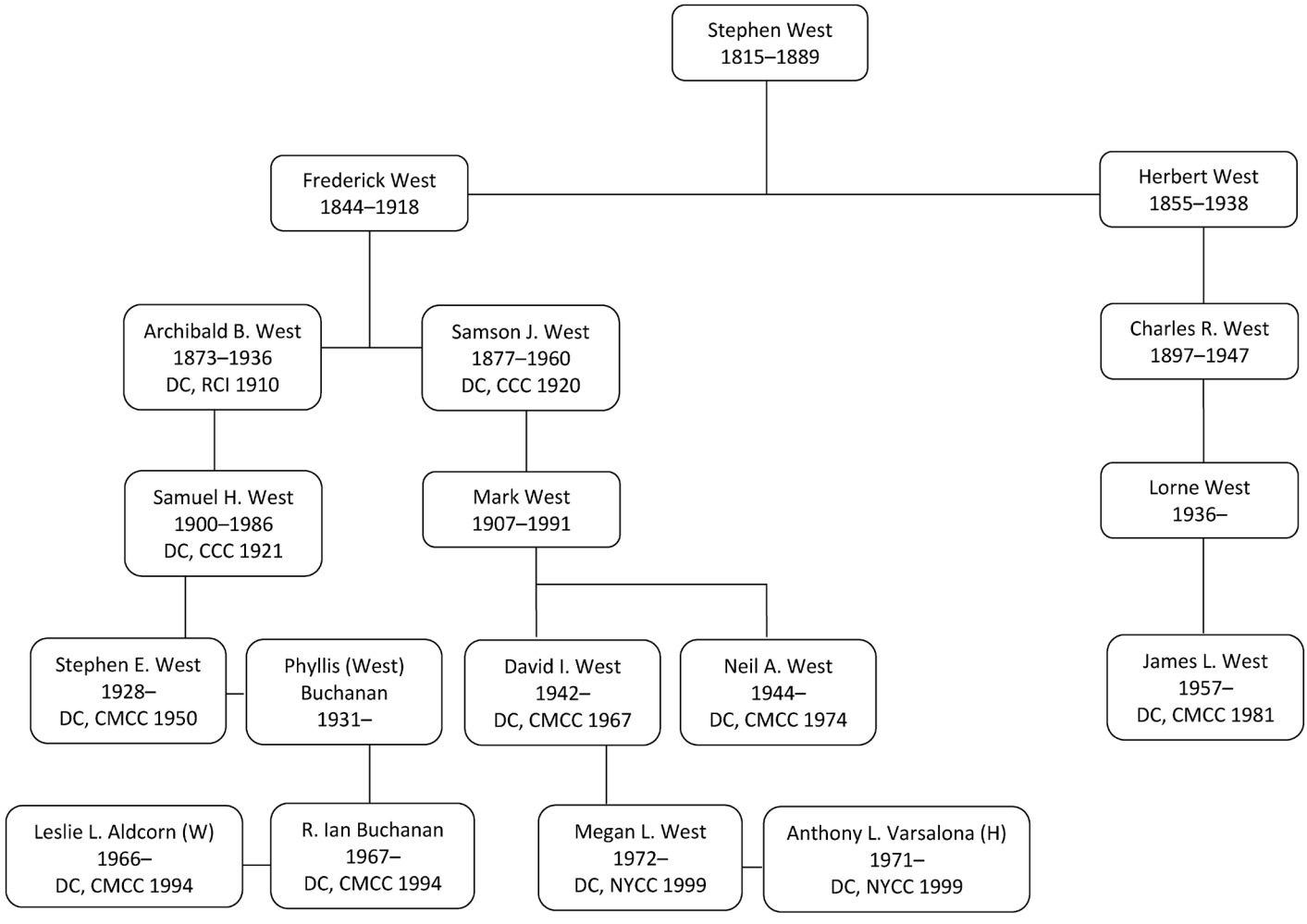
Frederick and Mary Ann West had 12 children; eight boys and four girls. Archie, the eighth child, was born in 1873, while Samson, the tenth, was born January 3, 1877.

Back in the summer of 1881, Frederick West had purchased and developed a 300 acre tract of land at the upper end of Ottertail Lake, in Algoma Township, which he later sold to Samson. Samson was 41 years old, married to Eliza (Emma) Marshall, with two sons and one daughter when, in the fall of 1918 he enrolled, along with his nephew Samuel West (Archie's son), in the Canadian Chiropractic College (CCC), then located at 22 Main Street West, in Hamilton.

Samson attended the CCC for 18 months. His course comprised 12 months of classes followed by six months of clinical training. Formal courses included anatomy, physiology, pathology, spinology, the art of chiroprac-

* 281 Ridgewood Road, Toronto, ON M1C 2X3. Tel.: 416-284-1168. E-mail: browndouglas@rogers.com

West Family Tree



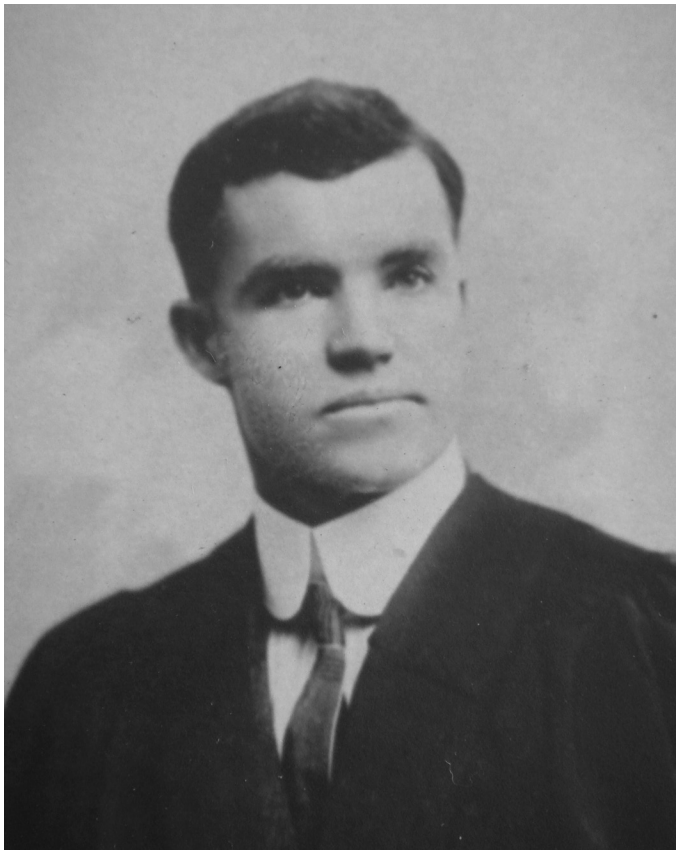
tic (palpation, adjusting and nerve tracing), chiropractic philosophy and the polemics of chiropractic (logical arguments to defend the science and convince sceptics).[2] Samson graduated on March 23, 1920. By then the CCC had moved to 757-759 Dovercourt Road, in Toronto.

Upon graduation, Samson established a part-time practice at his farm. Patients would come to the farmhouse kitchen, to be adjusted a number of times a day for several days. Around 1922–23, Samson left his property in the care of his wife and children, travelling to the clay-belt area near Ottawa, to open a practice. After a year, he returned to his family in Algoma, resumed farming and practicing there, and probably saw patients at Bruce Mines as well. David West describes his grandfather as "free thinking. In addition to agriculture and chiropractic he was among the first to install telephones in this area and was an amateur photographer." [Interview, David West by Brown, April 5, 2008]. Samson died on February 10, 1960.

David I. West DC, and Neil A. West DC: Samson's Grandsons

Background

Samson and Emma West's second son Mark, was born October 30, 1907. In 1933 Mark purchased the farm from his father and on September 27 that year, he married



Samson West 1918

Helen Harnden. They had four sons; Ian, Alex, David and Neil. David was born July 26, 1942 and Neil on May 15, 1944. In 1955, Mark shocked his relatives and friends by selling the property, which had been owned by the West family for three generations, and moving to Grimsby, Ontario. Helen was well-educated and obtained a good job working in the admissions department of the Grimsby Hospital. Mark purchased a 14 acre fruit farm, which ran in a narrow strip from Highway 8 to the Niagara Escarpment and augmented his income in various ways, such as working in the local grocery store.

David and Neil's memories of chiropractic go back to their early childhood. Neil relates that when he and David were small boys living on the Algoma farm, their father's cousin Samuel West, would come to visit. Often he would adjust both boys and afterward, give each of them a piece of candy. [Phone call, Brown to Neil West, May 2, 2008] They also travelled to Sault Ste. Marie, where they were

David West, Megan West, Anthony Varsalona 2008

adjusted by Sam and his son, Stephen. David remembers that "father and son were very busy with patients lined up out the door and down the street."

Education

While in high school, David and Neil became patients and friends of Emil Zmenak, DC, a 1960 graduate of the Canadian Memorial Chiropractic College (CMCC) and the only chiropractor in Grimsby, who took them on a tour of the College, at 252 Bloor Street West, in Toronto. David received his senior matriculation from high school in 1963 and was admitted to CMCC in September that year. While there he participated in a number of sports, belonged to the Junior Canadian Chiropractic Association, the X-ray Club and the Clinic Committee. David admits that "Probably my greatest personal achievement occurred at the end of my third year at CMCC, when on May 28, 1966, I married Diana (nee Sexsmith)." [Letter, David West to Brown, September 15, 2009]

Neil West also graduated from high school in 1963 but took a detour, enrolling in the Economics program at the University of Western Ontario, where he earned a Bachelor of Arts degree in 1966. Neil was hired by the John Deere Company and on September 23, 1967, married Lynn Urban. In 1970 he changed vocations, tracing his brother's footsteps to CMCC. Neil was "a driving force during his College years. He was elected to the position of Executive Secretary in his second year and was President

of the SAC (Student Administrative Council) in his last two. He was also active in 'Practichiro' (an annual variety show), as an actor and producer. In 1973 he was editor of the Cornerstone and assistant editor in 1974. His athletic prowess was shown in floor hockey, baseball, volleyball, curling and bowling."[3]

David West's Professional Career

David West graduated from CMCC in May 1967 and promptly opened an office in Grimsby. His practice grew rapidly. Anticipating that his brother Neil would soon join him, in 1972 he built a modern, 4,000 square foot, multi-doctor, well-staffed facility, including an X-ray technician and a registered nurse. The Ontario Chiropractic Association (OCA) was curious to discover how he could run such a large operation and still provide competent service. "Follow me around and find out," was David's response. The OCA was so impressed, it used David's statistics as guidelines for developing standards of care for chiropractors in Ontario. [Letter, David West to Brown, September 15, 2009]

David's involvement in chiropractic organizations started in 1967 when he was inducted into the Hamilton District Chiropractic Council (HDCC). "We were fortunate to have wonderful peers in the Hamilton/Burlington area, including Drs. Robert Wingfield, David Churchill, Ronald Oswald and John MacRae, to name a few." David held all executive positions in the HDCC and chaired the Historical Committee, interviewing a number of senior practitioners, including his uncle, Dr. Samuel West, of Sault Ste. Marie.

In 1973, David Churchill, DC, then Chair of the CMCC Board of Governors, invited David to join the College Board. On April 23 that year, David attended his first meeting and was soon chairing the Education Committee. "With much help from Dr. Herb Vear and Dr. Tom Maxwell, in 1975 we expanded the admission standards at CMCC from senior matriculation to one year post-secondary education. In 1979 these were further extended to two years prerequisite and in 1993 to three." [Letter, David West to Brown, September 15, 2009]

When CMCC's Bayview campus was opened in 1968, it was designed to house four classes of 75 students. By 1973 the freshman class had mushroomed to 150 students and total enrolment was headed for 600. As Chair of the College Expansion and Development Committee, solving

David West Grimsby clinic

this problem would test David's endurance and ingenuity for five years. In 1975 a three-phase plan was approved that would see the successful construction of three amphitheatres, various administrative offices, a large technique lab and renovation of the clinic and its associated departments. The last major change under David's watch took place in 1980, when the library was doubled in size by relocating it to the entire top floor of the College's south wing.

October 30, 1976, David replaced William S. Baird, DC, as Chair of the CMCC Board of Governors. In July 1976 the Board had begun exploring the complexities of accreditation and in October 1977 started the process by amending its by-laws to allow it to hire a president. By April 1978 the Board was totally committed to accreditation and was instrumental in convincing the CCA to form and sponsor an independent agency, the Council on Chiropractic Education (Canada) Inc. [CCEC]. David describes the decade between 1976 and 1986 as "a time of transition." Others have called it tumultuous. Much of this "transition" occurred within the CMCC Board as the College evolved from an organization similar in some respects to a proprietary trade school, to a fully accredited institute of higher learning in chiropractic. Implementing a presidential system of governance was the Board's most difficult task, requiring its evolution from a body deeply involved in administrative matters, to one mainly concerned with policy formation, accountability and fund raising.[4]

On October 24, 1980, David left the Board but maintained his ties to the College and in April 1982 was elected as the first President of the CMCC Governors' Club, which became an important and still active fund raising arm of the institution.

Back in May 1978, as Chair of the CMCC Board, David had attended the inaugural meeting of CCEC, and declared it to be, "one of the most significant events in chiropractic history in Canada."[5] In April 1984, David was made a Director of CCEC and Secretary of its Commission on Accreditation and in January 1985 chaired a team that conducted a short visitation of the CMCC clinics. "The CCE board was going through personnel difficulties at the time and as a result, much effort was spent familiarizing ourselves and refining the standards to mesh with the Canadian scene. These were exciting times in chiropractic education and I was fortunate to be a part of it." [Letter, David West to Brown, September 15, 2009] David resigned his post with CCE in 1988.

From 1975 to1980, David was one of CMCC's representatives at numerous liaison meetings between the Ontario Ministry of Health, the Board of Directors of Chiropractic and the OCA, attempting to negotiate new chiropractic legislation under the Health Disciplines Act.

In 1980 the HARP (Healing Arts Radiation Protection) Act was passed, placing limits and restrictions on the operation and function of X-ray machines in Ontario. Its legislation applied to medicine, dentistry, podiatry and chiropractic, and each profession had its own advisory committee. David was an ad hoc member of the Chiropractic Advisory Committee. A critical task was to develop uniform, mandatory, quality assurance tests. The members met once a month for five years and finally adopted a safety code acceptable to all parties. This was a major accomplishment. [Information courtesy of Robert Wingfield]

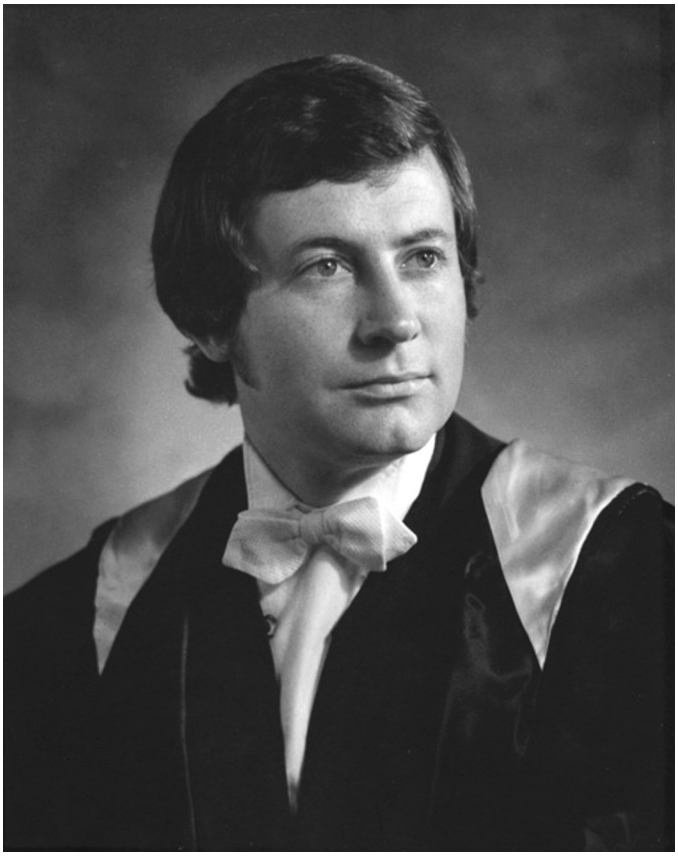
In May 1990 the Canadian Chiropractic Association (CCA) Board of Governors voted to establish national chiropractic practice guidelines and on April 15, 1991, a Guideline Review Group of 25 chiropractors was formed and began critiquing the literature and consulting others in the profession. By August 1992, initial drafts of the Guidelines Document had been completed and distributed to over 23 sponsoring organizations for their input. At this point the Guidelines Review Group was disbanded and replaced by a Guidelines Consensus Commission of 35 members. The Commission's job was to re-evaluate the Review Group's draft guidelines and provide further clinical support for suggested revisions. The work was divided into 20 teams, one for each chapter. David was appointed Team Leader for chapter 15, Maintenance/ Preventative/ Supportive Care. This re-evaluation took place over seven months and preceded a four day, roundtable conference held at the Glenerin Inn, Mississauga, Ontario, April 4–7, 1993. Here 305 guideline recommendations were debated and voted upon in plenary sessions with nearly all votes achieving a consensus level greater than 90% and no minority opinions. "Three years after the CCA initiated the project, it was finally complete. There had been as much professional participation as possible. More than a few hundred people were involved in shaping the document."[6] This made chiropractic one of the first health care professions to have nationally based clinical guidelines in print.

Neil West's Professional Career

Neil West graduated from CMCC in May 1974 and immediately joined his brother David, in the Grimsby clinic. Neil`s role as President of the SAC during his last two years at the College, required him to represent student interests at meetings of the Board of Governors and the Senate. In fact, he was present on April 23, 1973, when David was welcomed to the Board. It seemed appropriate that Neil, with his background in economics, would join his brother on the Board, which he did, January 19, 1975.

In 1975 CMCC began implementing its extensive Expansion and Renovation plans and Neil became David`s unofficial "executive assistant," working and travelling with him extensively, sitting at his side during meetings and somehow finding time to tackle his own project; the creation of a Satellite Clinic for the College at Parliament and Gerrard Streets, in Toronto, a feat he accomplished in less than a year. In 1977, Neil "chaired a senate study into the development of the various terms of reference and a flow chart of all administrative personnel at CMCC. This has been a commendable task and a very important one for it now gives our administration a foundation upon which to build and develop."[7]

Neil parted company with his brother in 1979, moving his family to Tecumseh, Ontario, a town on the eastern edge of Windsor. Although this more than quadrupled the



Neil West 1974

distance he had to travel, Neil maintained his commitment to the CMCC Board until his term ended in February 1981.

Arriving in Tecumseh, Neil opened two solo practices in rapid succession; one in Tecumseh and the other 17 km east, in Belle River. "When I moved here in 1979, I was the only chiropractor for 30 km along the south shore of Lake St. Clair, east of Windsor. Today there are more than 20. That is similar to the rest of Ontario and represents our strengthening and expanding base…I had a relatively high volume fun practice. My focus was to emphasize my practice and avoid too many collateral activities." [Email, Neil West to Brown, April 21, 2010] Actually, Neil had little time for other endeavours. He worked five and a half days a week, spending his mornings in Tecumseh and his afternoons in Belle River. Still, in addition to his involvement with CMCC, he held executive positions on the Hamilton and Windsor-Essex Chiropractic Societies and served on the board of the Ontario Chiropractic Credit Union.

In 1988 Neil and a partner constructed the 30,000 square foot Tecumseh Life Centre. The Centre contained a four doctor chiropractic clinic, a pharmacy, X-ray, ultrasound and medical laboratories, medical doctors, dentists, optometrists, audiologists, a psychologist, speech therapist, chiropodist and orthodontist. It also offered something unique at that time; an urgent care centre. This was a walk-in clinic, staffed by emergency specialists from the nearby Grace Hospital.

Megan L. West, DC

Background

Megan, the second of David and Diane's three children, was born on May 2, 1972, into a large chiropractic family. Megan relates that, "It was all I ever knew. I grew up hearing stories of my great, grandfather, Samson, farming all day, seeing patients in the evenings, and of Grandma West (David's mother) taking her sons to Sault Ste. Marie for adjustments by Sam West." Megan too was adjusted regularly and talked to her friends about "how good it makes me feel." Even the teachers knew that the West children didn't have any sick days. One of her happiest childhood memories occurred in 1981, when she "attended CMCC's Convocation and Dad was the guest speaker."

Education

There wasn't much doubt that Megan would take after her father. Following high school, she selected the human kinetics course at the University of Guelph, because it offered full body human dissection and was highly recommended as a pre chiropractic program. Megan graduated from Guelph with honours in 1995. By this time it was too late to apply to CMCC so Megan investigated the New York Chiropractic College (NYCC). Situated in Seneca Falls, NY, on 286 acres of land, Megan describes it as having "an amazing campus."

In January 1996, Megan was one of 120 students to begin the program at NYCC. Many of her classmates were Canadian. Megan was "very happy" with the education she received, particularly the adjustive techniques. In addition to diversified, she was exposed to a lot of alternative methods, which made her "very confident." One member of her class was Anthony Varsalona, an American

Neil West's Tecumseh Life Center

citizen who was raised in Branchville, a small town in the northern region of Sussex County, New Jersey. Anthony was first exposed to chiropractic in grade seven, when he injured his chest wrestling. Because he was having difficulty breathing, he was taken to a hospital where all tests were negative. A local chiropractor diagnosed Anthony's problem to be a displaced rib, which he promptly corrected.

In grade eight, Anthony became interested in the spine itself and began considering chiropractic as a career. That summer he started researching the profession by arranging to observe a variety of chiropractors in their offices. He was also receiving regular adjustments from two local chiropractors. Following high school, Anthony won a wrestling scholarship to George Mason University, in Fairfax, Virginia, where he completed a pre-med, major biology course.

Prior to university, Anthony began exploring chiropractic colleges. He was interested in the Palmer College, Davenport, Iowa, and the Life College in Atlanta, Georgia. He had been accepted by both colleges but a friend told him to check out the NYCC. As soon as he toured the campus, Anthony knew "this was the right place" for him, and luckily, he ended up in Megan's class.

Megan and Anthony began dating in their second year, graduating together in April 1999. Megan's proud father David, recalls participating in the ceremony. "At my daughter Megan's NYCC convocation, I was permitted to hood her. This was a great thrill for me, with our entire family in attendance."

Professional Practice

By the time they graduated, Megan and Anthony had a good idea of how they wanted to practice. Now they had to decide where they wanted to practice. December 31, 1999, Megan and Anthony spent New Year's Eve with Megan's parents in Grimsby. That weekend they made up their minds to return to Ontario and become associates in David's clinic. On February 26, 2000, Megan and Anthony were married and the clinic's ground floor was renovated to provide them with plenty of space for growth. By June the happy couple had settled into the bustling, well-established, West clinic. [Interview, Megan West and Anthony Varsalona, by Brown, June 21, 2010]

Ten years later, Megan and Anthony are raising their bright, energetic, six year old son Colin, in a spacious home perched on the brow of the bluffs overlooking Lake Ontario. They have taken over much of the clinic's administrative duties and David now works just three days a week. Although their main adjustive technique is still diversified, they utilize Thompson Drop, Sacro-Occipital and Pro Adjuster methods when appropriate. Anthony is

certified in Active Release Technique and handles a lot of sports injuries. Megan has her fellowship in paediatrics with the International Chiropractic Paediatric Association, so her focus is on children.

The clinic has evolved into a wellness centre, offering affordable, patient-centred, chiropractic care, along with supportive disciplines such as massage and physical therapy. Megan and Anthony are adamant that business will never take precedence over public service.

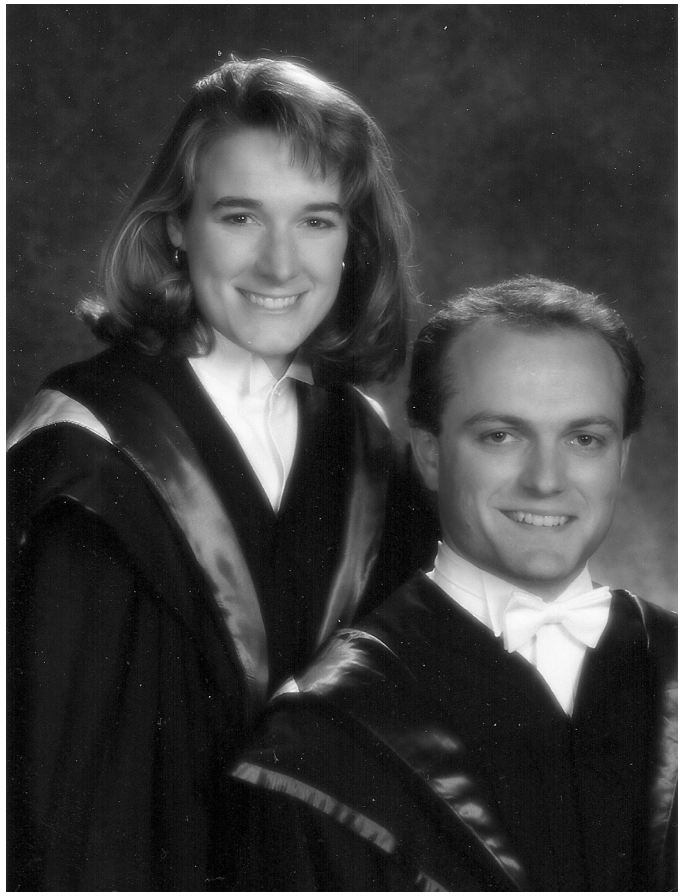
Robert Ian Buchanan, Stephen West's Nephew

Background

In 1954, Stephen's sister Phyllis, married Stanley Buchanan, in Sault Ste. Marie. Stanley was a store manager for Sears Canada, requiring the family moved from city to city across Canada, eventually settling in Toronto. Phyllis and Stan sired six children. Their five sons and one daughter were born in various locations. Ian, the youngest, arrived on the scene in 1967, in Winnipeg, Manitoba.

Ian has memories of his grandfather, Sam West, striding briskly through airports to visit them, carrying a can of Maple Syrup from the Sault, under his arm. In the late 1970s, while living in Vancouver, Ian recalls playing football in the backyard with three friends, when Grandpa Sam called them into the house and told them to lie down on the living room floor to be adjusted. Ian says he only received upper cervical adjustments from his grandfather. [Phone call Brown, to Ian Buchanan, July 8, 2009] His mother Phyllis recollects driving with her family to attend Lyceum, at the Palmer School in Davenport, Iowa, when she was eight years old. Phyllis was impressed by meeting BJ Palmer in his "Little Bit 'O Heaven," an indoor tropical paradise designed and constructed mainly by BJ himself. She was also frightened to be leaving for home on September 1, 1939, the day World War II was declared against Germany, by the Western Allies. [Phone Call, Brown to Phyllis Buchanan, Oct. 3, 2009]

Phyllis relates that Sam and his wife May, like their parents before them, were faithful members of what was originally known as the Albert Street Gospel Hall, in Sault Ste. Marie. This evangelical Protestant assembly had its beginnings in 1900, with Archie West becoming one of its first two converts.[7] In 1947, Sam and another parishioner donated a new property at the corner of Spring and Wellington Streets, where a larger Hall was erected. After church, Sam and May usually invited parishioners back to their home for dinner, where the topic of conversation invariably got around to discussing the merits of chiropractic care.



Leslie Aldcorn and Ian Buchanan 1997

Education

Upon graduating from Grade XIII, Ian Buchanan applied to study engineering at the University of Toronto (U of T). On January 4, 1986, Grandpa Sam died and the Buchanan family drove to the Sault for the funeral. During the visitation, Ian and Brian, an older brother, were up in the attic, rummaging through memorabilia stored there and eavesdropping on the folks who had gathered below, reminiscing about their grandfather. Ian was examining a clock which featured the letters chiropractic in place of the numbers one to twelve, when suddenly he experienced an epiphany: "I'm supposed to become a chiroprac-

tor!" he shouted, and quickly changed his courses at the U of T to comply with CMCC's requirements.

From 1986-88, Ian completed the first two years of a three year BSc program before leaving for Jerusalem to pursue his interest in Old Testament historical geography. Returning to the U of T in 1989, Ian earned his BSc before enrolling at CMCC, where he graduated in 1994. Although initially surprised by the content of the course, which emphasized the science of chiropractic, rather than the philosophical aspects he was expecting, Ian found his four years at College to be "a great experience." One of his most memorable recollections is falling in love with fellow classmate Leslie Aldcorn. Leslie and Ian had something in common: they were both born in Winnipeg. At this time Leslie was living in Markham, Ontario. Her father Gary, was a professional hockey player who had skated on left wing for a number of leagues including the National Hockey League, where he toiled for Boston, Detroit and Toronto.

Professional Careers

Because Leslie and Ian had spent much of their youth in western Canada, both wanted to practice in a western province once they graduated. During the summer break of 1993, they began their search. Starting in Vancouver, British Columbia, the couple kept moving east, until they landed in Lethbridge, Alberta, which they found the most welcoming. In July 1994, before moving out west, Ian proposed to Leslie in front of the Palmer Homestead, on Old Simcoe Street, in Port Perry, Ontario. They were married on December 30 that year and now (2010), have two lovely children, Meghan 12 and Quinn 10. Although they began their careers as associates in separate offices, since 1997 Ian and Leslie have practiced together in their own 3,400 sq ft clinic.

For a few years Ian had an auxiliary office in Pincher Creek, south-west of Lethbridge, until the main clinic became too demanding. Recently the Lethbridge Clinic has been modernized. The office is now paperless and three massage therapists share the premises, although Ian and Leslie still take their own X-rays, use no modalities and the primary adjustive technique remains diversified.

Sixteen years later, Leslie and Ian are still motivated by Grandpa Sam, in that they use spinal adjustments, by hand only and practice the "Golden Rule," with affordable fees and a schedule that meets their patients' needs.

James L. West, DC

Background

James West's lineage goes back to Stephen West (1815–1889), the first family member to settle in Ontario. Stephen West and his wife Mary Ann had 11 children. Frederick West, their fifth child, was the father of Archibald West, the first of four generations of chiropractors previously discussed in Part I of these two papers. James West comes from a separate branch of the family. His great grandfather Herbert West was the tenth child of Stephen West and Frederick was his brother. (See the West Family Tree)

James' father, Lorne West, was born on a farm near Sault Ste. Marie in 1936. His family received chiropractic care from Samuel West and attended the Albert Street Gospel Hall. In 1946, Lorne's father Charles died suddenly, leaving his mother Dorothy with seven young children to feed. Members of the Gospel Hall offered to adopt the children and Sam said he would look after Lorne, who was a much younger second cousin. However, his mother didn't want to break up the family and determined to raise the children herself. In 1954, Lorne left his job at Algoma Steel and moved to Toronto, to stay with a sister who was studying to become a Victorian Order Nurse. The year after, he joined the North York Fire Department, where he became a Captain and served for 25 years. In 1955 Lorne married Beverley Baker and they had five sons, who produced 22 grandchildren, 11 boys and 11 girls. [Lorne West interview by Brown, August 12, 2010]

Education

James, the first child, was born in Toronto, Ontario, April 29, 1957. He always excelled academically, achieving his Grade XIII diploma with the second highest marks in the Region of York. After high school James studied neurosciences at the U of T, on a full academic scholarship. He already knew he wanted to be a chiropractor because of his personal experience and the stories his father had told him about Samuel West. "In the Sault, Sam was as influential as the mayor … He had a large practice, was always on the move and known for his generosity … Sam was an elder in the Gospel Hall and spoke a lot. Some people thought he was the pastor."

James' teachers at the University knew he wanted to be a chiropractor and he "took a lot of flack for it." When

James West 2007

he approached one of his professors for a letter of recommendation to the College, James was told he was making a big mistake; throwing his life away. Although this was intimidating, he wasn't deterred.

While at CMCC (1977–81) James supported himself as a part-time paramedic for the Ontario Ministry of Health and in his third year he assisted Donald Henderson (CMCC 1975) with the emergency care program. In his third and fourth years he worked as a lab technician for John Duckworth, MD, CMCC's illustrious Professor of Anatomy. "This wasn't a job, it was an opportunity, a magical experience." Despite this heavy schedule, James graduated first in his class, winning the top academic awards. [James West interview by Brown, August 12, 2010]

Professional Career

In 1980, a year before graduation, James purchased a bungalow on a half acre lot, fronting on Highway 7, at Kennedy Road in Unionville, which he converted into a home/office combination. A couple of years later he renovated the lower level and installed a 2,000 sq ft clinic. Next he had the property rezoned commercial, enlarged the first floor and added a second floor, where his parents conduct the retail side of Almira Fine Furniture, a prosperous enterprise they have owned for 30 years.

Although CMCC thoroughly grounded him academically, James thinks he was overly optimistic about his future success in private practice because, like Megan West, he "knew nothing about business." James rectified this by taking courses in practice management and shared this information by lecturing widely on the subject of "patient care and retention," throughout North America from 1994 to 2007. James firmly believes in continuing care. "Most patients come to our clinics because they are seeking resolution of a symptom. If all we do is alleviate that symptom…I feel we have done the patient a great disservice… Through education, patients should experience a shift in their thinking away from simply symptomatic relief to the benefits of long-term chiropractic management.[9]

James has also appeared frequently as a guest on CFRB radio and CBC TV, speaking about the prevention and correction of spinal injuries and the benefits of spinal maintenance. For a number of years James has hired CMCC students to work part-time in his clinic. His goal is to instil confidence, by providing them with professional advice, clinical training, business acumen and respect.

When he started practice, James used diversified, full spine adjusting. Gradually, he has evolved to Activator methods, in which he is certified, but still employs the static and motion palpation skills he was taught in College, for spinal analysis. In 2007, James converted his whole office to the latest generation of Impulse™ adjusting instruments, which he describes as electronic impulse adjusting. He finds this technique quite effective, particularly for patients in acute pain who cannot tolerate excessive force.

James is "convinced there are fundamentally two factors which make chiropractors unique, and therefore valuable, in the healthcare marketplace. The first is WHAT we treat – Vertebral Subluxation. The second is HOW we treat it – Spinal Adjustment. Diagnosing and correcting vertebral subluxations with spinal adjustments, and the continued performance of this distinct service, are keys to preserving our chiropractic identity."

Canadian Chiropractic College 1922

Summary

Considering the West chiropractic family's hundred year odyssey in the field of health care, it appears that much of the success Canadian chiropractors now enjoy, particularly in Ontario, emanated from the vision, initiative and courage of Archibald West. Archie began the journey in 1908, when he returned from a rigorous 530 km trip to Plainwell, Michigan, with WJ Robbins in tow and convinced him to open the Robbins Chiropractic Institute, in Sault Ste. Marie. That first bold step ensured that Archie would become a chiropractor and enabled stalwarts such as John Henderson, Albert Price and Sam Sommacal, to do likewise.

The RCI was short-lived, however in 1914 Henderson helped establish its successor, the Canadian Chiropractic College, in Hamilton. This made it easier for Samson and Samuel West to emulate Archie and opened the door for other notables like John Clubine and Arthur Kennedy to join the profession.

By 1919 the CCC had moved to Toronto and closed in 1923. In the meantime, John Clubine and John Cudmore had formed the Toronto Chiropractic College (TCC). Clubine was President of the TCC until its demise in 1926. A few of its memorable alumni were AB Bennett, Herbert Hill, JA Hetherington, HO Langford, Fred Lewis and Harry Yates.

From 1927 to 1945, no recorded chiropractic colleges existed in Canada. On January 10, 1943, the CCA decided to create a national chiropractic college in Toronto, which would be called the Canadian Memorial Chiropractic College. Archie West's influence was felt immediately through the presence of Clubine who attended the inaugural meeting, and reinforced when Henderson, Sommacal and Arthur Kennedy's son Keith, were appointed to the Organization Committee. In 1944, Sam West was successful in getting his colleagues to pledge the money needed to pay for our Bloor Street property, contributing a substantial sum himself. When CMCC opened on September 18, 1945, Clubine was the College's first President, Henderson its first Registrar and Sommacal would become its third President, 1947–51.

When CMCC's first graduating class obtained their diplomas in 1949, Fred Clubine, nephew of John Clubine, Glen Kennedy, another son of Arthur Kennedy and James Langford, son of HO Langford, were among the recipients and in 1950, the second graduating class included Denny Bennett, son of AB Bennett and Stephen West, who justified his father's faith in him by serving the profession diligently in a variety of roles, for 49 years.

Archibald B. West is known as the founder of the West Family Chiropractic Dynasty. He also deserves to be recognized and honoured, as the founder of chiropractic education in Canada.

References

1 Brown DM. The West family chiropractic dynasty: Celebrating a century of accomplishment in Canada. Part I. JCCA. 2010; 54(3): 187-189.
2 Canadian Chiropractic College prospectus, 1923:30–31.
3 CMCC Cornerstone, 1974: 37.
4 Brown DM. The path to full accreditation: CMCC and its Governors, 1945-86. Chiropractic History. 1987; 7(1):17–18.

5 West DI. President's report to the Executive Council of the CMCC Board of Governors, June 18, 1978: 1. CMCC Archives.
6 Henderson DJ. Clinical guidelines for chiropractic practice in Canada: Chairman's preface. http//www.chiro.org/LINKS/GUIDELINES/DISCONTINUED/CANADA/Preface.html
7 West DI. CMCC report to the general membership, 29/10/77: 2. CMCC Archives.
8 http://www.bretherenpedia.com/Albert_Street_Gospel_Hall
9 Developing Lasting Patient Relationships. J Am Chiropr Assoc. June 1999; 15.

Notice of Correction

Hart J, Omolo B, Boone R. Thermal patterns and health perception. JCCA. 2007; 51(2):106–111.

In the paper *Thermal patterns and health perception*,[1] an analysis error occurred. Briefly, our study involved 68 subjects, each of whom had 3 consecutive thermal scans at weekly intervals. At each visit, readings from each side of the spine (left and right channels), and the difference between sides (delta channel) were obtained. Thermal pattern percents were estimated by comparing Visits 1 and 2 (PP1), and Visits 2 and 3 (PP2). Participants also completed the SF-12 survey on each visit, from which physical and mental component summaries (PCS and MCS) were derived as outcomes.

In our original analysis, the data were organized so that subjects' PP1 readings were aligned with their outcome scores from Visit 2 while their PP2 readings were aligned with their outcome scores from Visit 3. However, we erred by analyzing the 68 "paired" (PP1 and PP2) scores as if they had been originated from 136 independent subjects. We also dichotomized the PP scores, then compared outcomes between "high" and "low" groups, again without recognizing the "within-subjects" pairing of the data.

The Correction here is based on converting paired observations to independent summary scores. We used the average of the 2 thermal pattern percents (PP1 and PP2) for each channel and the average of the Visit 2 and Visit 3 outcome scores for each participant. We then estimated the correlation between average thermal pattern percent and average (of 2 separately-timed) PCS and MCS scores. This way, all analyses were correctly based on only 68 independent observations.

In pattern theory, increased thermal pattern percent is considered unhealthy and indicative of a nervous system with diminished adaptive capabilities. For the outcome variables, PCS and MCS, higher scores signify better health. A total of 6 Pearson correlations were estimated (between pattern percent and each of 2 outcomes, for each of 3 thermal channels). As one outcome variable (MCS) lacked a normal distribution, a nonparametric statistic was used (Spearman test).

We found no correlation between average pattern percentages and PCS measurements (all Pearson r values < 0.100; all 2-tailed P values > 0.45). We found weak, but near-significant, inverse correlations between average pattern percentages and MCS scores: left channel Spearman's rho (r_s) = –0.206 (95% CI: –0.422 to 0.036, P = 0.09); delta channel r_s = –0.218 (95% CI: –0.433 to 0.023, P = 0.07); and right channel r_s = –0.206 (95% CI: –0.423 to 0.035, P = 0.09).

Contrary to our original analysis,[1] these results show that pattern percentages are not correlated with health status as assessed by the SF-12 PCS. Similar to our original analysis, we found nearly significant correlations of otherwise trivial magnitude between higher pattern percentages (poorer health status according to pattern theory) and poorer mental health status as assessed by the SF-12 MCS. Specifically, all estimated correlations between pattern percentage and MCS score were approximately 0.2, conventionally meaning weak to negligible correlation. Upon examining the 95% confidence intervals for r_s, the most extreme value was –0.43 (lower bound for delta channel), indicating that, at best, a weak-to-moderate correlation was compatible with the data.

The lead author (JH) apologizes for his error. Both authors appreciate the opportunity to provide a correction here, and wish to acknowledge our third author, Dr. Ralph Boone, who recently passed away.

John Hart DC, MHSc
Assistant Director of Research
Sherman College of Chiropractic
P.O. Box 1452
Spartanburg, SC 29304
Phone: 864-578-8770, ext. 232
Email: jhart@sherman.edu

Bernard Omolo PhD
Associate Professor
Division of Mathematics and Computer Science
University of South Carolina Upstate
Hodge Center 239
800 University Way
Spartanburg, SC 29303
Phone: (864) 503-5362
Fax: (864) 503-5930
Email: bomolo@uscupstate.edu

Reference

1 Hart J, Omolo B, Boone R. Thermal patterns and health perception. JCCA. 2007; 51(2):106–111.