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Spinal manipulative therapy and its role in the prevention, treatment and management of chronic pain

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CCRF Professorship in Spine Mechanics and Human Neurophysiology
College of Biological Sciences
University of Guelph

Chronic pain is a worldwide epidemic. It is characterized as "pain that persists beyond normal tissue healing time"[1] and is physiologically distinct from acute nociceptive pain. The current research estimates the prevalence of chronic pain in the general population to be anywhere from 10–55%,[2] predominantly affecting the adult population. Studies indicate that the prevalence of chronic pain in the over-60 age group is double that for younger adults.[3] Furthermore, over 80% of elderly (over 65) adults suffer from some form of painful chronic joint disease[4] and greater than 85% of the general population will experience some form of chronic myofascial pain during their lifetime.[5]

Chronic pain has substantial impact on sufferers, often citing significant impairments in physical, social and psychological function.[6] Many patients suffer from progressive health and physical deterioration owing to sleep and appetite disturbances, anxiety, depression, decreased physical energy and activity as well as excessive use of medication.[6] Chronic pain often leads to social withdrawal, impaired personal relationships and job loss.[1] Recent estimates suggest that 50–85% of adults report some degree of pain that may interfere with daily activities and quality of life.[7]

Chronic pain sufferers are five times more likely to utilize health care services than non-pain sufferers.[8] Conservative figures estimate that the annual cost of managing chronic pain in the United States currently exceeds $40 billion annually.[9] Of greatest concern is the fact that the ratio of the over-65:under-65 segments of the population is projected to double by 2050,[10] promising to make chronic pain one of healthcare's foremost challenges in the future.

Aging population

Age-related changes in the nervous system present unique challenges to the treatment and management of chronic pain in the aging population. In general, the body of research currently suggests that pain thresholds increase[11]

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and pain tolerance decreases[12] with advancing age; however, the specific qualities of these differences are dependent upon the nature of the noxious stimulus (thermal, mechanical) as well as the stimulus duration, size and location.[13] In addition, endogenous descending inhibitory mechanisms, which evoke profound inhibitory influence on the excitability of dorsal horn neurons, have also been shown to decline with age.[14,15] These age-related changes contribute to the susceptibility of older adults to central sensitization[13] and ultimately chronic pain.

Central sensitization is a neuradaptive response characterized by an increased responsiveness to input stimuli of neurons within the central nervous system. This heightened input-response profile manifests in the form of decreased pain thresholds and increased pain intensity and duration.[16] The phenomenon of central sensitization has been linked to the pathophysiology of widespread chronic clinical pain syndromes[17] such as myofascial pain[18] and fibromyalgia.[19] For this reason, the therapeutic management of central sensitization is of primary importance to the effective treatment and management of chronic pain.

According to the Neurogenic Hypothesis,[20] chronic myofascial pain is not a primary musculoskeletal condition; it is a neurogenic manifestation of central sensitization which arises from a remote primary pathologic focus(either somatic or visceral) originating within the common neuromeric field (neurologic segment) of the involved muscle(s). In other words, chronic myofascial pain is the clinical expression of localized or widespread pain resulting from a state of sensitization within the central nervous system that is caused by a distinct and remote source of persistent peripheral nociception, and not by localized pathology within the symptomatic muscle. The incidence of both chronic myofascial pain and degenerative joint or spinal disease correlate closely with age;[21] accordingly, we hypothesize that degeneration of the spine and joints may be the primary pathophysiologic mechanism responsible for the clinical manifestation and maintenance of chronic pain in the adult population.

The role of Spinal Manipulation

Spinal manipulative therapy may play an important role in the conservative prevention, treatment and management of chronic pain via two primary mechanisms. Firstly, we hypothesize that spinal manipulation evokes systematic physiologic and therapeutic effects by fundamentally modulating the neuradaptive phenomenon of central sensitization. Unpublished work by Srbely et al.[22] demonstrates robust segmental antinociceptive effects in myofascial trigger points of humans post-manipulation. Given that the pathophysiology of trigger points has been linked to central sensitization,[18] these observations led the authors to postulate that the physiologic mechanism of spinal manipulation is based on the principle of modulation of central sensitization within the manipulated segment(s).[20]

The prevention of degenerative disorders of the spine and joints may be the most important consideration in the continuing battle against chronic pain. Biomechanical joint dysfunction has been identified as one of the primary determinants of degenerative spine and joint disease.[23] Spinal manipulation optimizes joint mechanics[24] making it an important component of a lifelong preventive strategy to reduce the progression of chronic degenerative joint disease and, ultimately, mitigate the impact of chronic pain.

Conclusion

Chronic pain promises to be one of the foremost challenges to our health delivery system in the future. The accumulating body of research demonstrates that chiropractic medicine may have an important role to play in the conservative and cost-effective management of chronic pain. In this capacity, future research initiatives must aim to elucidate the preventive impact of spinal manipulation on the pathophysiology of degenerative conditions in the spine and joints. Additionally, further studies are needed to better characterize and quantify the precise physiologic impact of spinal manipulation on central sensitization. Elucidating these mechanisms will provide insight into the important role of spinal manipulation in the conservative treatment of chronic pain as well as providing a viable and cost-effective therapeutic alternative to the long term preventive management of this prevalent and costly disorder.

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The CCRF Board is delighted to announce the recent appointments of Dr. Brynne Stainsby BA, DC and Dr. Ryan Larson BSc, DC to the Research Foundation

Dr. Brynne Stainsby BA, DC
Markham, Ontario

Dr. Brynne Stainsby has been appointed as Development and Communications Officer to the Research Foundation.

Dr. Brynne Stainsby graduated from The University of Western Ontario with a degree in Kinesiology before attending the Canadian Memorial Chiropractic College. After graduating as a Doctor of Chiropractic in 2009, she was accepted into the Clinical Sciences Residency program at CMCC. Dr. Stainsby's research has focused on locus of control in patients with Huntington disease, and she is currently completing a literature synthesis regarding the prognostic validity of functional capacity evaluations. Currently, Dr. Stainsby is practicing in Markham, Ontario and continues teaching as a faculty member at CMCC.

E-mail: brynnestainsby@gmail.com

Congratulations to Dr. Stainsby!

Dr. Ryan Larson BSc, DC
Elmira, Ontario

Dr. Ryan S. Larson has been appointed as Assistant Secretary to the Research Foundation.

Dr. Larson graduated from the University College of the Fraser Valley and Simon Fraser University in 2003 with a Bachelor degree in Molecular and Biological Sciences. He continued his studies at the Canadian Memorial Chiropractic College graduating in 2007. He was the first intern to participate in a chiropractic internship at St. Michael's Hospital in Toronto. His continuing education interests are in clinical research, health policy and manual skill development. Clinically, Dr. Larson uses a combination of joint manipulations, muscle release therapies, stretching, spinal rehabilitation and nutrition recommendations in his approach to patient care.

E-mail: dr.ryanlarson.dc@gmail.com

Congratulations to Dr. Larson!

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Use of post-isometric relaxation in the chiropractic management of a 55-year-old man with cervical radiculopathy

Peter Emary, BSc, DC*

This case report chronicles the successful management of a 55-year-old patient diagnosed with cervical radiculopathy using spinal manipulative therapy and cervical paraspinal post-isometric relaxation stretches. (JCCA 2012; 56(1):9–17)

KEY WORDS: cervical radiculopathy, post-isometric relaxation, proprioceptive neuromuscular facilitation, chiropractic.

Le présent exposé de cas suit la gestion réussie d'un patient de 55 ans chez qui l'on a diagnostiqué une radiculopathie cervicale au moyen d'une thérapie manipulative et d'étirements de relaxation postisométrique des muscles cervicaux paraspinaux. (JCCA 2012; 56(1):9–17)

MOTS CLÉS : Radiculopathie cervicale, relaxation postisométrique, facilitation neuromusculaire proprioceptive, chiropratique

Introduction

Cervical radiculopathy (CR) is an impingement or inflammatory irritation of the cervical spine nerve root(s), resulting in pain (or numbness) radiating along nerves of the upper extremity;[1,2] the C6 and C7 levels are most often affected.[1,3] Limited research is available on the incidence and prevalence of CR; however, the incidence rate (in Rochester, Minnesota) has been reported at 83.2 cases per 100,000 people per year (107.3/100,000 for males vs. 63.5/100,000 for females), with peak incidence in those aged 50–54 years.[1] A history of physical exertion or major trauma precedes the onset of symptoms in less than 15% of cases. The most common causes are cervical spondylosis and intervertebral disc herniation,[1,3] accounting for approximately 70% and 20% of cases, respectively.[1] In the former, posterior vertebral body osteophytes and/or facet joint/ligamentum flavum hypertrophy encroach upon the intervertebral foramen; posterolateral herniation of disc material results in foraminal encroachment in the latter. In either case, cervical nerve root pain and dysfunction can occur.[4]

Post-isometric relaxation (PIR) is a technique often used by manual therapists (including some chiropractors) for treating muscle tension and joint dysfunction in myofascial pain syndromes;[5] however, studies investigating its effectiveness in the treatment of CR are extremely scarce. This case report chronicles the successful management of a 55-year-old patient diagnosed with CR using spinal manipulative therapy (SMT) and cervical paraspinal PIR stretches.

Case Report

History

A 55-year-old white male presented with severe and progressive right-sided neck, shoulder blade, and arm pain. He woke up (a week earlier) with pain after spending the day at home installing ceiling tiles. His arm pain was now described as a constant "burning" sensation, wrapping around through his right triceps muscle to the lateral forearm. The pain severity was graded as a 9 on a numeric rating scale of 10. The patient's symptoms also included

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Table 1 *Select orthopedic exam procedures for cervical radiculopathy*

Test	Description of procedure	Positive findings
Spurling	Patient seated with their neck extended and rotated to the ipsilateral side, and doctor applies a downward pressure through the top of the patient's head	Radicular symptoms are provoked
Upper Limb Tension	Patient supine and doctor performs the following movements to the patient's upper extremity: 1. scapular depression 2. shoulder abduction 3. forearm supination, wrist and finger extension 4. shoulder external rotation 5. elbow extension 6. ipsilateral/contralateral rotation of the neck	Radicular symptoms are provoked
Cervical Distraction	Patient seated and doctor grips under the patient's mastoids and tractions superiorly	Radicular symptoms are relieved
Valsalva	Patient seated and is asked to take and hold a deep breath while bearing down (as if for a bowel movement)	Radicular symptoms are provoked

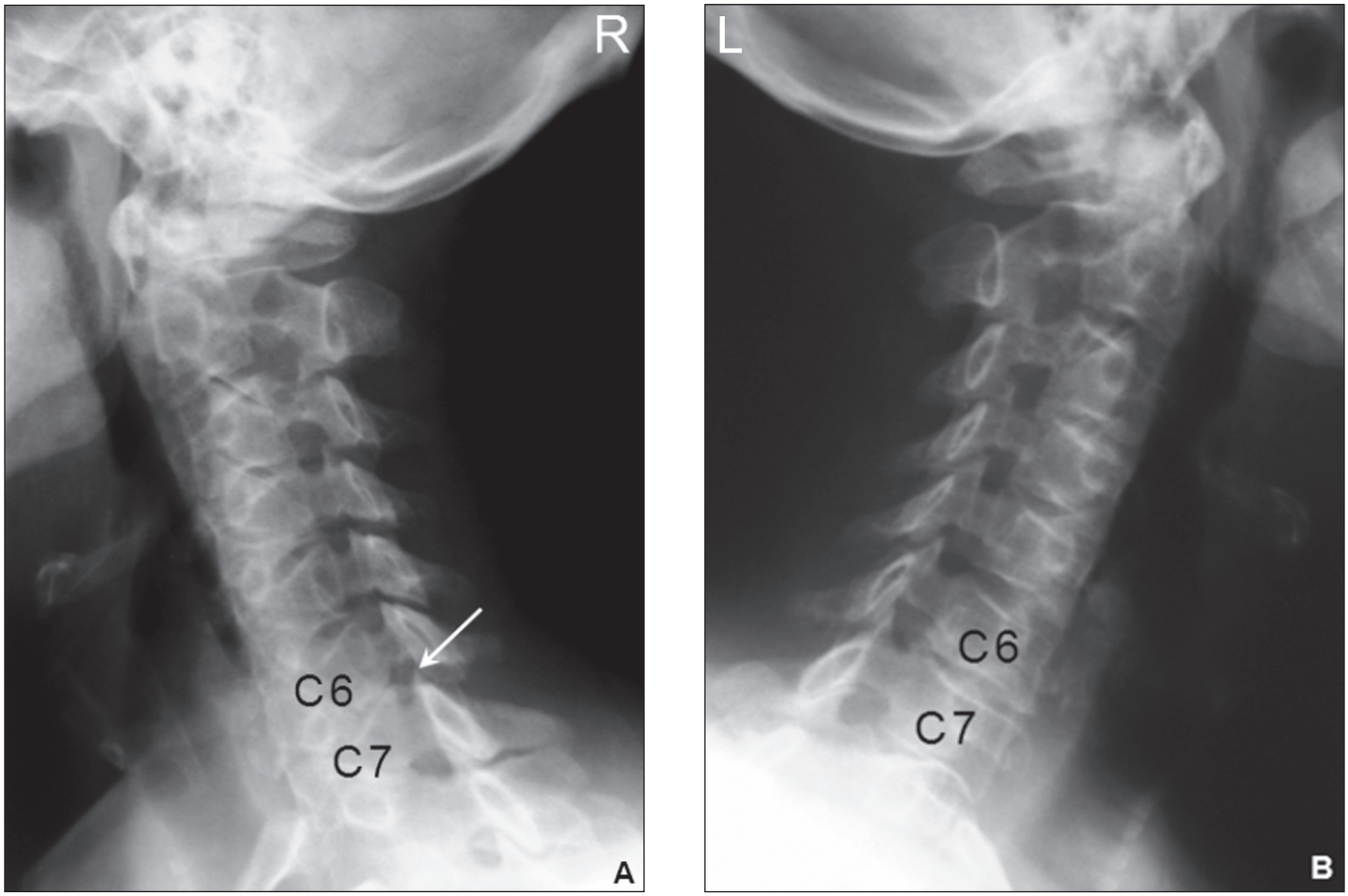
generalized weakness and "numbness" in his right hand. Any attempt to lift or reach would shoot a "stabbing" pain down his right arm. Holding the arm (bent at 90°) close to his body was palliative. Coughing, sneezing, or bearing down for a bowel movement (i.e. Dejerine's Triad) did not reproduce the neck, shoulder blade, or right arm pain. The patient also denied any lower extremity or myelopathy symptoms, and exhibited normal gait. Medically prescribed anti-inflammatories (Naprosyn), muscle relaxants (Robaxin), heat therapy, and time off work had not provided any relief.

Medical history was remarkable for coronary artery disease, including angioplasty surgery (4 years prior). Medications included Lipitor, Altace, Rhoxal-bisoprolol, and Aspirin. The patient denied any motor vehicle accidents, major falls or injuries, and had no previous history of neck problems. He had seen a chiropractor once before because of lower back pain, with good results. He was married with 3 children and had been employed as a shipper/receiver for the past 7 years. He did not smoke and consumed an average of 7 alcoholic beverages per week. He also walked a total of 2 hours per week for exercise and took a daily multivitamin.

Examination Findings

Blood pressure was normal at 104/68. Postural exam revealed severe antalgia, with the patient holding his head forward and tilted to the left. Motion palpation of his spine revealed joint restriction at C2-3 and C3-4 in left rotation, and T5-6 and T6-7 in extension. Static palpation revealed myofascial trigger points within the right rhomboid muscles, along with hypertonicity of the right paraspinals and localized tenderness of the right C2-3 and C3-4 facet joints. Cervical spine range of motion (ROM) was very painful (with parasthesia) and 90% restricted in extension, 75% in right rotation, and 90% in right lateral flexion. Passive flexion of the patient's neck produced some cervical facet pain on the right, without signs of myelopathy. The Spurling and Upper Limb Tension Tests provoked the patient's right-sided radicular pain, while the Cervical Distraction Test relieved it (see Table 1 for orthopedic test descriptions). Depression of the right shoulder while holding the neck in flexion and left rotation (i.e. Shoulder Depression Test) also provided relief. Upper extremity neurologic examination was unremarkable for motor, reflex, sensory, and vibratory testing, except for weakness of the right deltoid muscle (graded as

Figure 1 *Anterior oblique radiographs of the cervical spine showing (A) mild-to-moderate bony foraminal narrowing at C6-7 on the right (arrow), with mild narrowing at this same level on the left (B).*



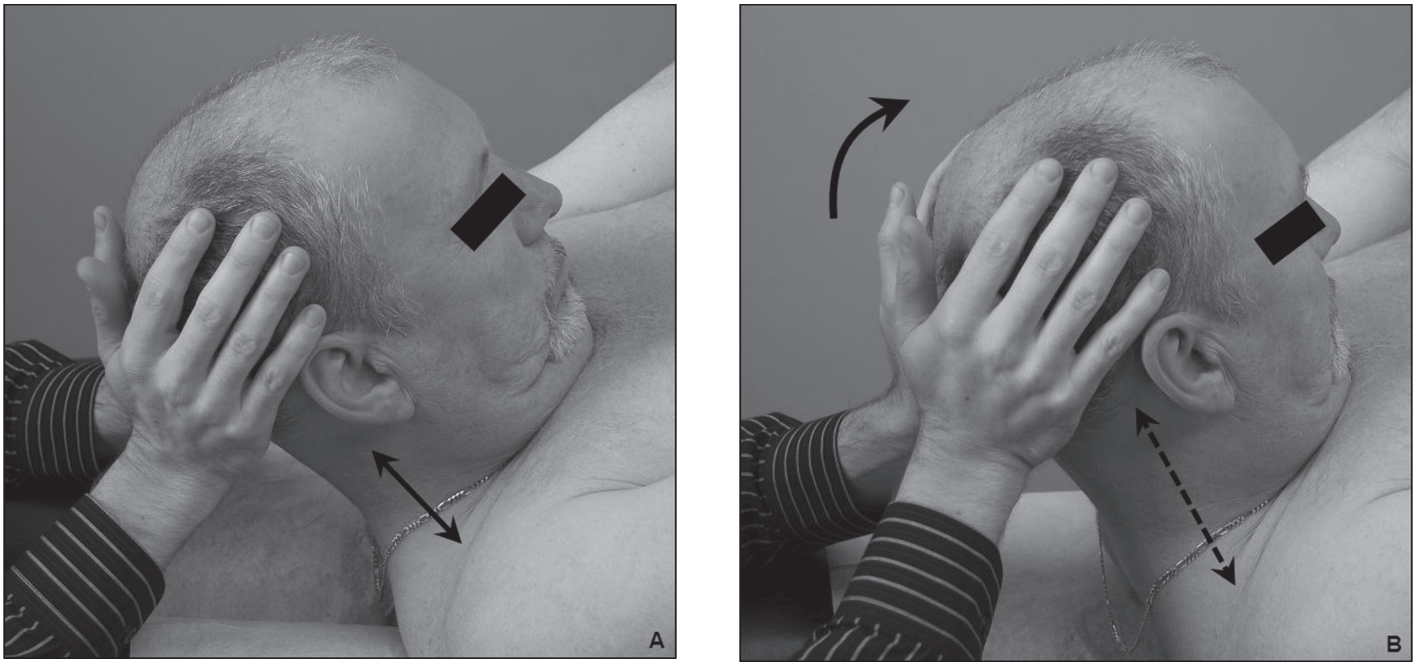
4/5), because of right-sided neck and radicular pain. Cervical spine radiographs revealed moderate degenerative disc disease at C6-7, with mild-to-moderate bony foraminal narrowing at this level on the right (Figure 1A) and mild narrowing on the left (Figure 1B). The patient was diagnosed with acute, right-sided C7 radiculopathy.

Plan of Management & Results

The patient underwent a course of chiropractic treatment consisting of supine cervical and thoracic SMT, soft-tissue trigger-point therapy to the right rhomboid muscles, home ice therapy (as needed), cervical spine isometric exercises, and ergonomic instruction (i.e. avoidance of provocative neck positions). To manipulate the right side of the patient's neck (i.e. side of radiculopathy), the patient's head was rotated 90° to the left and then a right lateral flexion "modified rotary break" procedure was used.[6] A supine rotary break (with 45° of right rotation and left lateral flexion) was used on the other side. The initial treatment frequency was 3 times per week for 2 weeks. Outcome measures used were numeric rating scale for pain; subjective changes in neck, shoulder blade, and arm pain; and patient self-rating of outcome (i.e. no, minor, or major improvement). Objective measures used were visual estimation for ROM, as well as orthopedic and neurological examination.

After 2 weeks of treatment, the patient's neck and shoulder blade pain had improved; each was reduced to

Figure 2 *Cervical paraspinal PIR is performed (in this case) with the patient supine, while the doctor slowly lifts the patient's head toward the ceiling (A). Once a comfortable stretch is felt, the patient is asked to push their head back (with approximately 10% of their strength), while the doctor resists this movement; thus, creating an isometric contraction. This position is held for 8–10 seconds. The patient is then asked to inhale deeply and, upon exhalation, is instructed to relax while the doctor lifts the patient's head a little further towards the ceiling (B). After an 8–10 second stretch, the protocol is repeated (to patient and tissue tolerance) for 2 to 3 more repetitions.*



between a 3 (at best) and 5 (at worst) out of 10. The right arm pain, however, remained unchanged. Cervical spine ROM was still painful and 75% restricted in right lateral flexion. Upper extremity neurological exam was normal, and the result of the Upper Limb Tension Test was negative. The Spurling Test was still positive, however, and passive flexion still elicited right-sided facet pain in the neck. At this point, the patient's self-rated improvement was "minor." Because of unresolved radicular symptoms, the author decided to include a cervical paraspinal PIR technique with patient treatment (Figure 2). On the next visit, during the application of this technique, the patient experienced immediate, short-term relief of his right arm symptoms. Based on this result, the patient was also instructed to begin performing cervical paraspinal stretches at home (Figure 3). Using this new protocol, the patient continued to be treated at a frequency of 2 times per week for 3 more weeks.

After 6 weeks and a total of 12 treatments (including 6 with PIR), the right-sided neck, shoulder blade, and arm pain were all reduced to between 1 (at best) and 3 (at worst) out of 10. Cervical ROM was within normal limits and unremarkable, except for right-sided neck and shoulder blade pain during passive right lateral flexion. Neurologic and orthopedic examinations, including the result of the Spurling Test, were normal. The patient's self-rated improvement at this point was "major." When asked to subjectively rate his overall percentage improvement on a scale of 0 (no improvement) to 100 (full improvement), he rated it at 75%. Regarding his activities of daily living, the patient's neck and arm pain were still provoked with prolonged sitting at work (at a computer) or when sleeping on his right side at home.

Based on the patient's overall improvement, the treatment frequency progressively decreased to once every 4 weeks. He was also encouraged to continue performing

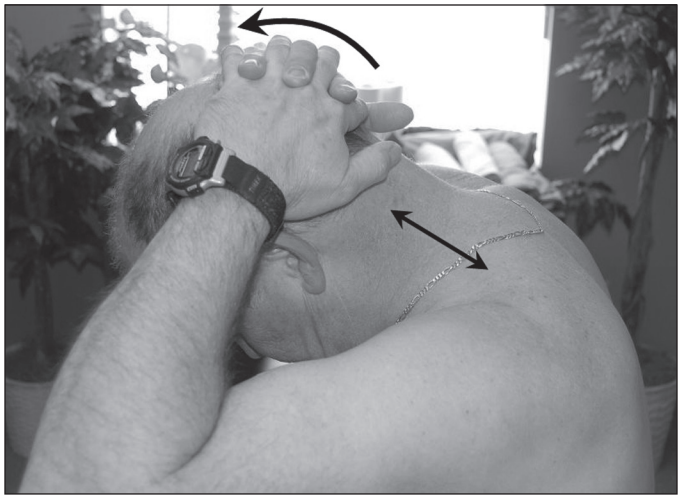


Figure 3 *Cervical paraspinal stretch (held for 15 seconds); 2 repetitions, 1 to 2 sets per day.*

his neck stretches on a regular basis (i.e. 1 to 2 times per day). Although the patient's symptoms had improved, his complaint of recurrent re-aggravation prompted a referral to his family physician for cervical spine magnetic resonance imaging (MRI) and needle electromyography (EMG) studies. MRI examination, performed 4 months after the onset of symptoms, showed dehydration and intervertebral disc bulging at multiple levels, most notably at C6-7; prominent stenosis of the right lateral canal was also evident at this same level (Figure 4).

Electrophysiological studies—including motor and sensory nerve conduction velocity of the radial, ulnar, and median nerves and EMG of the right deltoid, biceps, triceps, and extensor digitorum complex—were interpreted as normal. The attending neurologist did, however, report that the patient's history was "consistent with right C7 radiculopathy." He also noted that the patient's symptoms had "improved considerably [,] with residual cervical and right shoulder blade pain." Neurological examination was normal for cranial nerve, motor, sensory, reflex, coordination, and gait testing, with the exception of "mild weakness of the right tricep[s]." The neurologist told the patient that he had "no permanent damage" and that surgery was not indicated. The patient continued with chiropractic care and, at 6-month follow-up (after a total of 20 treatments, including 14 with PIR), the right-sided neck and radicular pain was completely resolved (graded as 0 out of 10). Cervical spine ROM and upper extremity neurological exam were normal.

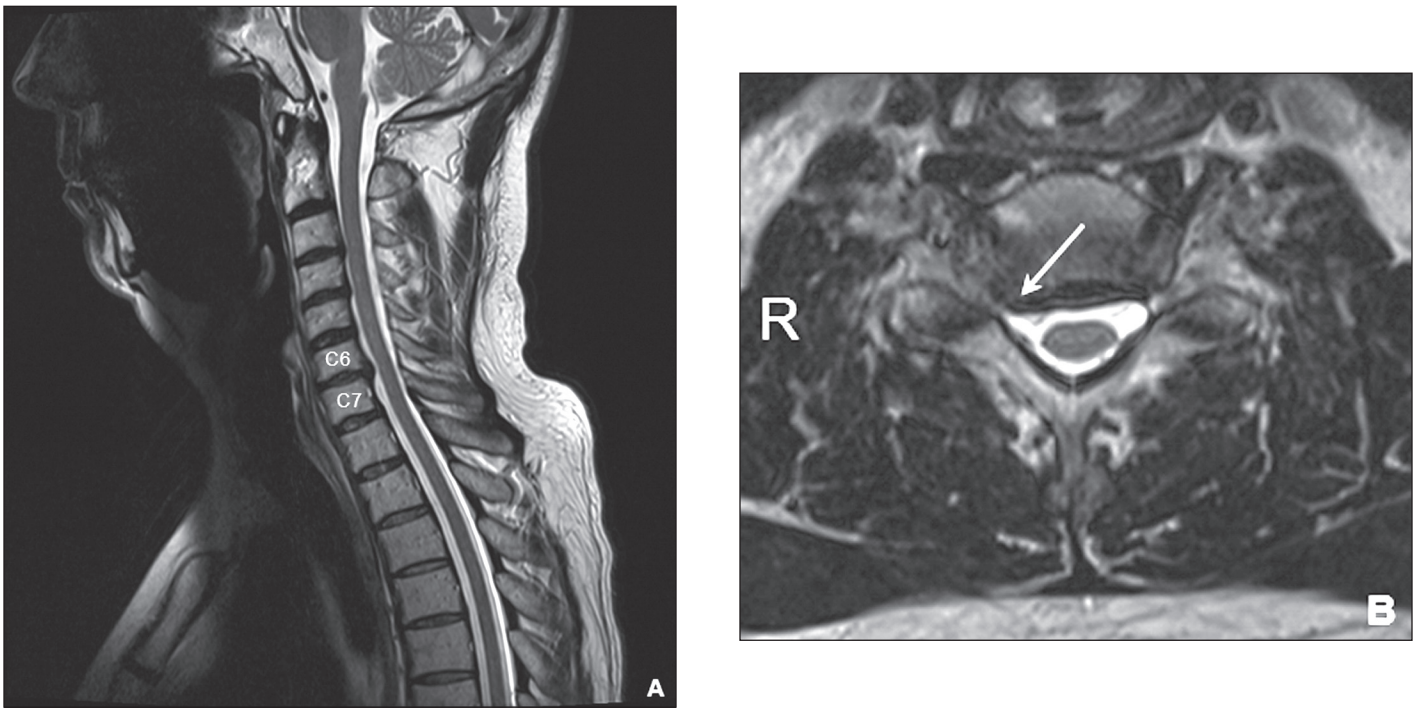
After 3 years, the patient's radicular symptoms continue to be graded as 0 out of 10, and he reports no limitations in his activities of daily living. Cervical spine ROM and upper extremity neurological examination remain normal. Only 2 minor episodes of neck pain (i.e. *without* radiculopathy and graded as 3 out of 10) have been reported during this time. Both were attributed to postural strain from sitting at a computer at work. The first episode was self-resolving, while the second was relieved with 1 treatment of manipulation and PIR. In addition, the patient continues to report that he has not used any prescription or over-the-counter medications during the entire course of treatment. The patient has given written consent to having his personal health information, including radiographs and photographs of his likeness, published.

Discussion

Examination of patients presenting with CR should include assessment of motor strength, deep tendon reflexes, and dermatomal sensation. In the absence of frank neurologic findings, more sensitive (or provocative) exam procedures may be required. In a recent systematic review, Rubinstein et al.[7] concluded that when consistent with history and physical examination findings, the Spurling, Neck Distraction, and Valsalva Tests (given their high specificity), along with the Upper Limb Tension Test (given its high sensitivity) are most useful in establishing a diagnosis of CR, especially in patients without neurological deficits. The scientific literature also supports the use of modern imaging techniques (e.g. MRI) and needle EMG, in diagnosing the cause and site of CR.[8] Advanced diagnostic testing can be expensive, however, and in the case of needle EMG, invasive.[7] In addition, MRI findings of disc herniation may not necessarily correlate with patient symptoms.[9] For the chiropractor, proper patient history and physical examination are the most cost-effective and non-invasive methods for diagnosing CR.

In patients with cervical spondylosis, as in the current case, the possibility of spinal cord compression (myelopathy) should be considered. Clinical findings may include abnormal gait, clumsiness, bowel or bladder dysfunction, or other upper motor neuron signs (e.g. hyperreflexia, muscle spasticity, Babinski's sign).[2,3] The chiropractor's differential diagnosis of CR should also include myofa-

Figure 4 *(A) T2-weighted sagittal MRI of the patient's cervical spine showing moderate intervertebral disc desiccation and protrusion at C6-7. Mild degenerative changes are also evident from C2 to C5, with mild disc protrusion at C3-4 and C4-5. (B) T2-weighted coronal MRI showing lateral canal stenosis and intervertebral foraminal encroachment at C6-7 on the right (arrow).*



scial trigger-point referral, peripheral nerve entrapment syndromes (e.g. thoracic outlet, carpal and/or cubital tunnel), and rotator cuff pathology. In the current case, radiculopathy was suspected over peripheral neuropathy because, in addition to patient history and diagnostic imaging findings, the patient had positive Spurling, Upper Limb Tension, and Cervical Distraction Tests, as well as limited ipsilateral neck rotation. Wainner et al.[10] found that when these 4 tests are positive, they together identify (with 90% probability) the presence of CR. Less common causes include referred cardiac pain, herpes zoster (shingles), and intra- or extraspinal tumours (e.g. Schwannomas, Pancoast tumours, lymphomas).[2,3]

Traditional medical management may include nonsteroidal anti-inflammatories, activity modification, traction (or other physical therapy modalities), epidural steroid injections, and/or surgery (if necessary).[1–3] Several chiropractic studies have described good outcomes in patients treated with SMT—either alone or in combination with other conservative therapies.[4,11–15] In their case series, Hubka et al.[13] also discuss the importance of the direction of thrust when treating CR patients using SMT procedures. In particular, these authors note that neck manipulation is best tolerated by the patient when performed by contacting on the side of radiculopathy, laterally flexing the neck toward the side of radiculopathy, and then rotating the neck away from the side of radiculopathy (followed by a gentle manipulative thrust). This is similar to the technique used in the current case. In their experience, Hubka et al. have found that manipulation in the opposite direction may provoke the patient's symptoms, as might prone upper thoracic SMT.[13] In the current case, supine upper thoracic and bilateral cervical manipulations were used, with no adverse effects. In their discussion on the safety of neck manipulation, Murphy et al.[4] conclude that, "when applied by properly trained and experienced

practitioners, [cervical SMT] is potentially a safe option for patients with CR." Nevertheless, the evidence base for both conservative and surgical management of CR, including data on its natural history, is limited.[4,16,17]

PIR Technique

The primary purpose of this article was to showcase a PIR technique that, when combined with SMT, may be useful to chiropractors in treating patients with CR. Historically, PIR has been used as a "muscle energy procedure" for joint mobilization and muscle relaxation.[5] The technique begins by placing the muscle (to be treated) in a stretched position. Lewit[5] describes this as "taking up the slack" in the muscle, by lengthening it, to the point where the first slight resistance (or "barrier") is felt. Next, the patient is instructed to resist this movement with minimum force, isometrically, for about 10 seconds, and then told to let go (or relax). Lewit stresses the importance of waiting until the patient has indeed relaxed, after which a gentle release is obtained and the muscle lengthens by "spontaneous decontraction" (relaxation). Release may continue for 10 seconds or more, until a new barrier is reached, from which point the procedure can be repeated. If nothing is gained by repetition, the normal physiologic barrier has been reached. In order to improve the patient's cooperation and enhance the effectiveness of PIR, the technique should be combined with other methods of facilitation and inhibition (e.g. patient inhalation and exhalation).[5] In general, inhalation facilitates muscle activity and is therefore useful during the isometric phase, while exhalation promotes inhibition and therefore helps relaxation. The overall goal of PIR treatment is to reduce muscle tension and relieve the resultant pain and dysfunction by restoring the full stretch length of the muscle.

The terms *PIR* and *proprioceptive neuromuscular facilitation (PNF)* are sometimes incorrectly used synonymously. The main difference with the PNF technique is that during the isometric contraction phase, the patient exerts against a much greater resistance (i.e. up to 100% of their maximum strength).[18] Furthermore, during the relaxation phase, the patient's muscle(s) is more aggressively stretched and the clinician does not necessarily wait to feel the patient's muscle release. Therefore, practitioners should be cautioned when using PNF as it may result in considerable discomfort to the patient, particularly in an acute pain presentation.

PIR and CR

A paucity of research exists on the effectiveness of PIR for neck pain and/or CR; therefore, it is difficult to compare this study with others in the scientific literature. Some authors have compared PIR with SMT in treating neck pain patients (*without* radiculopathy).[19–20] For instance, Cassidy et al.[19] found that 1 treatment of cervical SMT was more effective than mobilization (PIR) in decreasing neck pain intensity, while both treatments increased neck ROM to a similar degree. In a search of PubMed and Index to Chiropractic Literature, no studies were found combining the terms "cervical radiculopathy" and "post-isometric relaxation." In a hand search of references retrieved using combinations of the terms "cervical spine," "radiculopathy," and "chiropractic," the author found only 2 case reports relating PIR and CR.[14,15] In the first case by Daub,[14] he described the resolution of a C6 radiculopathy in a 44-year-old female following 18 treatments (over 7 weeks). Treatment consisted of cervical and thoracic SMT; PIR applied to the levator scapulae, anterior scalene, and suboccipital muscles; manual long axis traction of the cervical spine; and home-based exercises. After 1-year follow-up, any mild flare-ups of the patient's CR symptoms were quickly resolved using the same aforementioned therapies. Whalen's case[15] was a 40-year-old female with CR caused by spondylosis and disc protrusion at C5-6 and C6-7. Resolution of the problem occurred within 3 months (including 20 treatments) and remained after a year. Treatment consisted of cervical SMT, along with home-based cervical traction and stretching exercises—including instruction on stretching the upper trapezius muscles using PIR. Whalen did not, however, use PIR to treat the patient directly; nor was it discussed as playing a major role in the patient's recovery.

In the current case, the patient noted almost immediate relief of radicular symptoms with the application of PIR. PIR has been shown to reduce pain and improve joint function and ROM in the neck.[19,21] In addition to relaxing the paraspinal musculature and mobilizing the facet joints, the technique used in this study incorporated traction (see Figure 2), which altogether may have alleviated compression on the neural structures in the patient's neck. Other studies have demonstrated good results in CR patients when treated with cervical traction or other traction-type techniques (e.g. flexion-distraction).[22,23] MRI and computed tomography scans have also shown that

both flexion and traction significantly increase the size of the intervertebral foramen in the cervical spine.[24,25]

Practitioners should be cautioned when using the PIR technique described in this study—especially in patients presenting with acute cervical disc herniation and/or myelopathy. In cases of cervical myelopathy, this technique is contraindicated—particularly if, on physical examination, flexion of the patient's neck produces parasthesias and/or electric shock-like sensations that extend down the spine into the lower extremities (i.e. L'Hermitte's sign). In the current case, care was taken not to cause peripheralization of the patient's symptoms. All treatments (including both PIR and SMT procedures) were well tolerated by the patient with no reports of complications.

Limitations

Although remaining somewhat unclear, the natural course of CR is considered favourable;[1–3] therefore, this patient's positive outcome may not have resulted from the treatment(s) delivered. Furthermore, conclusions based on a single, retrospective case study are inherently limited. In light of the paucity of research on its use in the management of neck pain (with *or* without radiculopathy), more studies are needed to determine whether PIR (alone or in combination with SMT) is a safe and effective treatment for patients with CR. Future studies should include rigorous outcome measures for disability (e.g. Neck Disability Index, Bournemouth Neck Disability Questionnaire), which were lacking in this case.

Summary

Presented here was a patient with acute C7 radiculopathy that, despite MRI findings of a C6-7 disc protrusion with right-sided lateral canal stenosis, resolved following a course of chiropractic treatment that included SMT and cervical paraspinal PIR. The patient's radiculopathy symptoms did not return in 3 years of follow-up.

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Cervical radiculopathy: a systematic review on treatment by spinal manipulation and measurement with the Neck Disability Index

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Cervical radiculopathy (CR), while less common than conditions with neck pain alone, can be a significant cause of neck pain and disability; thus the determination of adequate treatment options for patients is essential. Currently, inadequate scientific literature restricts specific conservative management recommendations for CR. Despite a paucity of evidence for high-velocity low-amplitude (HVLA) spinal manipulation in the treatment for CR, this strategy has been frequently labeled as contraindicated. Scientific support for appropriate outcome measures for CR is equally deficient. While more scientific data is needed to draw firm conclusions, the present review suggests that spinal manipulation may be cautiously considered as a therapeutic option for patients suffering from CR. With respect to outcome measures, the Neck Disability Index appears well-suited for spinal manipulative treatment of CR.
(JCCA 2012; 56(1):18–28)

KEY WORDS: Cervical radiculopathy, spinal manipulation, chiropractic, high-velocity low-amplitude manipulation, Neck Disability Index.

La radiculopathie cervicale (RC), bien que moins courante que les cervicalgies seules, peut être une source considérable de douleur au cou et d'incapacité. Ainsi, il est essentiel d'établir des options de traitements adéquates pour les patients. À l'heure actuelle, l'insuffisance des recherches scientifiques limite les traitements conservateurs propres à la RC pouvant être recommandés. En dépit du manque de preuves soutenant l'emploi de la manipulation vertébrale à grande vitesse et faible amplitude pour le traitement de la RC, il s'agit d'une stratégie fréquemment considérée comme contre-indiquée. Il existe également un manque en ce qui concerne l'appui de la communauté scientifique envers la mise au point de méthodes servant à mesurer de manière appropriée les résultats. Bien qu'il soit nécessaire d'obtenir plus de données scientifiques pour tirer des conclusions solides, la présente étude suggère que la manipulation vertébrale peut être considérée, en toute prudence, comme une option de traitement pour les patients souffrant de RC. Pour ce qui est de la mesure des résultats, l'index d'incapacité cervicale (Neck disability index – NDI) semble convenir au traitement de la RC par manipulation vertébrale.
(JCCA 2012; 56(1):18–28)

MOTS CLÉS : Radiculopathie cervicale, manipulation vertébrale, chiropratique, manipulation à grande vitesse et faible amplitude, index d'incapacité cervicale

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Introduction

Cervical radiculopathy (CR) can be a significant cause of neck pain and disability. The reported annual incidence of CR is 83.2/100,000 persons[1], while the reported prevalence is 3.5/1000 persons.[2] Gender preference varies.[2,3] Individuals are most commonly affected in the 5th and 6th decades of life.[1,4] Physical exertion or trauma at onset is rare, involving less than 15%.[1] Causal relationship to an automobile accident ranges from 3–23%.[1,4]

Patients presenting with CR most frequently complain of neck pain, paresthesia and radicular pain.[1] While sensory symptoms typically present along a dermatome, pain is often myotomal.[5] When present, dermatomal pain patterns are more frequent at the C4 level (60%) as compared to the C7 (34.2% of cases) and C6 levels (35% of cases).[3] Scapular pain is found in 51.6% of cases.[3] Physical examination typically reveals painful cervical spine range of motion (ROM) and decreased deep tendon reflexes.[1] Upper limb weakness involves only 15% of cases.[1] Decreased sensation is found in 1/3 of cases; however, muscle atrophy presents in less than 2% of cases.[1] Level of involvement is most typically the C7 (39.3%–46.3%) and C6 (17.6%–42.6%) nerve roots.[1,3] Bilateral involvement is reported in 5–36% of cases.[1,4]

The intervertebral disc has be found to be causative in only 22% of cases, while 68% of cases appear to arise from a combination of discogenic and spondylotic causes.[1]

With respect to therapy, the Task Force on Neck Pain and Its Associated Disorders (TFNPAD) extensively reviewed the literature to make best-evidence recommendations on the management of neck pain disorders. The review found insufficient evidence to draw firm conclusions or make appropriate treatment recommendations for CR, or identify contraindicated therapies.[6]

This begs the question as to the role of spinal manipulative therapy (SMT) for CR patients'. In fact, Saal et al, stated that "forceful joint manipulation was not used" in their protocol for CR,[7] while Haas et al stated that intervertebral disc herniation and CR are contraindications to manipulation.[8] Unfortunately, statements such as these are unsupported by both basic science evidence which justifies a plausible risk, and epidemiological evidence suggesting hazard or ineffectiveness.

Recently, the first systematic review of manipulative therapy for radiculopathy (including CR) was published. Leininger et al. concluded that evidence for manipulative therapy in CR is minimal, low in quality and presents a high risk of bias.[9] Despite this, 93% of surveyed chiropractors stated they would use SMT despite a suspected or confirmed cervical disc herniation.[10] Therefore, a more detailed review of the existing studies may prove clinically valuable.

A secondary issue concerns the most appropriate outcome measure for determining the effectiveness of SMT for CR? Given that the Neck Disability Index (NDI) is the most commonly used outcome measure of self-rated disability due to non-specific mechanical neck pain,[11] use in a specific cause of neck pain (such as CR) should be evaluated.

The purpose of this paper is to systematically search and descriptively present the evidence as it applies to general chiropractic practice. Therefore, the primary objective of this paper is to review the use of high-velocity low-amplitude (HVLA) SMT for CR, reflecting on chiropractic treatment practices. A secondary objective is to review the use of the NDI, designed for use in neck pain patients, in the management of patients with neck and arm pain.

Methods

Objective 1:

Search Strategy

A literature search sought English language manuscripts published before February 28, 2011.

The databases of MEDLINE, Alt-Healthwatch, AMED and CINAHL were searched, using the terms found in Table 1. The Index to Chiropractic Literature (ICL) was searched using the terms "cervical radiculopathy" and "manipulation" within "all fields" and limited to the peer reviewed literature.

Relevant manuscripts were hand-searched and content experts were contacted for feedback.

Inclusion Criteria

All published, peer-reviewed interventional studies involving more than ten subjects receiving cervical manipulation (defined as an HVLA procedure), delivered by a licensed healthcare professional, for the treatment of CR (confirmed via special imaging and/or clinical examination or described as neck and arm pain/paresthesia) were

Table 1 *Objective #1 Search Strategy*

Pathophysiological Terms
Cervical AND (radiculopathy, radiculitis, neuralgia, brachialgia, disc herniation)
Interventional Terms
Spinal manipulation, spinal manipulative therapy, SMT, high-velocity low-amplitude, manual therapy, conservative therapy, non-operative therapy, physical therapy, physiotherapy, chiropractic

eligible for inclusion. Studies which presented mixed groups of patients with/without arm pain were not eligible for inclusion.

Manuscripts were excluded if the designs reported data via case-by-case format; identified a mechanical cause of neck and arm pain; involved low-velocity low-amplitude (LVLA) procedures such as mobilizations, flexion-distraction procedures and intermittent cervical traction as the principal method of manipulation (LVLA procedures ancillary to HVLA-SMT were acceptable); thoracic manipulation was principally used; a traumatic mechanism of injury (such as a motor vehicle accident) was identified; or if treatment fell outside the general scope of chiropractic practice (such as manual therapy performed under anesthesia or in combination with injection therapy). This selection process was conducted by one reviewer only (RR).

Quality Reviewing and Data Analysis
Formal quality review and data pooling were not conducted. Retrieved manuscripts underwent qualitative analysis only.

Objective 2:

Search Strategy
The database PubMed was searched to May 2010 with the key words "neck disability index" and "arm pain." Retrieved manuscripts were hand-searched for additional citations.

Inclusion Criteria
Only articles investigating the psychometric properties of the NDI in the assessment of patients with neck and arm pain were included. This selection process was conducted by one reviewer only (HV).

Quality Reviewing and Data Analysis
Data were tabulated on sample characteristics and reliability or validity statistics.

Results

Objective 1:

The process of literature consolidation and search results is depicted in Figures 1 and 2. Hand searching revealed an additional four citations.[12–15] Contacting content experts provided no further results.

Some inclusions of Leininger et al.[9] were excluded from this paper. As Shin et al. was published as a "letter to the editor" and avoided peer-review, the study was excluded.[12] Moretti et al. was excluded due to "the treatment of benign cervicobrachialgia of mechanical origin."[13] Walker et al. was excluded given the mixed population of neck pain sufferers, with or without unilateral upper limb symptoms.[13]

Table 2 presents the final exclusions, as they are relevant to readers in this field.[7,14–32] Three manuscripts met the objective criteria.[3,13,33]

Study Descriptions
Howe et al.[13] used cervical SMT for the treatment of pain/stiffness in the neck with or without shoulder, arm or hand pain/paresthesia, attributed to a lesion of the cervical spine.[13]

Blinded, goniometric ROM measurement of cervical rotation and lateral flexion was assessed before subjects were randomized to either the control or treatment group. Blinded measurement was repeated for the treatment group post-manipulation and subsequent to randomization for the control group, as well as at 1 and 3 weeks following initial consult.[13]

Twenty-six subjects were randomized to each group, a treatment and a control group. Baseline characteristics were comparable, except that more subjects in the treatment group had experienced pain for longer than 4 weeks (6 subjects versus 0).[13]

Arm and hand pain/paresthesia was experienced by 9 controls and 12 members of the treatment group. While

Figure 1 *Objective #1 – EBSCO literature search results*

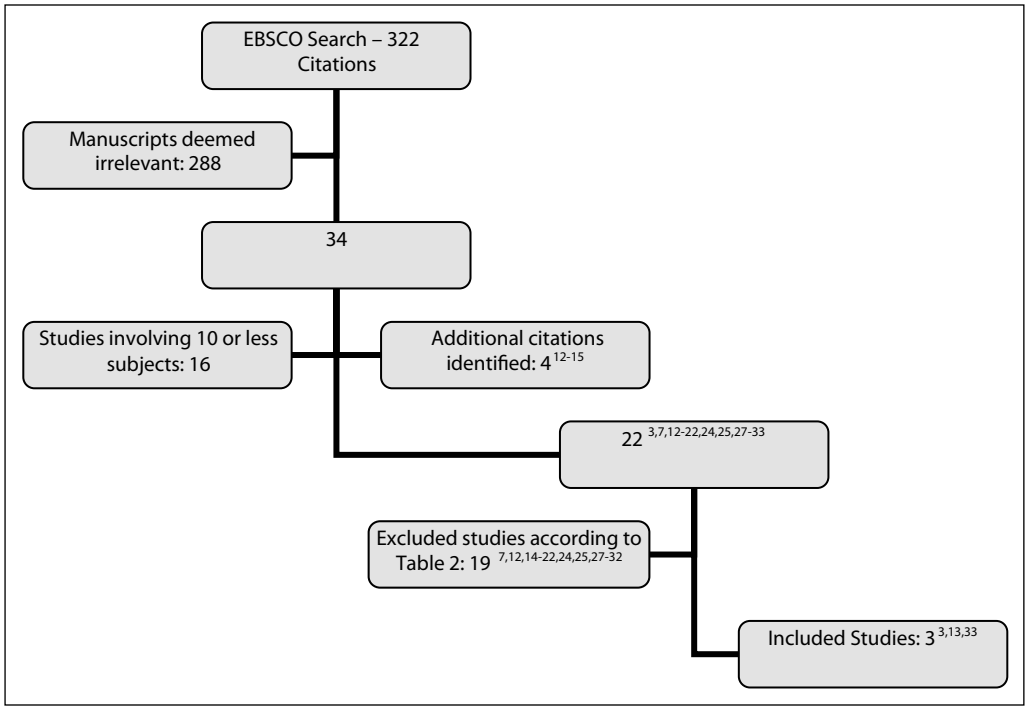

Figure 2 *Objective #1 – Index to Chiropractic Literature search results*

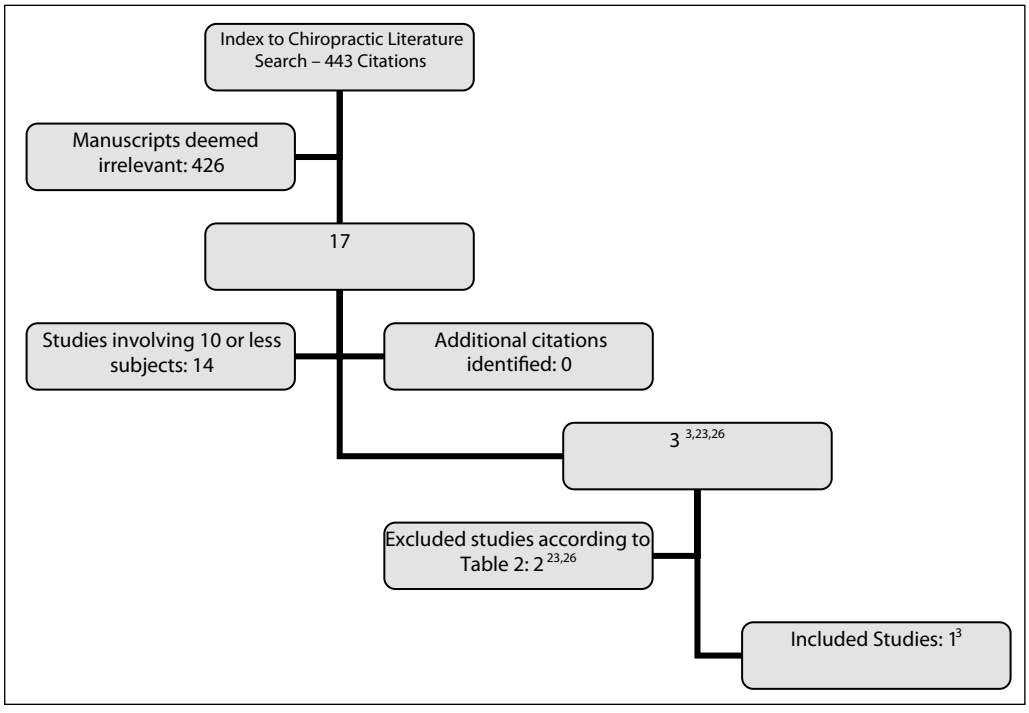

Table 2 *Excluded Studies*

Study	Study Design	Participants	Intervention	Reason for Exclusion
Saal & Saal[7]	Prospective case series	n = 26	Ice, rest, hard color for 2 wks, NSAIDS for 6-12 wks alongside 3 months of mechanical traction, home traction, exercise and postural education	No HVLA procedures were utilized in the cervical spine
Shin et al[12]	Randomized clinical trial	n = 26	Group 1: unspecified cervical traction Group 2: Chuna manipulative therapy (stated to be 'analogous to chiropractic manipulation')	Manuscript was not peer-reviewed
Moretti et al[14]	Randomized clinical trial	n = 80	Group 1: Manipulative therapy and traditional physiotherapy Group 2: traditional physiotherapy	Patient population suffered cervicobrachialgia of mechanical origin
Walker et al[15]	Randomized clinical trial	n = 98	Group 1: cervical joint thrust and non-thrust mobilization, muscle energy or stretching techniques and a standard home exercise program Group 2: postural advice, cervical ROM exercises, subtherapeutic ultrasound and encouragement to maintain daily activities.	No subgroup specifically identified with CR was listed.
Honet & Puri[16]	Prospective case series	n = 82	Group 1: Cervical collar for 4 days, then over-the-door continuous traction at home with standard medication Group 2: received outpatient care, intermittent cervical traction Group 3: hospitalization, horizontal cervical bed traction, standard medication and surgical consultation after 10-21 days	No HVLA procedures were utilized in the cervical spine
Rosomoff et al[17]	Case series of undefined perspective	n = 30	Aggressive physical medicine, behavioral medicine, vocational and recreational rehabilitation	No HVLA procedures were utilized in the cervical spine
Perrson et al[18]	Randomized clinical trial	n = 81	Group 1: surgical Group 2: 3 months with a hard collar Group 3: 3 months of physiotherapy	No HVLA procedures were utilized in the cervical spine
Sampath et al[19]	Prospective, multi-centre case series	n = 246	No clear plan was outlined. Interventions included narcotics, NSAID's, steroids, injections, bed rest, home exercise, cervical traction, bracing and surgery	No HVLA procedures were utilized in the cervical spine
Heckman et al[20]	Retrospective clinical trial	n = 119	Group 1: conservative therapy Group 2: surgery	No HVLA procedures were utilized in the cervical spine
Moetti & Marchetti[21]	Prospective case series	n = 15	Postural education, aerobic exercise, deep neck flexor strengthening and moist heat	No HVLA procedures were utilized in the cervical spine
Allison et al[22]	Randomized controlled trial	n = 30	Group 1: segmental lateral glide techniques, shoulder-girdle oscillation, muscle re-education and home mobilization Group 2: Glenohumeral mobilization, thoracic joint mobilization and home exercises Group 3: Control for 8 weeks, then allocated to Group 1 for cross-over protocol	No HVLA procedures were utilized in the cervical spine
Schliesser et al[23]	Retrospective case series	n = 39	Ultrasound, heat, ice and cervical spine flexion-distraction	No HVLA procedures were utilized in the cervical spine
Dougherty et al[24]	Retrospective case series	n = 80	HVLA procedures, flexion-distraction, stretching and stabilization exercises, NSAID's and pre-treatment lidocaine injections	As epidural lidocaine was used prior to manipulative procedures, this practice is not representative of a general chiropractors regimen
Joghataei et al[25]	Randomized clinical trial	n = 30	Group 1: ultrasound and exercise Group 2: ultrasound, exercise and manual traction	No HVLA procedures were utilized in the cervical spine
Dishman[26]	Retrospective case series	n = 80 (20 with CR)	HVLA-SMT following the receipt of an imaging guided epidural injection	This practice is not representative of a general chiropractors regimen
Cleland et al[27]	Prospective case series	n = 11	Segmental lateral glide techniques, mechanical traction, deep neck flexor strengthening and thoracic manipulation	No HVLA procedures were utilized in the cervical spine
Cleland et al[28]	Prospective (pragmatic) clinical case series	n = 96	Techniques frequently employed included non-thrust manipulation to the cervical and thoracic spine, manual and mechanical traction, electrotherapeutic modalities and stretching/strengthening exercises	No HVLA procedures were utilized in the cervical spine
Christiansen et al[29]	Retrospective case series	n = 162	Within cases of cervical radiculopathy, low-velocity, low-amplitude procedures were utilized	No HVLA procedures were utilized in the cervical spine
Young et al[30]	Randomized clinical trial	n = 81	Manual and exercise therapy was combined with either intermittent cervical traction or sham traction	No HVLA procedures were utilized in the cervical spine
Kuijper et al[31]	Randomized controlled trial	n = 205	Group 1: Semi-rigid cervical collar and at-home rest Group 2: physiotherapy and home exercise Group 3: continuation of daily activities (control)	No HVLA procedures were utilized in the cervical spine
Ragonese[32]	Randomized clinical trial	n = 30	Group 1: Manual therapy (segmental lateral gliding, thoracic mobilizations and neural dynamic techniques) Group 2: Strengthening of the deep neck flexors, lower and middle trapezius and serratus anterior muscles Group 3: Both manual and exercise therapy	No HVLA procedures were utilized in the cervical spine

a specific cause of CR via clinical testing or special imaging was not identified, arm and hand pain/paresthesia was deemed to be caused by a "cervical lesion" and data was presented separately in this presentation group.[13]

In the treatment group, unspecified manipulation was delivered to 17 subjects once, 4 subjects twice and 2 subjects three times. One subject received both cervical and lumbar manipulation. A subset of subjects received an analgesic injection prior to SMT due to high pain levels (n = 2/26).[13]

In all treated subjects, rotational ROM improved immediately following manipulation by an average of 5°. When results were stratified for patients with arm and hand symptoms, 6/12 members of the treatment group showed ROM improvement immediately following manipulation versus 1/9 of the control group. At 1 week, this number rose to 9/12 in the treatment group versus 4/7 in the control, and 9/11 versus 4/5 at 3 weeks. No statistical significance was found between the stratified groups at any time point.

Symptoms of stiffness and paresthesia were also reported as improved for the treatment group, though supporting outcome data was absent.[13]

BenEliyahu[33] conducted a more detailed clinical case-series. Subjects were required to have neck or back pain with referral into the associated extremity, extremity pain reproduced via stretch testing (ie. shoulder depression test), restricted ROM, neurological deficit and a clinically correlated disc herniation via magnetic resonance imaging (MRI). The overall study included 27 subjects, 11 of which presented with symptomatic cervical disc herniations.[33]

During the acute phase of care, subjects were treated with mechanical traction, interferential current/ultrasound and cold therapy. Cervical rotary SMT was introduced during the subacute phase, along with isometric exercises and stretching. Specific rehabilitation combined with distraction manipulation was introduced during the chronic phase. Subjects were treated 4–5 times per week for the first 2 weeks then 3 times per week with a decreasing frequency as symptoms resolved. Outcome measures included the Visual Analogue Scale (VAS), clinical findings and changes visualized with MRI. A "good clinical outcome" was sought, consisting of a VAS of 2 or less, resolution of extremity pain/paresthesia and improved clinical findings. Repeat MRI was performed upon achieving a good clinical outcome or if subjects had been under care for one year.[33]

Unfortunately, not all data was stratified for cervical and lumbar categories, complicating analysis. For all subjects, the mean duration of care was 9 months. Mean pre-treatment VAS was 6.9/10 and 1.9 post-treatment. Twenty-two subjects achieved a good clinical outcome, 17 of which demonstrated a reduced herniation via repeat MRI. This sub-group experienced an 80% reduction in VAS scores. The remaining 5 subjects demonstrated a marginal or poor clinical outcome, 2 of which demonstrated a worsening of herniation size. In one instance the worsened herniation did not correlate to clinical findings, while the other referred to an adjacent level. This final patient achieved good clinical outcome following 4 months of continued chiropractic care.[33]

Return-to-work data was organized into cervical and lumbar cases, demonstrating a 1 year return to former occupation rate in 82% of cervical cases and 75% of lumbar cases. Details regarding levels of involvement and applied SMT were not reported. No adverse events were reported during care.[33]

Murphy et al's[3] prospective cohort pragmatically studied 32 confirmed cases of CR. Imaging revealed correlated lateral stenosis in 15 subjects, disc herniation in 10 and a combination in 7subjects. The C6 segment was involved in 23 subjects, C7 in 21, C5 in 7, C4 in 2 and C8 in 1 subject. The mean age of subjects was 47.2 years (24–68; SD 9.2) with a mean duration of symptoms of 46.9 weeks (0.5–260; SD 79.9). The mean baseline Bournemouth Disability Questionnaire (BDQ) score was 37.7 points (11–62; SD 14.8) and a mean Numerical Pain Rating Scale (NPRS) score of 6.4 points (2–10; SD 2.4). A mean of 11.7 treatment sessions (4–24; SD 5.2) were delivered with long-term follow-up averaging 8.2 months (3–23; SD 4.7).[3]

Dysfunctional segments, not mutually exclusive of the level of radiculopathy, received SMT with a thrust-vector directed at symptom centralization. Neural mobilization and muscle energy techniques (MET: low-velocity movements aided by breathing techniques and patient eye movements), end-range loading and over-the-door traction were also employed. Treatment decisions were made as indicated, session to session. The plan of management consisted of 2–3 treatments per week for 3 weeks. Unless subjects were fully recovered at this time point, they were

seen 1–2 times weekly. Once fully recovered, subjects were seen every 2–3 weeks for at least 3 months.[3]

Outcome data was available for 31 subjects, 27 of which provided long-term follow-up. The mean self-rated improvement was 75.4% (0–100; SD 24.5), the mean BDQ score was improved by 53% (–240–100%; SD 63) and the mean change in NPRS was 62% (–20–100; SD 34.5) at final re-examination. Compared to baseline, long-term follow-up demonstrated a mean self-rated improvement of 88.2% (40–100; SD 14.9), the mean BDQ score was improved by 78% (5.3–100%; SD 32) and the mean change in NPRS was improved by 72% (66.7–100; SD 43).[3]

All 31 subjects received a manual procedure to the level of radiculopathy, with 18 of these cases being an HVLA procedure and the remaining 13 being MET. No differences were found when comparing HVLA to MET. Adjunctive over-the-door traction was used by 10 subjects.[3]

While no major complications were reported, increased pain not persisting beyond 2 days was experienced by 3 subjects who received HVLA manipulation, 6 subjects who received MET techniques and 7 subjects who received over-the-door traction.[3]

Objective 2:

The electronic search identified 91 citations, yielding 5 eligible studies.[28,34–37] One additional study was identified through hand-searching methods.[38]

The relevant data from these 6 studies are presented in Table 3 and reviewed in the discussion.

Discussion

Strengths & Limitations of the Presented Research

Howe et al's randomization of a treatment and a control group offered the highest quality design, though only a sample subset presented with arm and hand symptoms.[13] BenEliyahu utilized a lower quality retrospective design and consisted of a small sample size not adequately stratified for cervical case evaluation.[33] Murphy et al. was strengthened by prospective data, though pragmatic application complicated the evaluation of treatment specifics.[3]

Manipulative procedures, examination techniques and outcome measures were highly variable between studies.[3,13,33]

Murphy et al. was the only study to adequately describe the indications for SMT, consisting of dysfunctional motion segments identified on palpation in the sitting or prone position, responding with abnormal resistance compared to asymptomatic levels and the presence of clinical symptoms.[3] While Howe et al defines a manipulable lesion to be palpatory evidence of reduced segmental motion and/or palpatory atlas asymmetry, motion parameters, symptom response and positioning details were omitted.[13] BenEliyahu identified only a loss of cervical ROM.[33]

The manipulative procedure was adequately described in all studies. BenEliyahu described using rotational "high-velocity short-lever manipulation."[33] Howe et al. described moving joints to a comfortable endpoint and delivered a "quick thrust of moderate force" intending to move the joint(s) "as far as comfortably possible."[13] Murphy et al. moved the spinal joints until "a barrier of resistance" was felt, and delivered a "short and quick thrust."[3] Only Murphy et al. and BenEliyahu commented that an audible release was usually perceived.[3,33]

BenEliyahu suggested therapy be modified for stages of healing, utilizing traction and pain-relieving modalities during the acute phase while rotational manipulation was "judiciously added" during the subacute phase.[33] While Murphy et al. did not address this formally, pragmatic treatment showed that only 18 of the 35 patients received HVLA procedures.[3] The remainder of the patients received LVLA techniques and over-the-door traction.[3] Howe et al. did not amend their manipulative protocol; they added an analgesic injection where pain interfered with thrust delivery.[13] While injection therapy is technically part of our exclusion criteria, less than 10% of the subjects in this trial received an ancillary injection, therefore this was not felt to interfere with outcomes.[13]

Unfortunately, the mechanism of injury/onset was not adequately described within these studies. As traumatic onset is less common in CR and presents an alternate pathophysiology, this detail is relevant,[1] though affect on prognosis or treatment has not been commented on in systematic reviews.[39–41]

Conclusions on clinical course from these studies are difficult to draw. Howe et al. detailed a short timeline for outcome measure assessment, following subjects for only 3 weeks and excluded management details.[13] BenEliyahu

Table 3 *NDI Search Results*

Study	Sample	Reliability	Validity
Mehta et al[34]	66 patients with neck pain assessed with DASH for upper extremity disability	N/A	Correlation of Quick-DASH / NDI = 0.83
Carreon et al[35]	505 fusion patients: NDI scores compared to Health Transition Item of SF-36 (a form of Global Rating of Change (GRC))	N/A	One-year MCID = 7.5 / 50 One-year SCB = 9.5 / 50
Cleland et al[28]	96 neck and arm pain subjects: correlation to GRC	N/A	Predictors of short-term (28-day) improvement (GRC) = – Age < 54 – Dominant arm not affected – looking down does not worsen symptoms – receiving manual therapy
Peolsson[36]	95 neck and arm: follow-up scores	N/A	20% reduction in NDI is a reasonable criterion for success at 6 years post-surgery
Peolsson et al[37]	34 neck and arm: factors predicting recovery	N/A	For 1 and 3-year follow-up: Normal DRAM most strongly predicted improvement on NDI – other factors were: non-smoking and low pre-operative pain
Cleland et al[38]	38 neck and arm: psychometric properties	NDI test-re-test reliability = 0.68 [0.30, 0.90]	Median 21 days (13–31) / 6 treatments (5–7): MDC NDI = 10.2 MICD = 7.0

did not specifically report CR outcomes, aside from the return to work rate at 1 year follow-up.[33] Murphy et al. however provided excellent insight into the clinical course of manipulative therapy as 89% of the patients described their improvement as excellent or good after a mean of 11.7 (4–24; SD 5.2) treatment sessions at a frequency of 2–3 times per week.[3] Long-term follow-up was available for 27/31 subjects, indicating that over 90% maintained clinically significant improvement.[3]

Comparisons of HVLA-SMT versus the natural course of CR are also difficult to draw. Due to high levels of pain and disability, a true no-treatment comparison is difficult to evaluate and control. Therefore, the clinical course of various conservative therapies remains.

For consideration, CR sufferers randomized to hard collar immobilization did not demonstrate statistically different pain scores from baseline at either 4 or 12 month follow-up.[18] Meanwhile, a population based study found that while 90% of CR sufferers reported mild or no symptoms at 4–5 years follow-up, recurrence was observed at 31.7%.[1]

Based on the reported details of the three included studies, it is felt that Murphy et al. provides the best insight into the clinical-course of CR treated with HVLA-SMT.[3]

While limited, non-randomized and without reference to a true control group, this trial may still assist the general practitioner in reasonably designing a trial of therapy.[33]

Reporting of Adverse Events

As previously alluded, concern has been reported regarding the safety of HVLA procedures for confirmed or suspected CR.[8,10] In fact, published case reports have indicated cervical disc herniation and CR as adverse events related to SMT.[42–44]

While the included studies reported no major adverse events, safety conclusions of HVLA procedures for CR cannot be drawn from this data.[3,13,33] While Murphy et al. found a mild transient increase in pain in 16.7% of the subjects receiving HVLA procedures,[3] this is considerably lower than other estimates of similar events experienced in 44–62% of patients receiving SMT for non-specific neck pain.[45–52] Additionally, the TFNPAD did not find SMT to be contraindicated in CR patients.[6] Further research exploring this area is needed to determine proposed mechanisms as well as incidence.

NDI Appropriateness

Only one study reported on the test-re-test reliability of the NDI in neck and arm pain patients.[38] The value obtained, 0.68 (0.30,0.90) is somewhat lower than previously reported for neck pain-only patients.[11] Several studies provided data on the responsiveness of the NDI in neck and arm pain patients. Two studies reported minimum clinically important differences of 7.5 and 7 NDI points, respectively.[28,38] These values are only slightly higher than those previously reported.[1] One study reported that 20% improvement is a reasonable criterion of clinical success[36] while Carreon et al. provided an estimate of Substantial Clinical Benefit of 9.5 NDI points (19%).[35]

Several studies have reported on factors which predicted outcome as measured by the NDI.[11] While varied, these factors generally appear to indicate that low initial pain and distress levels and low impact on neck/arm function predict greater improvement in NDI scores at both 28 days and at 1–3 years.

Taken together, these data support the use of the NDI in studies of SMT for CR.

Review Limitations

First, the existing interventional evidence-base for CR is small and principally composed of low quality study designs. This foundation is further compressed when isolated to a distinct therapy.

Secondly, the inclusion process lacked quality assessment. As this review targets a clinical rather than an academic audience, the limitation is justified. Additionally, in the absence of data pooling, this factor has minimal impact.

Thirdly, the inclusion/exclusion process for each objective lacked consensus. Given the small evidence-base and clearly defined criteria, consensus is unlikely to have altered results.

Lastly, study designs required a threshold of 10 subjects for inclusion. Of the included studies, BenEliyahu presented the smallest sample size, pooling data for 11 CR subjects.[33] During our literature consolidation, no studies were identified that included less than 10 subjects while reporting pooled data. Therefore, it is not felt that this criterion generates bias.

Conclusions

As CR evidence for LVLA and exercise therapy continues to grow,[7,16–23,25,27–32] minimal research concerning HVLA procedures remains. Despite this, existing literature does provide support for the cautious application of HVLA procedures in cases of confirmed or suspected CR.

Currently, randomized trials in the field of CR are lacking. Additionally, the lack of HVLA-related research for CR, particularly comparing HVLA to LVLA procedures, offers a unique and timely opportunity for chiropractic science. In designing such trials, as well as for clinical use, the NDI is well-suited as an outcome measure.

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Conservative management of a lumbar compression fracture in an osteoporotic patient: a case report

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Objective: *To chronicle the conservative treatment and management of an osteoporotic patient presenting with acute back pain resulting from a lumbar compression fracture.*

Clinical features: *A 74-year old male presented with acute back pain in the thoracolumbar region after an episode of lifting. Radiographic evaluation revealed generalized demineralization and a moderate wedge compression fracture at L1.*

Intervention and outcome: *The conservative treatment approach included postural education, activity modification, interferential current, taping into extension, Graston Technique®, and rehabilitative exercise prescription. Outcome measures included verbal pain rating scale, medication use, and a return to activities of daily living (ADLs). The patient attained long-term symptom resolution with no recurrence of pain at 12 month follow-up.*

Summary: *A combination of conservative rehabilitation strategies may be successfully implemented to treat osteoporotic patients with mild to moderate osteoporotic vertebral compression fracture of the lumbar spine.*
(JCCA 2012; 56(1):29–39)

KEY WORDS: compression fracture, osteoporosis, Graston Technique®, chiropractic, rehabilitation

But : *Effectuer le suivi du traitement conservateur d'un patient ostéoporotique souffrant de lombalgie aiguë en raison d'une fracture lombaire avec tassement.*

Caractéristiques cliniques : *Un homme de 74 ans souffre de lombalgies aiguës dans la région thoracolombaire survenues après avoir soulevé un objet. Une évaluation radiographique révèle une déminéralisation généralisée ainsi qu'une fracture de L1 avec tassement cunéiforme modéré.*

Intervention et résultat : *L'approche thérapeutique conservatrice comprenait l'éducation posturale, la modification d'activités, l'électrothérapie à courants interférentiels, l'application de bandages élastiques (taping) en extension, la technique Graston^MD, et la prescription d'exercices de réadaptation. Les résultats ont notamment été mesurés par une échelle verbale de notation de la douleur, la quantité de médicaments ingérés, et le retour aux activités de la vie quotidienne (AVQs). Le patient est parvenu à une résolution à long terme des symptômes, sans récurrence de la douleur en date du suivi effectué après 12 mois.*

Résumé : *Une combinaison de stratégies de réadaptation conservatrices peut être mise en œuvre avec succès dans le traitement de patients ostéoporotiques atteints de fractures vertébrales ostéoporotiques avec tassement d'intensité légère à modérée au niveau de la colonne lombaire.*
(JCCA 2012; 56(1):29–39)

MOTS CLÉS : Fracture avec tassement, ostéoporose, technique Graston^MD, chiropractie, réadaptation

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Introduction

Individuals with osteoporosis have a greater likelihood of suffering vertebral compression fractures (VCFs), which can range from mild to severe in terms of associated pain and resultant disability.[1] In the United States, it is estimated that at least 10 million people suffer from osteoporosis and an additional 18 million people are at significant risk for development of the disorder. Within this affected group, it is estimated that 700,000 VCFs occur each year and approximately 70,000 result in hospitalization, with an average hospital stay per patient of 8 days.[2] The risk of major osteoporotic fracture in Canada is among the highest in the world,[3] with the incidence of VCFs expected to increase as the Canadian population ages.[4] The annual incidence of osteoporotic vertebral compression fractures (OVCFs) among Canadian women is currently reported to be approximately 37,000.[3] Although considered a female health issue, osteoporosis is also becoming a major health concern among males.[5–8]

It is estimated that many OVCFs remain asymptomatic, and that only one-third of individuals seek immediate medical attention, presenting predominantly as acute back pain patients.[9–12] For any given case, the diagnosis of a single OVCF increases the risk of subsequent fractures by a factor of five.[12] Patient population studies indicate an increased mortality rate in patients with OVCFs that correlates with the number of involved vertebrae.[13] In addition to acute pain and the risk for developing chronic pain, OVCFs may also be accompanied by other physical and emotional consequences.[1,9–11] Early recognition, diagnosis, and conservative management can play important roles in minimizing the negative sequelae of OVCF.

This case study was conducted to evaluate the conservative treatment and management of an osteoporotic patient presenting with acute back pain resulting from a lumbar compression fracture. Salient clinical features and diagnostic considerations are also discussed.

Case report

A 74-year old male presented with acute back pain of three days duration localized to the region of the thoracolumbar spine. The patient explained that this pain occurred while he was lifting 30–40 lb pieces of wood. During the mid-point of a lift, with his spine forward flexed, he reportedly heard a "pop" in his back and a sensation of pain immediately ensued. The patient did not seek medical treatment following this incident. He reports that he managed his symptoms with over the counter medication (ibuprofen).

The patient rated his pain as 8/10 on the Verbal Pain Rating Scale (VPRS) where 0 is "no pain" and 10 is the "worst pain that he had ever experienced." The pain was described as sharp and stabbing, and it was exacerbated by direct pressure over the painful area and any movements of the lower axial spine. He denied any radiating/referred pain symptoms into the lower extremities or difficulty with bowel and bladder function. Past medical history revealed that he had been diagnosed with "mild" osteoporosis two years prior. Systems review and family health history was unremarkable. The patient was a lifelong non-smoker. He did not report any previous history of disabling back injury. He indicated that he lived a very active lifestyle and walked two to four kilometres daily. His current state did not allow for him to continue his daily walking routine and he was having trouble getting a good night's sleep due to difficulty with finding a comfortable position.

Initial observation revealed that the patient walked slowly and moved in a guarded fashion during transfers. A slightly forward stooped posture was noted in the standing position. Lumbar ranges of motion were significantly restricted in all planes due to pain. Motor, reflex, and sensory testing for the lower extremities was within normal limits bilaterally. Seated straight leg raising was unremarkable bilaterally for nerve root tension signs. Percussion of the spinous processes with a reflex hammer revealed tenderness most notably over T11, T12, L1 and L2. Digital posterior to anterior (P-A) pressure of the spinous processes reproduced a sharp pain at these levels. Palpation revealed marked muscle spasm bilaterally in the thoracolumbar paraspinal muscles.

In consideration of the patient's reported health history, mechanism of injury, and physical examination findings, A-P and lateral thoracic and lumbar radiographs were completed due to suspected OVCF. The radiographic examination revealed generalized demineralization and a moderate wedge compression fracture at L1. There were no other radiographic features of significance identified that would clearly explain the patient's acute symptom presentation.

In office treatment commenced four days after initial

presentation. The patient was instructed after the initial assessment to maintain a neutral spine position and try to avoid forward stooped/spinal flexion movements. He was also advised to try and stay mobile and avoid prolonged inactivity. Initial treatment was focused on providing adequate pain control. This was accomplished with interferential current (IFC) applied to the hypertonic thoracolumbar paraspinal muscles, followed by taping of the thoracolumbar spine into a position of slight extension bias (Figures 1A–C). Exercises consisting of abdominal bracing, scapular setting, and gentle extension movements of the thoracolumbar region were introduced in week 3.

The patient made continuous improvement during the course of treatment with respect to pain scores, as well as his functional and impairment status. At the beginning of week 5, IFC application and taping into extension was discontinued. Augmented soft tissue mobilization using Graston Technique® (GT) was introduced and applied to the thoracolumbar paraspinal muscles. The patient's exercise program was also increased at this time. A sampling of these exercises is provided in Figures 2–7. A summary of the full treatment protocol and prescribed exercises is included in Table 1.

At week 9, the patient reported no spinal stiffness or pain and had resumed all his ADLs. The patient was encouraged to continue with his exercise program as a preventative measure. He was subsequently discharged from active care and advised to return if his symptoms recurred. At 12 month follow-up conducted via telephone, the patient reported no recurrence of symptoms.

Discussion

Vertebral fractures are one of the important clinical manifestations of osteoporosis. The prevalence of vertebral fractures rises with age, and may increase as much as five times between the ages of 50–54 and 75–79.[9] The risk factors associated with VCFs and osteoporosis are similar[1], and include nonmodifiable and modifiable factors (Table 2). Early recognition, diagnosis, and conservative management can play an important role in minimizing the complications and negative sequelae of OVCF (Table 3).

Unfortunately only about one third of VCFs are actually diagnosed.[14–16] Pain symptoms arising from OVCFs can be variable, ranging from asymptomatic,[17] to acute and intolerable pain.[9] Fractures may also escape diagnosis due to being dismissed as muscle strains, arthritis, or

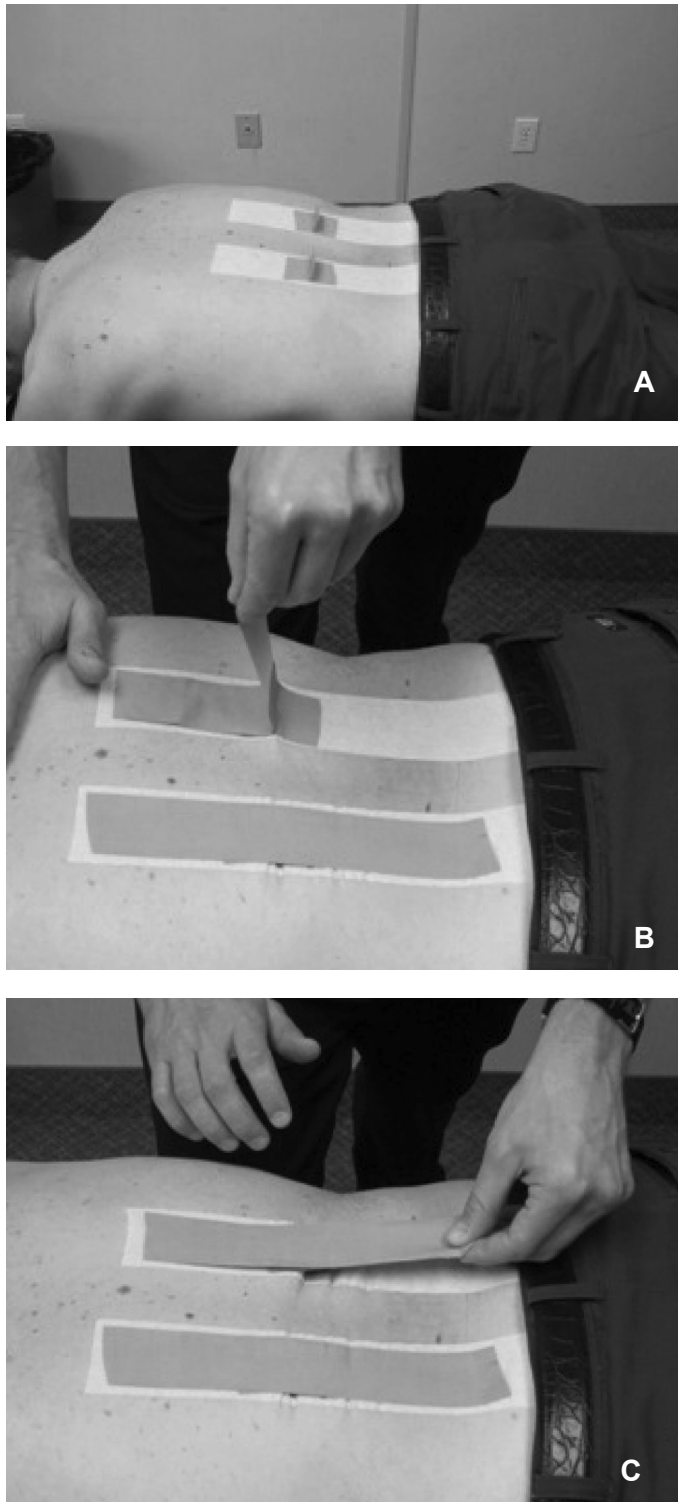

Figure 1(A–C) *Taping into extension bias of the thoracolumbar spine*

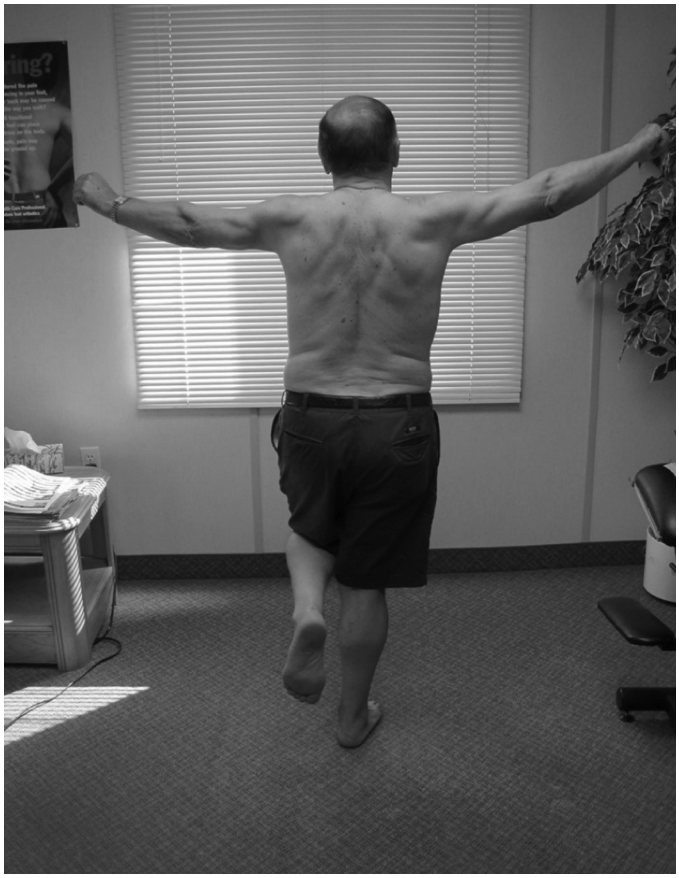

Figure 2 *Proprioceptive training with one-legged stance*

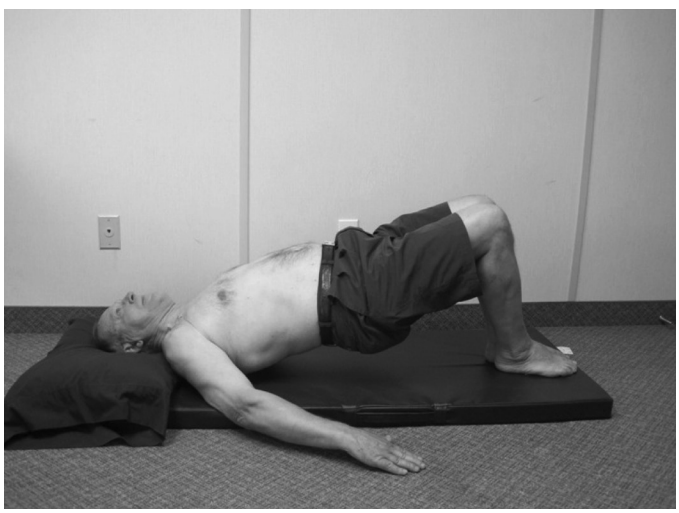

Figure 3 *Lumbopelvic conditioning with bridging exercise*

Figure 4 *Theraband scapular retraction exercises*

Figure 5 *Proprioceptive training with a Rocker Board*

Figure 6 *Lumbopelvic and back extensor training with Quadruped exercise*

Figure 7 *Theraband pull-down exercises*

a normal part of aging,[1,10] and may have no clear event tied to the onset of symptoms. Individuals with advanced osteoporosis may sustain a VCF after sneezing or lifting a light object, whereas patients with mild to moderate osteoporosis will require a greater force to create a fracture such as falling off a chair, tripping, or attempting to lift a heavy object.[1] Health professionals should consider OVCF as a diagnostic differential in all patients older than 50 with acute onset of back pain if one or more risk factors are present.[18]

It is reported that many patients with OVCFs experience a relatively benign natural history with predictable pain improvement over 6 to 12 weeks.[11,12] However, these sources also acknowledge that some patients experience persistent pain and disability. Chronic back pain in individuals with osteoporosis may result from the continuous occurrence of new vertebral fractures,[18,19] or may be a result of secondary changes in body configuration and posture,[20,21] and biomechanical strain on the posterior elements.[22,23] As individuals become more kyphotic, their back muscles, ligaments, and intervertebral joints are often extended beyond normal position and exposed to prolonged stress. This can result in joint dysfunction,[22,23] muscle fatigue[2] and reduced spinal extensor strength.[9] The pain brought on by this destructive cascade may continue long after the acute fracture has healed.[24]

The majority of OVCFs occur at T6-T8, T12-L1, and L4.[9,25] There are several clinical signs which may raise the suspicion of OVCF. The change in shape of the vertebral body after a fracture may result in a visible focal increase in kyphosis or loss of lumbar lordosis.[12,26,27] Multiple OVCFs can lead to a noticeable loss of height and a further accentuation in postural change.[9,12] Functional impairments, when present, typically affect activities such as walking, bending, transfers, carrying and lifting.[9,11,19,28]

Physical examination may reveal tenderness with palpation or percussion directly over the area of fracture, and paraspinal muscle spasm.[18,19,25,27,29] Active ranges of motion for the axial spine will be restricted with most acute fractures.[9] In cases of stable compression fractures, straight leg raise will be negative and neurological examination will be normal. The emergence of neurological radicular symptoms requires investigation to evaluate the stability of the injured region.[30] Symptoms of cauda equina signifies the need for immediate emergency referral.

Table 1 *Overview of average pain range, functional status, impairment status, and treatment interventions*

WEEK(S) SESSIONS	AVERAGE PAIN RANGE	FUNCTIONAL STATUS	IMPAIRMENT STATUS	TREATMENT INTERVENTION(S)
Initial Presentation	• 8/10 • Medication use to control pain symptoms	• Difficulty with most ADLs, mobility, transfers • Unable to walk far distances • Sleep disturbance due to pain	• Active lumbar ROM significantly restricted in all planes • Bilateral thoracolumbar paraspinal muscle spasm/hypertonicity • Percussion and digital P-A pressure over T11,T12, L1, L2 painful	• Postural education – neutral spine emphasized, avoidance of forward stooped/spinal flexion movements • Activity modification – remain as active as possible and avoid prolonged inactivity
WEEK 1 • 3 sessions	• Same as Above (SAA)	• SAA	• SAA	• Interferential Current (IFC) applied to thoracolumbar paraspinal muscles, 15 minutes each side • Visits 2&3 taping into extension bias of thoracolumbar spine (Figures 1 A–C)
WEEK 2 • 2 sessions	• 6/10 • Medication use – SAA	• Same as week-1 with slight improvement in overall mobility	• Same as week-1 with slight improvement in lumbar extension and rotation movements corresponding with mobility improvements	• IFC – SAA • Progressive taping into extension bias of thoracolumbar spine
WEEK 3 • 2 sessions WEEK 4 • 2 sessions	• 4–5/10 • Medication use only before bedtime to help with sleep	• Mobility continuing to improve, resumption of some ADLs and pre-injury walking routine at 50% of usual distance • Less overall difficulty with sleep positions	• Progressive improvement in lumbar ROM's, lumbar flexion still limited by 50–75% • Diminishing thoracolumbar paraspinal muscle spasm/hypertonicity • Digital P-A pressure reveals moderate pain, most notably over L1 spinous process	• IFC and progressive taping into extension bias of thoracolumbar spine – SAA • Introduction of: – *Abdominal Bracing; Scapular setting; Gentle Extension movements of thoracolumbar spine *Exercise prescription: 3 sets of 8–10 repetitions with 3–10 second holds **Exercise performed 2 times/week in office, 3 times/week at home
WEEK 5 • 2 sessions WEEK 6 • 2 sessions	• 2–3/10 • Medication use discontinued due to manageable pain levels	• Limitation in only some ADLs requiring bending at waist and lifting • Return to pre-injury daily walking routine of 2–4 km • No interference with restful sleep	• No sharp pain with axial movements; Lumbar forward flexion limited by 25° with report of discomfort and stiffness • Mild-moderate hypertonicity and tenderness in the thoracolumbar paraspinal muscles • Mild-moderate tenderness with P-A pressure over L1 spinous process	• IFC application and taping into extension bias discontinued • Graston Technique® (GT) applied to thoracolumbar paraspinal muscles • Exercise Progression to: – Pectoral stretching (15–20 second holds) – Proprioception – one-legged stance (Figure 2) – *Bridging (Figure 3); Prone hip/opposite arm extension; Theraband scapular retraction exercises (Figure 4) *3 sets of 10 repetitions **2 times/week in office, 3 times/week at home
WEEK 7 • 1 session WEEK 8 • 1 session	• 0–2/10	• Gradual return to all ADLs	• Progression of lumbar forward flexion from mild pain discomfort at end range to stiffness at end range • Residual hypertonicity and tenderness in thoracolumbar paraspinal muscles • Mild discomfort with P-A pressure over L1 spinous process	• GT – SAA • Exercise Program Addition of: – Rocker board training in office (Figure 5); Home proprioceptive challenge increased by performing one-legged stance with eyes closed – *Quadruped and Theraband pull-downs (Figure 6 and 7); Dynamic Prone Extension *3 sets of 10 repetitions **1 time/week in office, 4 times/week at home
WEEK 9 • Discharge	• 0/10	• Return to all ADL	• Lumbar flexion full with mild stiffness reported at end range	• Discharged, encouraged to continue with home program

Table 2 *Risk Factors for Osteoporosis and Vertebral Compression Fractures (VCFs)*[1]

Advanced age	Low body weight
Female gender	Previous OVCF
Caucasian race	Tobacco use
Early menopause	Alcohol use
Estrogen deficiency	Insufficient physical activity
Bilateral ovariectomy	Dietary calcium and/or vitamin D deficiency
History of corticosteroid medication use	

Table 3 *Complications arising from OVCFs*[1,9–11]

Constipation	Increased risk for further fracture
Bowel obstruction	Chronic pain
Prolonged inactivity	Loss of independence
Deep venous thrombosis	Functional limitations with ADLs
Increased osteoporosis	Low self-esteem
Progressive muscle weakness	Emotional and social problems
Crowding of internal organs	Increased nursing home admissions
Respiratory decrease-atelectasis, pneumonia	Mortality
Kyphosis and loss of height	

Plain frontal and lateral radiographs are the initial imaging study obtained for a suspected VCF. Common radiographic findings associated with VCFs include a step defect, wedge deformity, disrupted vertebral endplate, linear zone of condensation, paraspinal swelling and abdominal ileus.[31] Post-fracture stability is based on the classification of Denis where the spine is divided into three columns.[32] According to this model, the likelihood of neurological injury is high when damage occurs to more than one of these columns. VCFs involve failure of the anterior column only. The middle column is completely intact and is typically characteristic of compression fractures. Pathologic fractures may be identified by loss of posterior body height, pedicle or other structures, and a paraspinal mass.[31] Computed tomography (CT) and magnetic resonance imaging (MRI) may be used in cases of suspected spinal cord compression, progressive neurological deterioration, incrongruous neurologic or skeletal injury, unexplained neurologic deficit, or suspicion of malignancy.[1,33,34]

It is generally agreed upon that stable, non-malignant compression fractures can be treated conservatively.[1,10,12,35,36] An emphasis on pain control and maximizing functional outcome is important to prevent chronicity and the negative sequelae of OVCF. Even in acute cases, prolonged bed rest and inactivity should be avoided.[1,12] Education in activities of daily living may include ways to minimize pain.[10] In this case, the initial focus of treatment was to improve posture and body mechanics to reduce the compressive loads on the spinal column.[37] The patient was advised to avoid forward stooped-spinal flexion movements,[37,38] attempt to stay mobile, and avoid prolonged inactivity.

Zambito et al.[39] demonstrated that interferential current (IFC) was effective in alleviaitng both pain and disability in patients with chronic back pain due to previous multiple vertebral osteoporotic fractures. Bracing has also been advocated as a pain management strategy. Bracing is believed to promote healing by stabilizing the spine,[11] facilitating neuromuscular re-education, and reducing pain by decreasing postural flexion that causes increased loading of the painful fractured periosteum.[10]

Progressive taping of the thoracolumbar region into extension bias was utilized in this case as an alternative to bracing and well tolerated by the patient during the first four weeks of treatment.

Paraspinal muscular pressure has been found to be highly increased in the flexed standing position with loading in normal control groups and significantly higher in patients with osteoporosis, degenerative spondylolisthesis and lumbar compartment syndrome.[40] Hammer et al.[41] demonstrated reduced pain in a patient with lumbar compartment syndrome after using GT. GT utilizes stainless steel instruments to apply controlled microtrauma to the affected soft tissues.[42] Studies suggest that this controlled microtrauma induces healing via fibroblast proliferation,[43] which is necessary for soft tissue healing.[43,44] Additional studies have shown clinical efficacy using GT for the treatment of various disorders with painful soft tissue components.[42,45–50]

Physical activity plays a critical role in the rehabilitation of osteoporotic patients with vertebral fractures.[10,51–56] Extension or isometric back and abdominal strengthening exercises are useful and contribute to the avoidance of other fractures,[10,38] whereas flexion exercises seem to be detrimental.[38] Spinal extensor training has been demonstrated to help reduce pain by decreasing compressive loads and maintaining bone mineral density[51,53] Proprioceptive exercises also appear to play a role in the rehabilitation of OVCF. Vertebral fracture has been associated with impaired balance characteristics in the osteoporosis population.[57] This may be as a result of several factors including pain, impaired muscle control and fear of falling.[57] Adding dynamic proprioceptive training can help reduce pain and the risk of falls in patients with kyphosis related to osteoporotic compression fracture.[55]

Although spinal manipulation or adjustment is a routine mode of treatment administered by chiropractors, it was not utilized in this case. Osteoporosis is commonly regarded as a relative or absolute contraindication to spinal manipulation.[58] In a review of four cases, Haldeman et al.[59] indicated that manipulation or adjustment of areas suspected of compression fracture may result in increased pain and prolonged patient disability. Considering that occult compression fractures may be present in any osteoporotic patient, special care must be taken to avoid exacerbating the patient's condition.

Evaluation and management of osteoporosis is an integral part in the treatment of OVCF.[59] In this case, such management was deferred to the patient's family physician and naturopathic doctor as per the patient's request. Chiropractors can play a role in educating osteoporotic or at risk patients on preventative lifestyle choices such as calcium and vitamin D supplementation, increasing weight-bearing physical activity, and limiting/avoiding consumption of caffeine, alcohol, and tobacco.[60–63] Other treatment alternatives available to a patient with OVCF include pain medication and epidural steroid injections.[10–12] Surgical management is typically reserved for individuals with neural compression and progressive deformity with neurological deficits,[12] and may include percutaneous vertebroplasty or kyphoplasty.[10,36,64–66]

The natural history of OVCF may have played a role in the favourable outcome of this case. However, the implementation of a structured rehabilitation program minimized the likelihood of chronicity and burden associated with OVCF, and the patient demonstrated no recurrence of pain at 12 months. With the exception of his previously diagnosed osteoporosis, this patient did not have any other co-morbidities that would have complicated recovery or limited his participation in an active exercise program. The patient also shared the belief that activity within his tolerance would be of benefit during recovery. Postural education, advice on activity modification, and pain relieving measures minimized prolonged immobilization and likely provided re-assurance for a patient already motivated to remain active. GT was useful in decreasing the paraspinal muscle spasm and allowed the patient to participate in a progressive rehabilitation program consisting of spinal extensor training, abdominal and lumbopelvic strength training and dynamic proprioceptive training. The passive treatments used in this case were primarily utilized to support the exercise program and provide pain control during the rehabilitative process.

Summary

This case does demonstrate the successful management of moderate OVCF of the lumbar spine using a variety of conservative interventions that can easily be employed by chiropractic practitioners. Although favourable results were obtained, it is important to note that the nature of this investigation was that of a case study involving one patient. Therefore the treatment protocol utilized may not be appropriate for all individuals with OVCF. There is a pau-

city of quality scientific research documenting conservative management for OVCF. Most of the treatment data is heavily weighted toward pharmacological and surgical interventions. Research in this field is urgently needed to deal with the ever increasing aging demographic in North America. Evaluating conservative interventions that focus on returning an individual back to ADLs in a timely manner and minimizing the risk of chronicity and burden associated with OVCF require investigation in clinical trials with large sample sizes to determine long and short term efficacy. Furthermore, study is needed to evaluate other parameters (age, number of fractures, co-morbidities, etc.) that may predict a positive course in recovery among individuals with OVCF who attend chiropractic offices.

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Prognostic significance of subgroup classification for infant patients with crying disorders: A prospective cohort study

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Introduction: *Few convincing treatment options have been identified for the excessively crying infant. One explanation may be a lack of identification of patient subgroups. This study used a clinically plausible categorization protocol to subgroup infants and compared changes in symptoms between these subgroups during treatment.*

Methods: *An observational cohort design was employed. All infants presenting with excessive infant crying between July 2007 and March 2008 were categorized into three subgroups, (A) infant colic, (B) irritable infant syndrome of musculoskeletal origin (IISMO) and (C) inefficient feeding crying infants with disordered sleep (IFCIDS) based on history and physical findings. Mothers completed questionnaires which rated their own and their child's characteristics prior to and at the end, of a course of manual therapy. Independent associations between infant subgroups and changes in continuous outcomes (crying, stress, sleep, and consolability) were assessed. Multivariable analysis of covariance was used to identify and control for potential confounders.*

Results: *A total of 158 infants were enrolled. There was no significant difference in demographic profile between groups or any significant difference in infant crying or level of maternal stress at the start. Only the putative subgroups were significantly associated with differences in outcomes. In general, colic babies improved the most in consolability and crying.*

Conclusion: *Babies with excessive crying should not*

Introduction : *On connaît peu de traitements convaincants pour les nourrissons qui pleurent excessivement. Le manque de renseignements au sujet des sous-groupes de patients est une explication possible. Dans le cadre de la présente étude, un protocole de catégorisation cliniquement plausible est appliqué aux nourrissons faisant partie d'un sous-groupe, et tous changements aux symptômes entre les différents sous-groupes sont comparés tout au long du traitement.*

Méthodologie : *La méthodologie employée se fonde sur l'observation de cohortes. Tous les nourrissons faisant preuve de pleurs excessifs du nourrisson entre juillet 2007 et mars 2008 ont été assignés à l'un de trois sous-groupes : (A) coliques du nourrisson, (B) syndrome de l'irritabilité du nourrisson d'origine musculosquelettique et (C) alimentation inefficace et sommeil perturbé. Les groupes assignés sont déterminés selon les antécédents et les constats physiques. Les mères ont rempli des questionnaires sur lesquels elles notaient leurs propres caractéristiques, et celles de leur enfant, avant une série de traitements manuels, et à la fin de celle-ci. Des associations indépendantes entre les sous-groupes de nourrissons et des modifications dans les résultats continus (pleurs, stress, sommeil et consolabilité) ont été évaluées. Les facteurs de confusion éventuels ont été identifiés et contrôlés au moyen d'une analyse de la covariance à plusieurs variables.*

Résultats : *Au total, 158 nourrissons ont participé à l'étude. Il n'y a eu aucune différence significative dans le*

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be viewed as a homogenous group. Treatment outcomes may be improved by targeting appropriate subgroups prior to treatment.
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KEY WORDS: Subgroups, infant colic, excessive crying of infancy

profil démographique entre les groupes, ni de différence significative dans le niveau de pleurs des nourrissons ou de stress maternel au début de l'étude. Seuls les sous-groupes putatifs étaient significativement associés à une différence dans le résultat. Dans l'ensemble, les plus grandes améliorations ont eu lieu dans les niveaux de consolabilité et de pleurs des bébés souffrant de coliques.

Conclusion : *Les bébés qui pleurent excessivement ne doivent pas être considérés comme un groupe homogène. Le ciblage d'un sous-groupe approprié préalablement à un traitement peut donner lieu à de meilleurs résultats.*
(JCCA 2012; 56(1):40–48)

MOTS CLÉS : Sous-groupes, colique du nourrisson, pleurs excessifs du nourrisson

Introduction

Infant crying is a normal and natural activity and may occur for any number of reasons, including hunger, illness, tiredness or a need for comfort. However, some babies will not settle, even when their needs have been met and every method of soothing tried.

The excessively crying infant is difficult to understand and manage both for parents and clinicians. It is a prevalent and expensive condition,[1] with as many as one in five parents reporting problems regarding infant irritability or crying during the infants' first three months and is the most widely reported parental concern in the first year of life.[1–5] Excessive crying was traditionally thought to be harmless with no long-term consequences, however, associations with maternal depression[3,4] and child abuse[6] may question this assumption.

Despite concentrated research efforts, no single intervention has been identified as superior in efficacy for infants with excessive crying. One plausible explanation common to other non-specific clinical presentations may be that these infants do not form a homogenous group, but rather are composed of subgroups that respond differently to treatment or differ in their natural course or aetiology. Clinical observation supports the idea that all excessive infant crying is not colic and that despite aetiologies being varied, they remain clinically recognisable.[7–11] However, unanimity concerning any possible classification is lacking. The ultimate goal of classification systems is to improve clinical outcomes, since each case would be treated relative to the signs and symptoms identifying each group, and more efficient targeting of clinical effort might be achieved

Previous investigations have hinted at the possible presence of different subgroups of excessively crying infants, which have been based on clinical observation.[7–12] However, a firmer basis for sub grouping is needed.

This study aimed to determine any possible justification of the use of three *a priori* clinically determined categories of excessively crying infants, based on differences in parent reported outcomes after a course of chiropractic treatment.

Methods

A cohort of infants presenting with excessive crying to a UK chiropractic teaching clinic were followed through a course of treatment. All babies between the ages of one day and 18 weeks who presented between July 2007 and March 2008 with the chief complaint of excessive crying were eligible for inclusion. Infants were included if they could be categorised using clinical signs and symptoms into one of the three classification groups; infant colic, irritable Infant syndrome of musculoskeletal origin (IISMO) or inefficient feeding crying infant with disordered sleep (IFCIDS). (Table 1) Infants were excluded if they had symptoms of any other disorder that might be implicated in infant crying such as cow's milk protein

Table 1 *Proposed characteristics of colic, IISMO and IFCIDS syndromes of infancy*

Characteristics	**Infant Colic**	**Irritable Infant Syndrome of Musculoskeletal origin**	**Inefficient Feeding Crying Infant with Disordered Sleep**
Common age range	2 weeks–3 months; Onset most commonly within first 2 weeks	3 weeks to 3 months but may occur outside of these ranges, infant needs ability to hold antalgic posture	1–6 months (seen less frequently 7–12 months)
Crying patterns	Loud, disturbing, relentless unsoothable crying often late afternoon/ evening	Crying may be high-pitched at any time of day. Often triggered by positioning child out of position of comfort	Many episodes and long bouts of crying, peaking during the day; high intensity, priercing cries common
Physical presentation/ behaviour	Tense abdomen, flexed posture, kicking, flailing legs and boxing arms. Unconsolable whether picked up or not.	Antalgic posture held for sake of comfort; asymetric movemetns/unilateral spinal hypertonicity; tactile defensive; musculoskeletal sensitivity.	"Pained faces" (facial grimaces) accompany crying; body unrest, arching postures, general irritability and difficult to soothe; difficult to distinguish from colic crying/movements, but not limited to end of day and longer hours
Other signs/ symptoms	Appears in pain, changes from happy to crying in an instant, wants frequent cuddling but may not respond	Restless sleep; may not wish to rest supine (some will only sleep in car seat); affective disorder common.	Male predominance (60:40); feeding problems common, sleep disorders common (difficulty falling asleep and staying asleep)

After Miller, 2007

intolerance or gastro-oesophageal reflux disease or suspected pathology.[12]

The data were collected using questionnaires and patient files. Questionnaires were given to the parents before the start of their child's treatment. Parents were asked to rate their child's behaviour in terms of irritability, the degree of maternal stress caused, consolability of the child and quality of the child's sleep. All of these metrics were measured using a 10 point scale, with 1 being the most positive (e.g. very easy to console) and 10 being the most negative response (e.g. difficult or cannot be consoled). They were asked to tick the box of the numerical value that best represented their child's behaviour.

At the end of the course of treatment, parents were asked to answer the same questions using the same methods. In addition, they were also asked to rate the degree of improvement (if any) that their child had shown. A scale ranging from 1 (none at all) to 10 (completely better) was used. They were also asked whether the child's condition worsened and whether the child had experienced any negative side effects from care. (yes/no)

Additional data gathered included age, gender, ges-

Table 2 *Demographic Characteristics of Categorized Crying Babies (N =158)*

Variable	Colic (n = 77)	IISMO (n = 56)	IFCIDS (n = 21)	p†
Mean age (SD) in weeks*	5.0(2.6)	6.1(4.1)	6.7(4.2)	0.08‡
Mean gestational age (SD) in weeks*	39.3(1.7)	39.0(2.2)	39.4(1.6)	0.71§
Mean Birth Weight (Kg) (SD)*	3.4(0.51)	3.4(0.46)	3.3(0.77)	0.55§
Breast feeding stopped in weeks (SD)*	1.4(1.3)	2.5(3.0)	1.6(1.2)	0.12§
Female	34(44)	21(37)	11(52)	0.46
Birth Intervention (% yes)	50(65)	35(62)	18(84)	0.10
Referral (%)	49(64)	34(61)	14(67)	0.70
Allergy/Asthma in family (% yes)	27(35)	13(23)	6(28)	0.42
Breast Fed (% yes)	64(84)	52(93)	18(88)	0.32
Medication (% yes)	60(78)	48(86)	16(78)	0.65
Family member treated (% yes)	37(48)	21(37)	8(36)	0.37

* Means with standard deviations in parentheses where specified. Counts with percentages in parentheses otherwise.
† Pearsons Chi^2 unless otherwise specified.
‡ Kruskal Wallis.
§ One-way ANOVA.

tational age, birth weight, birth type, medication usage, whether the child was breast fed, average age breast feeding stopped (if applicable), referral by health professional, chiropractic treatment of other family members, allergies or asthma in immediate family, main body part treated, and number of visits for this episode of care

Proportions and measures of central tendency were calculated and one sample Kolomogorov-Smirnov tests were used to ascertain normality of continuous data. Differences in baseline variables were compared between groups using appropriate parametric and non-parametric analysis of variance for continuous variables, and Pearsons chi-squared tests for categorical variables. All analyses were carried out using SPSS 17.0. The study was approved by the Anglo European College of Chiropractic ethics (AECC) panel and data from all patients were anonymous.

Results

During the period, July 2007 to March 2008, 173 babies presented with the complaint of excessive crying. Of the158 infants who could be categorised, 90 (57%) were male and 68 (43%) were female. Fifteen (8.7%) could not be placed into categories; nine (5.0%) had suspected cows' milk protein intolerance and six (3.5%) were referred to the GP for possible further investigation to rule out pathology. The remaining 158 were placed into crying categories according to the criteria in Table 1. The colic category accounted for 77 (49%), IISMO 56 (35%) and IFCIDS 25 (16%) of the total study population respectively. None of the remaining demographic variables measured were statistically different between the 3 groups (Table 2). However, mean age was generally younger in the colic babies.

Primary areas of spinal dysfunction as indicated by the treating clinician were also investigated for each group. Although cervical and thoracic problems were identified most commonly across groups, IFCIDS and IISMO babies had a greater range of other musculoskeletal problems than colic babies (Table 3). The area treated was not significantly associated with any of the outcomes at a univariate or multivariable level.

Table 4 shows the number of treatments received in each group at discharge from care. A between group analysis showed significant differences ($p < 0.001$) with colic showing significantly fewer treatment sessions than IISMO or IFCIDS categories.

Table 5 summarises the parents' perception of infant improvement after chiropractic treatment. The changes of parental ratings were significant at a level of $p < 0.001$

Table 3 *Comparison across the groups of practitioner-determined areas of primary dysfunction**

	Colic	IISMO	IFCIDS
Occiput	3(4)	3(6)	1(4)
Cervical	46(60)	17(31)	10(40)
Thoracic	21(28)	14(24)	8(32)
Lumbar	2(2)	5(9)	2(8)
Pelvis	5(6)	(19)	3(12)
Extremity	0(0)	6(11)	1(4)

* Column frequencies with percentages in parentheses.

Table 4 *Number of treatments at release from care*

	Infant colic	IISMO	IFCIDS
Mean number (SD)	4.5(1.2)	6.6(2.3)	7.2(2.3)
Difference (95% CI) vs. colic		2.1(1.3–2.9)	2.7(1.7–3.7)

within all groups during treatment although colic and IISMO babies improved the most. Differences between groups for parent's ratings are also shown in Table 5. At the multivariable level of analysis, the only variable that was significantly associated with change scores was the proposed subgroup, with the exception of the number of treatments on changes in sleep and stress. In this case, the number of treatments was weakly associated with increased sleep and decreased stress scores. For changes in both sleep and crying scales, the IFCIDS group displayed significantly poorer change scores than both colic and IISMO subgroups. For stress and consolability change scores, colic babies improved significantly more than the other two categories.

Discussion

This prospective observational study showed that crying babies, when divided *a priori* into clinical categories, show significant differences between groups in parent reported outcomes at the end of treatment. Generally infants classified as "colic" had fewer treatments to discharge and parents of infants with colic reported greater overall improvement compared to the other two categories. Those infants categorised as IFCIDS at presentation improved less so in comparison to colic babies and IISMO babies, who improved the most, relative to the treatment outcomes. Baseline characteristics of the three groups did not significantly differ in gender, gestational age, birthweight or birth type although colic babies were slightly younger and had the most unconsolable crying and this may indicate that parents are less tolerant of "waiting out" crying that cannot be soothed.

All three categories of irritable babies in this study shared a propensity for a higher than average rate of birth interventions, ranging from 65% in colic infants to 84% in IFCIDS in comparison to the average rate of interventions in the local area hospitals (which birth approximately 5000 babies yearly) of 34.8%[13] This is consistent with various studies that found an association between type of birth and the excessively crying baby.[9,14–17] Although this could possibly reflect a biomechanical mechanism of infant distress, this study cannot confirm this idea.

In all three groups spinal areas of dysfunction were found primarily in the cervical, thoracic and pelvic areas. There were considerably more colic infants for which the cervical region was the primary area of dysfunction. Previous studies have found that the most common dysfunction pattern found in irritable babies involves the upper cervical complex and the most common abnormal motion segment in infants with musculoskeletal problems is C1-2.[2,7,17]

There were significant differences between groups in the number of treatments received, with the colic group receiving the fewest average number of treatments and the IFCIDS group receiving the most. At a multivariable level, more treatment was significantly associated with improved sleep, but not significantly associated with changes in other outcomes. A number of manual therapy trials have reported an average of four treatments for children with colic.[18–20] However, in other trials, fewer or more treatments have been reported and it is clear that little consensus about the optimum number of treatments appears in the literature.[21–23] It is possible that trials have not always recruited exclusively colic patients and consequently, a heterogeneous population of crying babies may have been included in previous trials and could plausibly account for disparity in treatment numbers.

Table 5 *Results of linear regression models assessing the effects of infant group and other independent variables on change scores*

Outcome	Independent variable	Unadjusted effect Coefficient (95% CI)	P Value	Adjusted effect Coefficient (95% CI)	P Value
Crying					
	Infant subgroup		<0.001		<0.001
	IFCIDS	2.6 (reference)		2.5 (reference)	
	Colic minus IFCIDS	1.9 (1.0 to 2.9)		2.4 (1.1 to 3.6)	
	IISMO minus IFCIDS	1.8 (0.7 to 2.8)		1.5 (0.3 to 2.7)	
	Age	0.04 (–0.06 to 0.1)	0.41	0.09 (–0.02 to 0.2)	0.10
	Birth Weight	–0.16 (–0.8 to 0.7)	0.63	–0.3 (–0.9 to 0.3)	0.36
	Number of treatments	–0.78 (–0.23 to 0.7)	0.32	0.10 (–0.07 to 0.28)	0.23
	Gender				
	Female	4.2 (reference)	0.86	3.1 (reference)	0.98
	Male	–0.07 (–0.8 to 0.7)		–0.06 (–0.8 to 0.7)	
	Refer by health care practitioner				
	No	3.8 (reference)	0.17	3.0 (reference)	0.20
	Yes	0.5 (–0.2 to 1.3)		0.5 (–0.3 to 1.3)	
	Allergy/Asthma in family				
	No	4.0 (reference)	0.37	3.6 (reference)	0.50
	Yes	0.3 (–0.4 to 1.1)		0.3 (–0.6 to 1.2)	
Sleep					
	Infant subgroup		<0.05		<0.001
	IFCIDS	2.2 (reference)		1.5 (reference)	
	Colic minus IFCIDS	1.4 (0.1 to 2.7)		2.7 (1.5to 4.0)	
	IISMO minus IFCIDS	2.2 (0.8 to 3.6)		2.5 (1.3 to 4.6)	
	Age	0.03 (–0.1 to 0.2)	0.44	0.02 (–0.1 to 0.2)	0.75
	Birth Weight	–0.7 (–1.5 to 0.2)	0.12	–0.7 (–1.5 to 0.2)	0.12
	Number of treatments	0.18 (–0.04 to 0.37)	0.06	0.35 (0.13 to 0.56)	0.002
	Gender				
	Female	3.5 (reference)	0.56	3.6 (reference)	0.42
	Male	0.3 (–0.7 to 1.3)		0.3 (–0.5 to 1.1)	
	Refer by health care practitioner				
	No	3.1 (reference)	0.06	3.0 (reference)	0.26
	Yes	1.0 (–0.04 to 2.0)		0.2 (–0.3 to 1.3)	
	Allergy/Asthma in family				
	No	3.6 (reference)	0.87	3.1 (reference)	0.66
	Yes	0.1 (–0.9 to 1.1)		0.2 (–0.7 to 1.1)	
Stress					
	Infant subgroup		0.11		0.03
	IFCIDS	3.1 (reference)		3.1 (reference)	
	Colic minus IFCIDS	1.1 (0.03 to 2.1)		1.7 (0.6 to 2.9)	
	IISMO minus IFCIDS	0.5 (–0.6 to 1.7)		0.3 (–0.8 to 1.4)	
	Age	–0.02 (–0.1 to 0.1)	0.65	–0.007 (–0.1 to 0.1)	0.89
	Birth Weight	–0.2 (–0.9 to 0.5)	0.50	–0.13 (–0.8 to 0.5)	0.69
	Number of treatments	–0.02 (–0.19 to 0.14)	0.80	0.18 (–0.02 to 0.38)	0.07
	Gender				
	Female	3.8 (reference)	0.77	3.8 (reference)	0.90
	Male	0.1 (–0.7 to 0.9)		–0.04 (–0.8 to 0.7)	
	Refer by health care practitioner				
	No	3.3 (reference)	0.02	3.3(reference)	0.39
	Yes	0.9 (0.1 to 1.7)		0.3 (–0.4 to 0.7)	
	Allergy/Asthma in family				
	No	3.7 (reference)	0.64	3.4 (reference)	0.66
	Yes	0.2 (–0.6 to 1.0)		0.2 (–0.7 to 1.0)	
Consolability					
	Infant subgroup		<0.001		<0.001
	IFCIDS	3.0 (reference)		2.8 (reference)	
	Colic minus IFCIDS	2.0 (1.0 to 3.0)		2.7 (1.6 to 3.7)	
	IISMO minus IFCIDS	0.2 (–0.9 to 1.3)		0.4 (–0.6 to 1.4)	
	Age	–0.07 (–0.2 to 0.04)	0.19	0.03 (–0.07 to 0.1)	0.60
	Birth Weight	0.2 (–0.4 to 0.9)	0.48	0.06 (–0.5 to 0.7)	0.85
	Number of treatments	–0.15 (–0.3 to 0.02)	0.07	0.15 (–0.03 to 0.34)	0.10
	Gender				
	Female	4.4 (reference)	0.20	3.9 (reference)	0.53
	Male	–0.5(–1.3 to 0.3)		–0.2 (–0.9 to 0.5)	
	Refer by health care practitioner				
	No	3.7 (reference)	0.07	3.7 (reference)	0.34
	Yes	0.7 (–0.06 to 1.6)		0.3 (–0.4 to 1.0)	
	Allergy/Asthma in family				
	No	4.1 (reference)	0.64	3.6 (reference)	0.90
	Yes	0.2 (–0.6 to 1.0)		0.06 (–0.7 to 0.8)	

Although some authors suggest scant evidence for efficacy in the treatment of colic using chiropractic as an intervention,[24] others such as Hughes and Bolton suggest that "there is good evidence that taking a colicky infant to a chiropractor will result in fewer reported hours of colic by the parents."[25] This may indicate a dearth of high quality trials or, alternatively, evidence of a genuine treatment effect. Either way, it is an important finding that parents genuinely perceive that children cry less after a therapeutic encounter. In support of the Hughes and Bolton proposition, this study also shows that parents reported that all three groups showed reductions in crying prior to discharge with the greatest improvement in crying and consolability in those infants categorised as "colic."

Given the self-reported nature of outcomes by parents, it is quite likely that changes in parents' stress may have affected crying and that changes in crying may have affected parents' stress. It is possible that with infant recovery came lowered stress levels in the parents.

On the other hand, it must be considered that parental stress may have reduced naturally with time rather than as a result of crying reduction. Whatever the mechanism, it is apparent that the same level of parental stress reduction did not occur in the IFCIDS category who's crying did not reduce as markedly as the other two groups. This study was not designed to understand the interaction between parental stress and infant crying, but it is still important to note that mothers reported experiencing reduced stress when crying was reduced. This finding is consistent with that of other studies.[2,26,27]

The primary objective of this study was to describe unique characteristics of crying infants that differ between clinically plausible subgroups. There is clinical logic to the divisions; colic babies cry a great deal and are inconsolable, but sleep reasonably well. IISMO infants cry a great deal, but are consolable when they are able to reach a comfortable position with antalgic posture and therefore cry less, but do not sleep well because they are unable to maintain this position when placed supine in a cot (required due to the back-to-sleep programme). IFCIDS cry the most and sleep the least. It has been hypothesized that crying can occur at the expense of sleep and that seems to be the case in the IFCIDS group. Additionally in this group there may be another component to these children's discomfort as they do not feed well; this is not a problem in either of the other two groups. Therefore, hunger may be part of the problem, although there were no notable differences in growth charts (results not shown). Further studies should be carried out to see if this is the case.

Improved sleeping patterns in paediatric patients after manual therapy treatment is frequently reported in the literature.[18,23,28,29] In a RCT of 43 infants, the mean hours of sleep per day were significantly improved at day 14 in both groups that received manual therapy.[23] Parents also reported improved sleep in our study to a significant degree.

True to their reputation, colic infants were the least consolable[1–5,8,9,18] at baseline and the IISMO group were the easiest to console. This observation may have clinical plausibility in that IISMO infants become comfortable with help achieving their posture of comfort. Colic infants do not respond to postural change. After chiropractic care the colic group became more consolable than the IISMO group. To reach this level, the colic group reported the highest average improvement score in consolability.

Both the IISMO and colic groups reported the highest average level of overall improvement compared to the IFCIDS category. It is interesting to note that in those infants considered to have a preponderance of musculoskeletal problems (IISMO and Colic).[8,10,7,18–23] that improvement during chiropractic treatment was most marked. Such an association was not found in the IFCIDS group and it is possible that manual therapy may not be the treatment of choice for this group of crying infants, although further investigation is needed to corroborate this idea.

Clear limitations exist in this study. First, the prospective cohort design precludes any association of changes seen with treatment as all the effects observed may be a consequence of effect upon the mothers reporting rather than direct effects on the baby, natural history or age, although the treatment times of 2–3 weeks was generally shorter than the accepted natural history of the disorder (12–24 weeks).[1–6,15,30] However, parent reporting of cryfuss problems are clinically relevant and have been used in other studies in the literature.[30,31] Second, it should also be noted that this study was subject to sampling bias as it was limited to one teaching clinic, the patient population of which may be different from that of a small field practice or to other larger geographical areas.

In summary, the main aim of the study was to document any differences between clinically defined cat-

egories of crying infants. Although categorisation was achieved without prior strong evidential support, considerable observational data suggest that there may be real differences between types of crying babies, particularly three groups described herein, IISMO and IFCIDS. Further studies should be carried out to ascertain the veracity of these observations but at the very least, in this study, *a priori* categorisation of crying infants was associated with significant differences in measured outcomes.

In conclusion, the excessively crying infant may not be a homogenous group and it is possible that the categorization used here may capture relevant characteristics that serve to differentiate meaningful subgroups. It remains a possibility that treatment outcome can be improved by clinically dividing patients into appropriate subgroups prior to manual therapy.

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Clinical effectiveness of the activator adjusting instrument in the management of musculoskeletal disorders: a systematic review of the literature

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Objective: *The purpose of this study was to conduct a systematic review of the literature investigating clinical outcomes involving the use of the Activator Adjusting Instrument (AAI) or Activator Methods Chiropractic Technique (AMCT).*

Methods: *A literature synthesis was performed on the available research and electronic databases, along with hand-searching of journals and reference tracking for any studies that investigated the AAI in terms of clinical effectiveness. Studies that met the inclusion criteria were evaluated using an instrument that assessed their methodological quality.*

Results: *Eight articles met the inclusion criteria. Overall, the AAI provided comparable clinically meaningful benefits to patients when compared to high-velocity, low-amplitude (HVLA) manual manipulation or trigger point therapy for patients with acute and chronic spinal pain, temporomandibular joint (TMJ) dysfunction and trigger points of the trapezius muscles.*

Conclusion: *This systematic review of 8 clinical trials involving the use of the AAI found reported benefits to patients with a spinal pain and trigger points, although the clinical trials reviewed suffered from many methodological limitations, including small sample size,*

But : *La présente étude a pour objet d'effectuer un recensement systématique des écrits portant sur les résultats cliniques suivant l'utilisation de l'instrument d'ajustement activateur (Activator Adjusting Instrument ou AAI) ou de la technique chiropratique des méthodes de l'activateur (Activator Methods Chiropractic Technique ou AMCT).*

Méthodologie : *Une synthèse des écrits a été effectuée à partir des bases de données de recherches et celles sur support informatique disponibles, ainsi qu'en cherchant manuellement dans des revues et en effectuant un suivi des références trouvées dans les études portant sur l'efficacité clinique de l'AAI. Les études qui répondent au critère d'inclusion ont été évaluées au moyen d'un instrument calculant leur qualité méthodologique.*

Résultats : *Huit articles ont répondu au critère d'inclusion. En général, les bienfaits cliniquement significatifs de l'AAI sont comparables à ceux de la manipulation à haute vitesse et faible amplitude ou de la thérapie par zone gâchette pour les patients souffrant de douleur aiguë ou chronique à la colonne vertébrale, de dysfonction de l'articulation temporomandibulaire (ATM) et de zone gâchettes du trapèze.*

Conclusion : *Selon la présente revue systématique de huit essais cliniques portant sur l'utilisation de l'AAI, on rapporte des bienfaits pour les patients souffrant de douleur à la colonne vertébrale et de zones gâchettes, quoique les essais cliniques étudiés étaient soumis à de nombreuses limites sur le plan méthodologique, comme un échantillon de petite taille, des périodes de suivi*

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relatively brief follow-up period and lack of control or sham treatment groups.
(JCCA 2012; 56(1):49–57)

KEY WORDS: Activator Methods chiropractic technique, mechanically assisted adjusting instrument/device, instrument assisted manipulation

relativement brèves, et d'un manque de groupes témoins ou placebo.
(JCCA 2012; 56(1):49–57)

MOTS CLÉS : Technique chiropratique des méthodes de l'activateur (*Activator Methods chiropractic technique*), instrument/dispositif d'ajustement à assistance mécanique, manipulation aidée par un instrument

Introduction

With the notable exception of the manual Diversified technique, which involves high velocity and low amplitude (HVLA) thrusting spinal manipulative therapy (SMT) (also commonly referred to as spinal adjustments), the therapeutic intervention most commonly used for patient care by chiropractors is instrumented-adjusting using the Activator Adjusting Instrument (AAI). According to the 2005 National Board of Chiropractic Examiner's (NBCE) Job Analysis[1] 51.2% of American chiropractors report using the AAI for patient care, although this data does not differentiate between those practitioners who use the AAI only (often as a substitute for HVLA manipulation) from those practitioners who use the Activator Methods Chiropractic Technique (AMCT), a technique system that involves a group of specialized diagnostic procedures during prone leg length checking.[2] [The 2005 NBCE Job Analysis is the most recent source of information on the rates of use of different technique systems by chiropractor since the NBCE's Practice Analysis of Chiropractic 2010 did not capture this data]. The 1993 NBCE Job Analysis[3] reported roughly 40% of Canadian chiropractors use an AAI, although more recent estimates range from 31.4%[4] to 22%.[5] A survey of British chiropractors reported 82% of respondents indicated they use an AAI, although only 2% of them stated they used it as their primary treatment method[6] and the NBCE 1994[7] reported that 72.7% and 54.3% of Australian and New Zealand chiropractors, respectively, used an AAI.

In 2001, Cooperstein et al.[8] and Gatterman et al.[9] published companion articles that sought to characterize the literature with respect to chiropractic technique procedures for various low back conditions and rate the effectiveness of specific chiropractic procedures for low back conditions, respectively. These systematic reviews reported that the widest base of evidential support existed for side posture HVLA manipulations and a panel of experts ascribed a value of 9.3/10 with respect to clinical effectiveness for acute low back pain and 8.1/10 for chronic low back; by contrast, instrumented-adjusting was only allocated a score of 3.7/10 for acute low back pain and 1.6/10 for chronic low back pain.[9] This led Cooperstein et al. to assert: "These considerations suggest that those researchers attempting to validate the appropriateness of their favored methods had best focus more on the type of research they do- more on outcomes and less on peripheral matters such as modeling and the reliability of diagnostic procedures."[8p410]

A review of the literature conducted in 2001 found that the number of retrievable articles from the peer-reviewed literature on AMCT (n = 21) was second only to the number of retrievable articles on Upper Cervical techniques (n = 28).[10] [It should be noted that the developers of Chiropractic BioPhysics/Clinical Biomechanics of Posture have also been very prolific with respect to publishing in the peer-reviewed literature, but many of those studies principally focused on mathematical modeling of the spine.[11,12]].

Since that time, investigations of AAI and AMCT have continued at an impressive rate. That being said, many of these published articles have investigated the mechanical properties of the AAI, the reliability and validity of prone leg length checking and the reliability and validity of diagnostic tests unique to AMCT (isolation, stress and pressure tests). Despite Cooperstein et al's admonishment a decade earlier, relatively few studies have investigated the clinical effectiveness of the AAI. For example, the 2001 review of the literature cited above[10] found only 6 case studies, 2 case series and 2 clinical trials involving AAI or AMCT. A textbook chapter devoted to describ-

ing AMCT published in 2004[13] found only one additional clinical trial published between 2001 and 2004. Moreover a DVD[14] listing all published studies on the AAI or AMCT [distributed by Activator Methods Inc to attendees of the 2011 Association of Chiropractic Colleges and Research Agenda Conference (ACC-RAC)] had only one incomplete additional clinical trial, indicating a continued under-representation of studies of this nature. Even so, notwithstanding the relative paucity of clinical investigations, advocates of the AAI and AMCT continue to extol its clinical value and usefulness.[13,14]

The purpose of this study was to conduct a systematic review of the literature investigating clinical outcomes involving the use of the AAI or AMCT. A brief narrative review of each article that met the inclusion criteria is also provided.

Methods

This study was approved by the Ethics Review Board of the Canadian Memorial Chiropractic College.

The following electronic databases were searched from their earliest date of publication to April 2010: ICL, MANTIS, and AMED. CINHAHL and MEDLINE were searched through EBSCO publishing. The following key terms were used: "Activator Adjusting," "Activator Technique," "Neck pain," Low back pain," "Mechanical manipulation," "Mechanically assisted device" and "Instrument assisted manipulation.") The initial search strategy was then further refined by using the following MeSH terms: chiropractic*, therapy*, joint dysfunction* and cervical vertebrae*. References were also used from citations found in papers that were included after reviewing the inclusion and exclusion criteria for each. Citations from specific articles (reference tracking) were then researched independently through selected databases followed by hand searching throughout the periodicals.

Inclusion/exclusion criteria

Several inclusion/exclusion criteria were used to select studies eligible for this review. Inclusion criteria were as follows: studies must involve more than one subject; treatments must have been administered by a qualified chiropractor; papers were written in English; were published between January 1980 and March 2010; prospective or retrospective studies including RCTs, controlled clinical/quasi-experimental trials, cohort, case control and case series; studies using some type of outcome measure for determining the effect of chiropractic care [i.e. Visual Analogue Scale (VAS), Numerical Pain Rating Scale (NPRS), Neck Disability Index (NDI), Oswestry Disability Index (ODI), McGill Pain Questionnaire, range of motion, algometer/goniometer devices]; published in peer-reviewed journal and; only studies involving human subjects.

Subject age, sex, demographic, and pain type and duration were not consistent among studies and were therefore not utilized as inclusion criteria in this review. Manuscripts from conference proceedings or abstracts of studies were not included in this review since the criteria for inclusion in a conference proceeding is often much less stringent than the criteria used for inclusion in peer-reviewed indexed journals. Using these inclusion criteria, eight articles qualified for review.

Instrument Used to Review Eligible Articles

The articles selected for review were evaluated using an instrument developed by Sackett (see Table 1).[15]

Four authors (TH, ALB, MP, LB) independently reviewed the studies meeting the inclusion criteria. The data from all included articles were recorded onto a data extraction sheet by the authors as part of the review. The authors checked and edited all entries for accuracy and consistency. Recorded data included study authors and quality score, details of the study design, sample, interventions, outcome measures, and main results/conclusions of the study. These four authors met on April 5th, 2010 to compare their graded scores. Any discrepancies of scores between the authors were settled via discussion until consensus was reached.

Results

The initial search strategy yielded 283 hits when using the search terms "Instrument and Manipulation." Many articles found that discussed instrumentation other than an AAI or discussed unrelated topics such as historical development of the Activator, diagnostic testing used by AMCT practitioners or other non-clinical issues. Once refined to "Mechanically Assisted Manipulation" 51 articles were found. Of these 51 articles, only eight met our inclusion criteria.[16–23] After methodological quality assessment of each article using the grading instrument, papers were allocated scores out of a possible 50 points

Table 1 *Instrument Categories Used to Grade Articles for this Review*

Grading Criteria:

Assignment of patients (/9)
No mention of randomization-score 0; case study fully described-score 2; retrospective study fully described-score 4; prospective study fully described-score 5; non-randomized clinical trial-score 6; randomized clinical trial-score 7; non-randomized controlled trial with inadequate randomization-score 8; randomized controlled trial with adequate randomization described-score 9.

Baseline values of groups (/8)
No mention of baseline values-score 0; baseline values mentioned but not statistically significant-score 4; baseline values mentioned and not statistically significant-score 8.

Relevance of outcomes and clinical significance (/7)
No mention of outcomes and clinical significance-score 0; subjective outcome measures-score 3; objective outcome measures-score 5; both subjective and objective outcome measures-score 7.

Prognostic stratification (comorbidity and risk factors) (/6)
No clear mention of study inclusion or exclusion criteria-score 0; inadequate mention of inclusion or exclusion criteria-score 3; complete mention and description of inclusion and exclusion criteria-score 6.

Blinding strategies (/5)
No blinding strategies mentioned-score 0; single blinded study without method described and appropriate-score 2; single blinded study with method described and appropriate-score 3; double blinded study without method described and appropriate-score 4; double blinded study with method described and appropriate-score 5.

Contamination/co-intervention (/4)
No mention of ways to control for contamination or co-intervention-score 0; some patients received some sort of contamination or co-intervention-score 2; assumed that no contamination or co-intervention took place due to immediate follow-up-score 3; contamination and co-intervention closely monitored and accounted for-score 4.

Compliance of subjects to study procedures (/4)
No mention or detail given to compliance of study subjects-score 0; compliance and co-intervention of patients monitored but not closely monitored-score 1; some patients were compliant and did not receive co-interventions and was closely monitored and detailed-score 2; compliance of subjects was assumed due to immediate follow-up-score 3; all patients were compliant and closely monitored and detailed-score 4.

Drop-out rates of subjects (/3)
No mention of drop-out rates-score 0; drop-out rates mentioned-score 1; no drop-out rates assumed due to immediate follow-up-score 2; number and reason for drop-outs described- score 3.

Follow-up levels (/2)
No mention of subject follow-up-score 0; immediate follow-up mentioned/performed-score 1; adequate follow-up mentioned/performed-score 2.

Publication date of research (/2)
Published prior to 1990-score 0; published after 1990 and before 2000-score 1; published after 2000-score 2.

Total Score: /50

(Table 2). Articles are listed in descending order of their score using the Sackett criteria; in the event two or more articles had the same score, they were arranged alphabetically (Table 3).

Discussion

When assessed in terms of clinical effectiveness, AAI and manual manipulation were both found to result in equally statistically significant patient outcomes, although the differences between the use of these two treatment interventions was not statistically significant. Studies investigating the use of AAI only reported that it conveyed clinically meaningful benefits to patients.

Instrumented-Adjusting in Chiropractic

Instrumented adjusting has grown in popularity since the time Solon Langworthy first developed a table mounted percussive device in the early 19th century.[24] Along with the AAI other chiropractic technique systems have developed adjusting instruments. There are a number of instrumented Upper Cervical techniques that involve cervical adjusting devices that are handheld, floor-mounted or table-mounted.[25] Other notable examples include the Integrator associated with Torque Release Technique[26] and a floor mounted device used by CBP practitioners.[27] An internet search for "instrumented-adjusting devices in chiropractor" found a device called an "Impulse Adjusting Instrument" developed by NeuroMechanical Innovations,[28] and a device called the "Pro-Adjustor"[29] has recently been demonstrated at chiropractic trade shows over the past few years (for example, the 2011 World Federation of Chiropractic conference in Rio de Janeiro, Brazil and the 2010 Canadian Chiropractic Conference in Toronto, Ontario, Canada).

Instrumented adjusting is thought to convey multiple benefits to both patients and practitioners.[2,30–33] From the perspective of the patient, benefits conveyed by instrumented-adjusting include: the management of patients with osteoporotic bone fragility;[2,31–33] for children; for patients who are fearful of manipulative procedures that result in joint cavitation (i.e "cracking"); for extremity adjusting; to (theoretically) achieve greater joint specificity[2,30] and; it can be used for patients who wish not be physically touched (perhaps they have been physically or sexually abused, for example).[30] To date, no experimental or clinical evidence exists that the use of instrumented-adjusting demonstrates a better safety profile compared to manual manipulation with respect to serious adverse events (i.e stroke) in patients with identified or unidentified vascular risk factors, since manual manipulation has not been conclusively linked to the incidence of stroke at all.[34]

From the perspective of the practitioner, instrumented adjusting can be used in cases of doctor injuries (disabilities of the hand, wrist, elbow or shoulder, for example) and it can used to compensate for anthropomorphic differences between a small doctor and a large patient.[2,30] Lastly, AAI conveys benefits to the research community since it can be used as a "sham" procedure by setting it to "0" since even set to "0" the AAI will still produce an audible sound.[2]

Currently, instrumented-adjusting is permitted for use by chiropractors in all Canadian, American, British and Australian jurisdictions,[5] although that has not always been the case. As recently as 2004, Saskatchewan prohibited its members from instrumented adjusting. The reasonableness of this standard of practice was raised in an article by one the authors of this review (BG) in an article published in 2002;[30] this spawned a heated exchange of letters to the editor.[35–37] Contemporaneously, the Chiropractic Association of Saskatchewan (CAS) struck a Committee to evaluate the literature on the efficacy, safety, usage and educational requirements for chiropractic practice relative to AAI [or mechanical adjusting devices (MAD) as it was termed in that report[38,39]]. Overall, the majority of the Committee members (4–2) concluded that, while all of the studies it reviewed were flawed to varying degrees and the literature was generally weak, the evidence supported the statement that AAI procedures were as effective as manual HVLA procedures in producing clinical benefits and biological change.[38] The Committee reached consensus (5–1) that AAI procedures are widely used for spine related and extremity conditions, is safe and has no more risk than do manual HVLA procedures (majority opinion 4–2).[39] Lastly, the Committee reached consensus (5–1) that there was no evidence with respect to educational requirement to form any conclusions.[39]

General Weaknesses of Studies Reviewed

Irrespective of the wide utilization rates among chiropractors, and despite the plethora of practical benefits to patients and practitioners championed by its proponents,

Table 2

ARTICLE / CRITERIA	Gemmell et al. 2009	Yurkiw/ Mior. 1996	DeVocht et al. 2003	Osterbauer et al. 1993	Wood et al. 2001	Gemmell et al. 1995	Schneider et al. 2010	Shearar et al. 2001
ASSIGNMENT OF PATIENTS (/9)	7	7	5	6	7	7	7	7
BASELINE VALUES OF GROUPS (/8)	4	4	4	4	4	0	8	4
RELEVANCE OF OUTCOMES & CLINICAL SIGNIFICANCE (/7)	7	7	7	7	7	3	3	7
PROGNOSTIC STRATIFICATION (COMORBIDITY AND RISK FACTORS) (/6)	6	3	6	3	6	6	6	6
BLINDING STRATEGIES (/5)	3	3	0	0	0	3	0	0
CONTAMINATION/ CO-INTERVENTION (/4)	3	3	3	2	4	3	2	0
COMPLIANCE OF SUBJECTS TO STUDY PROCEDURES (/4)	4	4	3	4	0	3	0	0
DROP-OUT RATES OF SUBJECTS (/3)	3	2	2	3	0	2	0	0
FOLLOW-UP LEVELS (/2)	2	1	0	2	2	0	0	2
DATE OF PUBLICATION (/2)	2	1	2	1	2	1	2	2
TOTAL (/50)	41	35	32	32	32	28	28	28

Table 3

Reference	Objective	Trial Design	/50	Patients/ Conditions	Interventions	Main Outcome Measures	Follow-Up Period	Main Results/Conclusions
Gemmell et al. 2009	1 To examine the effects of ischemic compression vs. Activator on trigger points	Randomized Clinical Trial	41	52 volunteer subjects w/ tender, active trigger points of trapezius muscle	1 Ischemic compression 2 Activator	1 PGIC 2 NRS 3 PPA (Algometer)	10 minutes	– Both interventions showed improvement in all outcome measures, but no statistical significance b/w groups
Yurkiw & Mior 1996	1 Comparison of Diversified SMT & Activator on ROM & Pain	Randomized Comparative Clinical Trial	35	14 established patients w/ subacute unilateral neck pain	1 Diversified SMT 2 Activator	1 C-ROM Goniomentric (inclinometer) device 2 VAS	Immediate	– No statistical significance b/w interventions – Both interventions showed improvement in all outcome measures, but no statistical significance b/w groups
DeVocht et al. 2003	1 To evaluate the effectiveness of Activator treatment on TMD	Prospective Case Series	32	8 patients w/ chronic articular TMD	1 Activator	1 VAS 2 Maximum active mouth opening in pain free range (ROM)	None	– Signs & symptoms of patient TMD improved w/ course of Activator treatment
Osterbauer et al. 1993	1 To evaluate diagnostic and biomechanical assessment of SIJS 2 To assess treatment value of Activator on SIJS	Descriptive Case Series	32	10 patients w/ chronic sacroiliac joint syndrome	1 Activator	1 VAS 2 ODI 3 Lumbosacral provocation tests 4 Gait analysis 5 Postural Sway	1 year	– Activator proved beneficial in treatment of chronic SIJS
Wood et al. 2001	1 Comparison of Diversified SMT & Activator on cervical spine dysfunction	Randomized Clinical Trial	32	30 patients w/ subacute neck pain	1 Diversified SMT 2 Activator	1 NDI 2 NPRS 3 McGill Pain Questionnaire 3 ROM w/ Goniometer	1 month	– No statistical significance b/w interventions – Both interventions showed beneficial effects in reducing pain & disability while increasing ROM
Gemmell et al. 1995	To examine the immediate effects of Activator vs. Meric technique on acute LBP	Randomized Control Trial	28	30 established patients w/ acute LBP	1 Activator 2 Meric	1 VAS	Immediate	– Both interventions showed improvement in all outcome measures, but no statistical significance b/w groups
Schneider et al. 2010	1 Examine treatment effect on NPRS and ODI when comparing Activator and manual SMT (Low back)	Non-Randomized Cohort	28	92 established patients from 3 chiropractic clinics w/ 3 month history of low back pain	1 Activator 2 Diversified Side Posture	1 NPRS 2 ODI	None	– Study found neither intervention superior to the other, while providing profession with valuable information on the influence of treatment expectation
Shearar et al. 2001	1 Comparison of Diversified SMT & Activator of SIJS	Prospective Randomized Clinical Trial	28	60 subjects w/ a previous history of SIJS	1 Diversified SMT 2 Activator	1 NRS-101 2 Revised ODI 3 Orthopedic rating scales 4 Algometer	None	– No statistical significance b/w interventions – Both interventions showed improvement in all outcome measures, but no statistical significance b/w groups

this study found only 8 clinical trials that sought to determine the clinical effectiveness of the AAI, the form of instrumented-adjusting with the most publication in the peer-reviewed journals. None of the clinical trials reviewed here were randomized clinical trials; that is, none of them included a control (no-treatment) group or a sham treatment group or included patients without any clinical symptoms at all.

In general, examiners in the studies reviewed in this article were seasoned practitioners well acquainted with

AAI use or with AMCT as well as the other treatment modality option employed (i.e. spinal manipulation, trigger point therapy). All the studies used small study populations, ranging from 8 to 92 subjects. Moreover, not all studies were adequately controlled with respect to both subject and examiner blinding, with 5 of the studies being assigned a "0" out of 5. An additional limitation was that all but one study failed to either strategize or adjust for relevant baseline characteristics. Due to the lack of long-term follow-up care and the use of a single treatment intervention, contamination and co-intervention grading had to be assumed in 4 of the 8 studies which may have further influenced the overall quality of these studies. A further limitation was that 7 of the 8 studies utilized a previously established patient base as study subjects, thus introducing the possible confounding factors of treatment expectancy and type II errors.

Conclusion

This systematic review of 8 clinical trials involving the use of the AAI found reported benefits to patients with spinal pain and trigger points, although these results were not statistically significantly different when compared to the use of HVLA manual manipulation or trigger point therapy.

Given the wide use and clinical utility of the AAI, it is unfortunate that most of the clinical trials investigating its effectiveness were only pilot studies involving between 8 and 92 patients and typically involving only one or two treating doctors with a limited post-study follow-up. That said, there does exist case studies, case series, clinical trials and now this systematic review that suggests patients do experience positive and clinically meaningful benefits when treated for spinal pain and trigger points using an AAI. Clinically meaningful improvements were documented in patients with acute and chronic low back or SIJ pain, acute and subacute neck pain, TMJ disorders and trigger points in the trapezius muscle.

Further studies ought to include a larger patient base using a placebo or sham group and a no-treatment group, better randomization and blinding protocols and longer-term post-intervention follow-up in order to more definitively assess the benefits of AAI treatment.

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Spontaneous conus medullaris infarction in a 79 year-old female with cardiovascular risk factors: a case report

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Objective: *To detail the case of a 79 year-old female who presented with sudden bilateral neurological deficits of the lower extremities and was later diagnosed with non-traumatic conus medullaris infarction. The purpose of this case report is to inform primary contact practitioners of the presentation, diagnosis and the associated risk factors of this condition in order to facilitate prompt management.*

Clinical Features: *Spinal cord infarction presenting as low back pain with a high degree of bilateral loss of motor strength, sensation and reflexes in the lower extremities and bowel/bladder dysfunction, in a patient with previous coronary artery bypass graft surgery and renal insufficiency.*

Intervention and Outcome: *Referral to emergency within hours of symptom onset allowed for immediate assessment, management and relatively favourable partial recovery.*

Summary: *Although rare, conus medullaris infarction is potentially devastating and requires an appropriate clinical index of suspicion for timely diagnosis, treatment and optimal neurological recovery.*
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KEY WORDS: spinal cord diseases, spinal cord ischemia, spinal cord infarction, conus medullaris

But : *Il s'agit d'un rapport détaillé du cas d'une femme de 79 ans souffrant de déficits neurologiques bilatéraux d'apparition soudaine aux membres inférieurs, qui a ultérieurement reçu le diagnostic d'infarcissement non traumatique du cône médullaire. Ce rapport de cas a pour objectif d'informer les praticiens de premier contact du tableau clinique, du diagnostic et des facteurs de risques associés à ce trouble afin de faciliter une prise en charge rapide.*

Caractéristiques cliniques : *Infarcissement de la moelle épinière se manifestant sous forme de douleur lombaire accompagnée d'un degré élevé de perte de motricité bilatérale, de sensation et de réflexes dans les membres inférieurs ainsi que d'une dysfonction intestinale/vésicale chez une patiente ayant déjà subi un pontage coronarien et une insuffisance rénale.*

Intervention et résultat : *La patiente a été transférée au service d'urgence dans les quelques heures suivant l'apparition des symptômes où elle a pu être immédiatement évaluée et prise en charge, et bénéficier d'un rétablissement partiel relativement favorable.*

Résumé : *L'infarcissement du cône médullaire, bien que rare, a le potentiel d'être dévastateur et nécessite un indice de suspicion clinique approprié pour que le diagnostic, le traitement et le rétablissement neurologique optimal puissent se faire en temps opportun.*
(JCCA 2012; 56(1):58–65)

MOTS CLÉS : Maladies de la moelle épinière, ischémie médullaire, infarcissement médullaire, cône médullaire

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Consent: Patient gave consent verbally to use her file and images for the purpose of this case report.
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Introduction

Spinal cord infarction occurs much less frequently than cerebral infarction, accounting for 1% of all strokes.[1] This can occur anywhere along the length of the spinal cord, with infarctions at the conus medullaris thought to be particularly rare.[2,3] Although the condition is rare, it is potentially devastating and may result in significant and residual impairments in sphincter control and ambulation. Thus, prompt assessment and diagnosis is necessary to ensure appropriate management in order to preserve neurological function.

The purpose of this case report is to heighten awareness of spinal cord infarction since the main predictors of long term outcome are the neurological state and duration of symptoms at time of diagnosis. The report details the clinical presentation of a non-traumatic conus medullaris infarction in a 79 year-old female with associated cardiovascular risk factors of previous coronary artery bypass graft surgery (CABG) and renal insufficiency. The prompt assessment and management resulted in relatively favourable partial recovery of neurological function.

The report underscores the varied presentation of conus medullaris infarctions and emphasizes its consideration to facilitate immediate referral to the emergency department for surgical consultation and appropriate management. Further, the demographics and outcomes of conus medullaris infarction are not well studied. This case report sheds some light on the potential risk factors and treatment outcomes of spontaneous conus medullaris infarctions.

Figure 1 *Sagittal T2 weighted MR image of the thoracic and lumbar spine demonstrates mild expansion and diffuse abnormal high signal intensity within the central distal cord and conus medullaris.*

Case Report

A 79 year-old female awoke in the morning with spontaneous low back and right leg pain that developed into bilateral total lower extremity paresthesias and progressive bilateral motor weakness. She was transferred to the emergency department by ambulance shortly after the onset of symptoms. On initial examination, hip flexion, knee extension, and ankle dorsi- and plantar flexion strength were graded as 0/5 bilaterally. Lower limb deep tendon reflexes were absent, while upper limb reflexes were normal. Sensation to pin prick was decreased below the T12 level. The plantar reflex was flexor bilaterally (i.e. negative Babinski sign). There was a decrease in anal tone and moderate urinary retention. Vital signs were within normal limits. Cardiovascular, respiratory, and abdominal examination were unremarkable. Peripheral pulses within the lower limbs were also normal. Past medical history was remarkable for coronary artery disease with previous coronary artery bypass graft (CABG) surgery, right mastectomy with lymph node dissection, bipolar disorder, and renal insufficiency.

An MRI of the thoracic and lumbar spine and CT aortogram were conducted. MRI revealed diffuse abnormal high T2 signal centrally within the expanded conus medullaris with a peripheral rim of sparing; this extended over approximately the distal 9 cm of the spinal cord (Figures 1 and 2). Associated restricted diffusion was additionally noted in this region (Figure 3). CT angiography images demonstrated marked diffuse atheromatous disease of the aorta and its major branches including a posterior penetrating ulcer at approximately the T12 to L1 vertebral levels with evidence of plaque rupture, as

Figure 2 *Corresponding axial T2 weighted MR image taken at the level of the distal cord shows the centrally located high signal (arrow).*

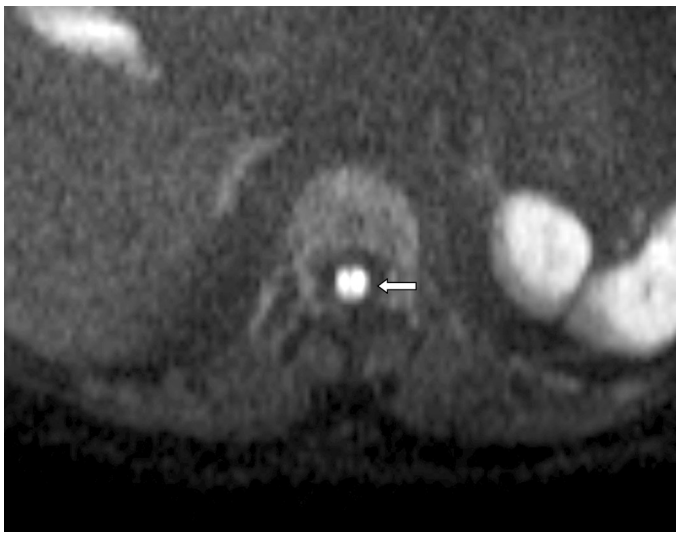


Figure 3 *Diffusion weighted imaging reveals that there is restricted diffusion in this area (arrow).*

demonstrated by an adherent intraluminal filling defect / thrombus within the aorta (Figures 4A and 4B).

Following the diagnosis of conus medullaris infarction, the patient was admitted under the neurology service for management. A vascular surgeon was consulted but medical management was favoured. The patient was also seen by psychiatry for her history of bipolar disorder and a labile mood during her stay in the hospital. No psychiatric treatment was deemed necessary as mood changes (depression) were thought to be related to her current physical condition. She experienced minor complications in renal function, as well as occasional low blood pressure that required a modification to her medications.

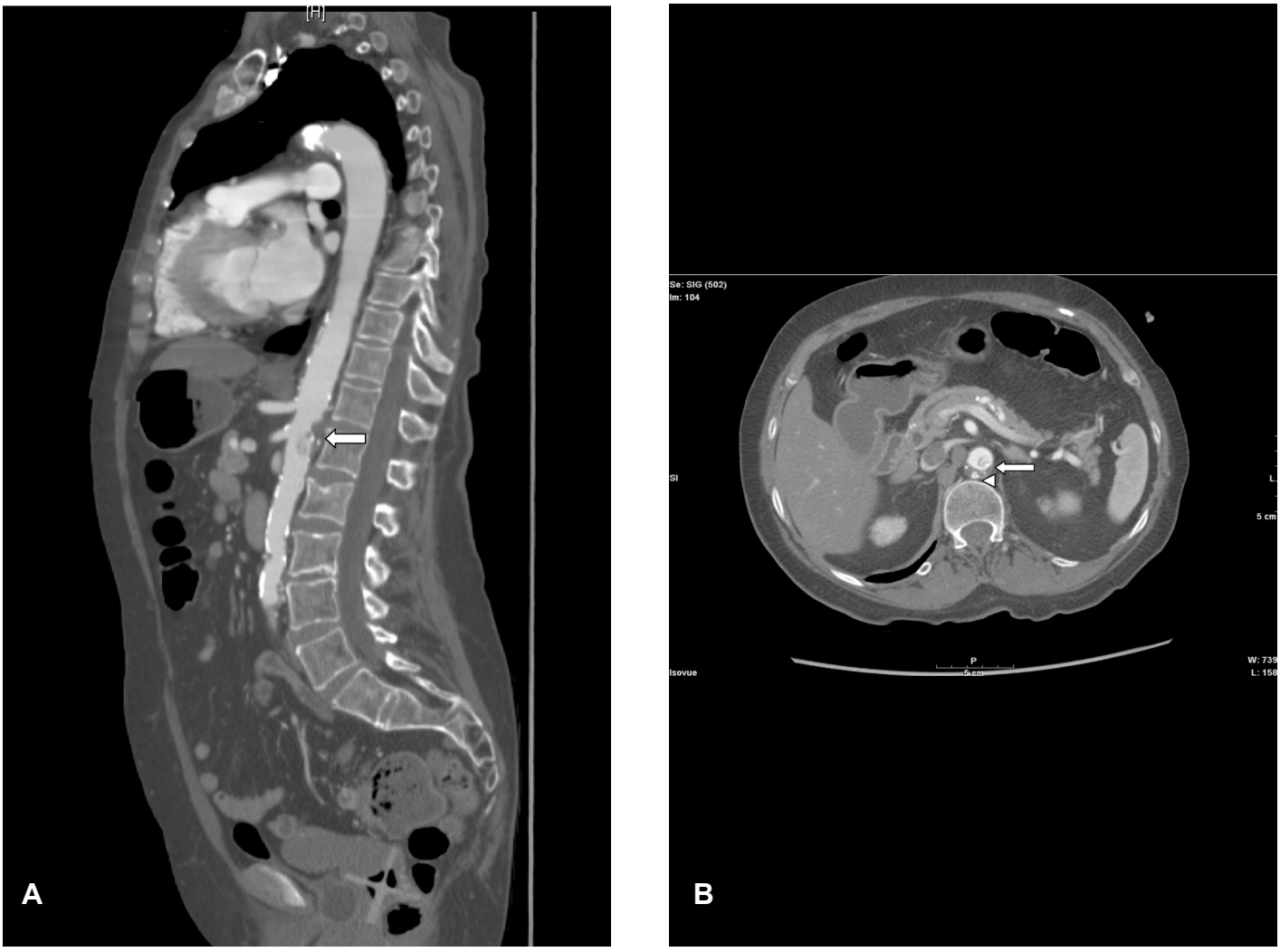
In-hospital treatment included anti-platelet (clopidogrel) and anti-coagulation medications (initially with intravenous and subsequently subcutaneous heparin), as well as physical therapy and occupational therapy directed at her activities of daily living, in preparation for transfer to a rehabilitation hospital for more extensive care. The symptoms of bilateral total lower limb paresthesias and motor weakness gradually improved through the length of her hospital stay. The patient regained partial strength in her lower extremities, with greater improvement on the right. At the time of transfer to another hospital for rehabilitation, her strength on the right was 3/5 for hip flexors, 2/5 for knee extensors, and 1/5 for right ankle dorsi- and plantar flexors. On her left extremity, the hip flexors were rated 2/5, while knee and ankle strength was 0/5. The neurological symptoms were stable at the time of transfer, indicating partial but relatively favourable recovery of the conus medullaris infarction.

Discussion

The incidence of conus medullaris infarction is not well understood. Some of the first reports on this condition were published in the 1980's[2,4] and studies to date have largely explored this entity retrospectively and in concert with other spinal cord infarctions. In a 2007 retrospective review of 175 patients diagnosed with a spinal cord injury clinical syndrome in an acute rehabilitation centre, 14 patients were classified as having conus medullaris syndrome.[5] Only three of these patients were associated with non-traumatic etiologies, namely hypoperfusion, infection or tumour.[5]

The most recognized etiologies of ischemia of the spinal cord are atherosclerosis and cardio-embolic infarc-

Figures 4A and 4B *Sagittal and axial CT images, acquired with intravenous contrast in the arterial phase, reveal diffuse calcified and noncalcified atheromatous disease of the aorta and its major branches. At approximately the L1 level, there is a posterior penetrating atheromatous ulcer of the descending aorta (arrowhead) with evidence of plaque rupture (intraluminal thrombus/plaque material) (arrow).*



tion, leading to obstruction of the tissue's blood supply.[6] Rare causes of conus medullaris injury include traumatic fractures,[5] acute disc herniations,[7] intradural tumours[8] and aortic surgery.[2,9] To appreciate how such causes may result in the subsequent neurological deficits of conus medullaris infarctions, the arterial and neurological components of the spinal cord are briefly reviewed.

Anatomy of the cord

It has been suggested that spinal cord infarctions may result from 1) interruption of the blood supply anywhere between the aorta and intramedullary vasculature;[1,6] 2) deficient systemic perfusion pressure;[1,6] 3) hypercoagulation;[6] or 4) a combination of these.[1,6] Since the anterior and posterior spinal arteries closely approximate the ver-

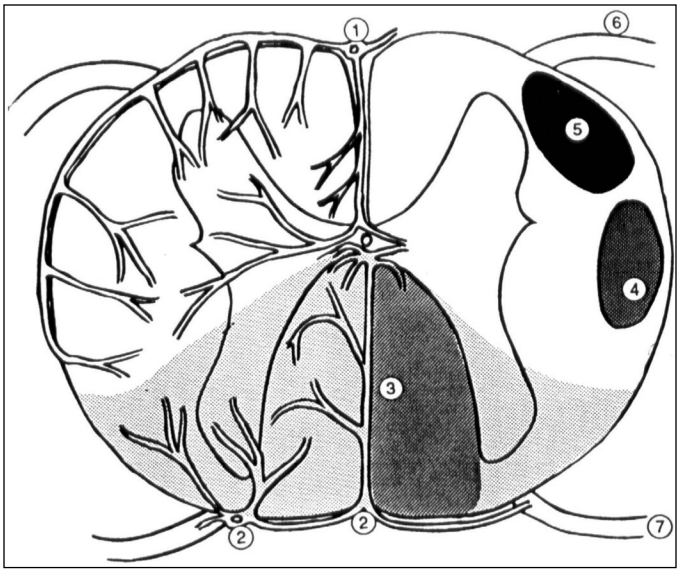


Figure 5 *Schematic cross-sectional representation of the spinal cord vascular supply:* ***1*** *anterior spinal artery;* ***2*** *posterior spinal artery;* ***3*** *posterior column;* ***4*** *lateral corticospinal tract;* ***5*** *spinothalamic tract;* ***6*** *ventral root; and* ***7*** *dorsal root. Most of the cord receives its vascular supply from the anterior spinal artery (unshaded area). The right side of the diagram illustrates the common tracts that are found in the region supplied by the anterior and posterior arteries. (Reprinted by permission of JCCA Burns et al. 1991)*

tebral bodies, discs and ligamentum flavum,[10] prolonged compression of these arteries from pathologies in these structures may also result in arterial compromise and formation of an infarct. In consideration of the spontaneous nature of this patient's injury and in the absence of any direct trauma or compressive lesions at the spinal cord, the presumed cause of the infarction was vascular disease.

In general, the major extrinsic arteries of the spinal cord are the anterior and posterior spinal arteries, anterior and posterior radiculomedullary arteries and pial arteries.[10] Originating from the vertebral arteries,[10] the single anterior spinal artery supplies the anterior third of the spinal cord, including the central grey matter and anterolateral white matter, while the paired posterior spinal arteries supply the posterior third, including the posterior columns (Figure 5).[11] The radiculomedullary arteries, originating from the segmental spinal arteries, meet the anterior and posterior spinal arteries at various levels, and pial arteries run circumferentially between the anterior and posterior spinal arteries.[10]

However, the spinal cord vasculature at the level of the conus medullaris has some added characteristics. First, it has been reported that anastamosis invariably occurs between the anterior and two posterior spinal arteries, known as the anastomotic ansa of the conus.[6] The most caudal region of the spinal cord, extending from T8 to the conus, is additionally supplied by the artery of Adamkiewicz, branching from the intercostal artery, and occasionally the Desproges-Gotteron artery, branching from the internal iliac artery.[3] This regional vasculature supports the notion that infarctions at the conus medullaris are more infrequent than those at other parts of the spinal cord. Further, Monteiro et al. proposed that the anastomotic ansa of the conus allows eventual reperfusion of the necrotic tissue after obstructed blood flow from the artery of Adamkiewicz,[6] thereby providing insight into its potential natural history.

Clinical presentations

Neural ischemia at the conus medullaris can result in variable clinical presentations, depending upon the degree of compromise along the length of the spinal cord. Injury to the conus medullaris commonly results in sudden non-specific low back pain that progresses to bilateral leg pain with bladder and bowel dysfunction and saddle anesthesia.[12] Specifically, conus medullaris injuries lead to a lower motor neuron (LMN) syndrome, where sacral and limb reflexes are diminished and muscles become flaccid and atrophic.[13] There are also varying degrees of LMN bladder-bowel dysfunction (atonic bladder and flaccid anal sphincter) and sexual dysfunction (loss of reflexogenic but preserved psychogenic erection in men).[13] Although the LMN syndrome is similar to cauda equina lesions,[14] injuries to the cauda equina are typically characterized by asymmetrical lower extremity weakness and variable sensory and reflex deficits.[13] However, due to its close proximity to the epiconus, conus medullaris lesions can present with mixed neurological deficits of combined upper and lower motor neuron syndromes. For instance, upper motor neuron syndrome is often reported with conus medullaris lesions, likely due to ischemia that overlaps the epiconus region, which characteristically presents as a pure upper motor neuron syndrome.[3]

To further add to this diagnostic challenge, the conus medullaris has a variable anatomical location. Although the conus medullaris represents a transition from the central to the peripheral nervous system,[15] there is no fixed anatomical landmark.[16,17] A 2007 review by Kesler et al. found the most common location for termination of the conus medullaris was the L1-2 disc space, but had a large anatomical range extending from the T11-T12 disc space to L4 vertebra.[18] Others have suggested that distinguishing between the conus and the cauda equina is of little value[8] and difficult to conduct.[19] Thus, these findings suggest that both the cauda equina and the conus medullaris should be carefully examined in these patients.[7] For example, the infarction in the case presented herein was found to be located outside of the commonly cited region and situated more superiorly at the T12-L1 level. This emphasizes the importance of evaluating the epiconus, conus medullaris and cauda equina regions in these patients.

In light of this varied clinical appearance, clinicians should also evaluate and be aware of potential risk factors. Cheng et al. (2008) found that in a small sample of 22 subjects with spinal cord infarctions, hypertension was the leading risk factor, followed by diabetes mellitus and heart disease.[20] These vascular diseases are in line with the biological plausibility of arterial occlusion that leads to eventual tissue necrosis. However, other less obvious risk factors have been suggested. A recent case report described the onset of bladder and bowel incontinence from a partial conus medullaris lesion immediately following a CABG.[21] In our case report, the infarction did not occur immediately after the patient had undergone a CABG procedure, suggesting that intraoperative micro-injury may have led to an occult decrease in vascular supply that, over time, resulted in conus medullaris ischemia, in the setting of this patient's aortic atherosclerotic disease. Previous reported cases of conus medullaris ischemia following aortic surgery support such a mechanism of injury.[2,9]

Clinical management and prognosis

There appears to be no clear guidelines for the treatment of spinal strokes.[3] Initially, magnetic resonance imaging and surgical consultation are used to evaluate the need for immediate surgical decompression of the spinal cord, particularly in patients with underlying tumours.[8] For spontaneous infarctions, the most appropriate pharmacological interventions have not been confirmed. In animal studies, some benefit has been found with certain agents, such as prostaglandins or corticosteroids,[22] but these have not been studied prospectively in humans. In a retrospective study by De Seze et al., no differences in treatment outcomes were found in subjects who were treated with corticosteroids and anti-platelet therapy compared to those who received anticoagulation with anti-platelet therapy.[3] Following this, similar to cerebral strokes, spinal cord infarctions require close monitoring, controlling for hypotension and managing co-morbidities that may impair patient recovery.[23]

Patient recovery from a conus medullaris infarction is dependent on a number of prognostic factors. Severe neurological impairment at the time of assessment has been associated with poor recovery of motor functions.[3,9,20,24] In addition, older age has generally been associated with poor outcomes,[3,9,24] though not in all studies.[20] As in our case report, the patient's older age did not appear to be a negative factor for functional recovery, as motor strength stabilized prior to rehabilitation. In extreme cases, a mortality rate of approximately 20% has been reported in retrospective analyses of spinal cord infarctions,[9,25,26] though the causes of death were not conclusive.

The degree of morbidity and mortality emphasizes the potential burden of spinal cord infarctions and importance of prompt diagnosis. Yet promptness in diagnosis depends upon the clinician's awareness and maintenance of high index of suspicion, particularly in conditions that do not present or respond as expected. Caputo et al. (1997) suggested that a tendency for delayed diagnosis was more frequently found in rarely encountered conditions with central neurological presentations, which increased the risk for ineffective, harmful or lack of treatment.[27] For example, Morandi et al. published a case where caudal spinal cord ischemia was diagnosed in a subject 36 hours after receiving lumbar vertebral manipulation for an acute exacerbation of chronic low back pain, with no evidence of a proper physical or neurological examination prior to treatment.[28] Given its likelihood for sudden and severe onset, it is possible that such spinal cord ischemia was in evolution prior to the manipulative treatment and perhaps a thorough neurological examination would have identified the incriminating red flags. While the authors did discuss potential mechanisms for this occurrence, including arterial occlusion from fibrin-platelet or disk material

embolism,[28] it is important to note that case reports are unable to determine causal relationships. Thus, primary contact practitioners, including chiropractors, should conduct thorough examinations to facilitate prompt referral to the emergency department for suspected cases of spinal cord infarction.

Summary

This case report illustrates a relatively favourable partial recovery of a conus medullaris infarction in a 79 year-old female who received prompt assessment. The report underscores the importance of awareness of this condition among clinicians in order to facilitate immediate management.

While the incidence of conus medullaris infarction is rare, it has the potential of a variable clinical presentation, making it difficult to recognize. This may result in a delayed diagnosis, progression of neurological symptoms, and the increased likelihood of poor recovery. In extreme cases, spinal cord infarctions have led to permanent paraplegia and even mortality. This case report illustrates the importance of establishing an appropriate clinical index of suspicion that can lead to timely diagnosis and treatment for suspected cases of spinal cord infarction.

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Chiropractic leadership in the eradication of sexual abuse

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Health practitioners work under fiduciary constraint, and are obligated to favour patient needs over all others and in particular their own. The principles of professionalism demand that professionals take great care to ensure that boundaries are maintained safely to provide an optimal setting in facilitating patient care. Boundary violations cause serious harm to the patient. Any romantic or sexual activity between parties is the most serious form of boundary violation. The chiropractic profession is included in the list of disciplines which are at an increased risk for boundary violations. The authors propose a four stage protocol which is designed to offer all parties maximal protection beginning with undergraduate professional education and then mandatory continuing education for registrants in professional practice. The protocol would affect all aspects of professional life including training in boundaries and jurisdictional regulation.
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KEY WORDS: professionalism, sexual abuse, chiropractic

Tout professionnel de la santé est contrait par des obligations fiduciaires, et les besoins du patient doivent avoir la priorité sur ceux de toute autre personne, y compris des siens. Les principes du professionnalisme exigent que les professionnels fassent très attention pour veiller à ce que les limites soient respectées en toute sûreté afin d'optimiser le milieu où le patient est soigné. Toute transgression à ces limites cause de graves dommages au patient. Une liaison romantique ou sexuelle entre les parties est la forme la plus grave de transgression d'une limite. La profession de chiropraticien fait partie de la liste des disciplines pour lesquelles il y a un plus grand risque de transgression des limites. Les auteurs de l'article proposent un protocole à quatre étapes conçu pour assurer une protection maximale, à partir de la formation professionnelle donnée au premier cycle, puis lors de l'éducation permanente obligatoire offerte aux praticiens professionnels. Le protocole toucherait à tous les aspects de la vie professionnelle, y compris une formation pour la sensibilisation aux limites et sur les pouvoirs de réglementation.
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MOTS CLÉS : Professionnalisme, exploitation sexuelle, chiropratique

Introduction

Much has already been written on the defining tenets and characteristics of professionalism and on that which constitutes the position and work of a professional.[1–7] The two most basic and important features of all professions are control over a specialized body of knowledge,

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and a commitment to use this knowledge for good. The overriding construct governing professionals is that this specialized work is service based and is always, without exception, for the benefit of the client. However, putting the public interest ahead of the self interest of the members of the professions has constituted a growing conflict over the last few decades to seeing such groups becoming more political, whose major interest is advancing their own agendas.

This has given rise to tensions between professionals and the public and is manifest in various ways.[8] One is the increase in the reporting of unprofessional behaviors to regulatory authorities.[9,10] In response, jurisdictions have employed various tactics to ameliorate these disputes ranging from the use of cease and desist orders, dispute resolution, on to formal disciplinary hearings and litigation for the most offensive cases.[10]

We are able to understand why some of these professional-client disputes are occurring, and, most importantly, that an opportunity for the professions to formulate a strategy to resolve and remediate these difficult problems exists. We further propose that just such an opportunity is very timely for one profession, chiropractic, and that the profession demonstrate leadership to the professional and public domains, as representative of the social contract that all professions have with society.

In 1993 the province of Ontario enacted legislation with strict and absolute provisions for all of the health professions, targeting any regulated health care provider found guilty of patient sexual abuse, with the definitions of abuse much broader than had been described previously. The definitions included, not just overt sexual behaviours, but comments of an intimate and/or sexual nature.[11]

This initiative represented the first Canadian legislative effort to detail a sexual abuse regime applicable to the regulated health professions. Included was the adoption of the "zero tolerance" of sexual abuse by health professionals, a mandatory five year revocation of the registration of a member found guilty of sexual abuse, and mandatory reporting requirements of members reasonably suspected in abuse of a patient by both other members and facility operators. All regulatory bodies are required to develop initiatives to address the prevention and eradication of sexual abuse within their profession.

In light of these advances, we propose that a much more thorough and comprehensive approach to identify and prevent patient abuse is still needed with this being equally proactive and preventive at multiple levels of professional-public engagement. We propose that the current *status quo* approach to oversight is less than adequate and is inefficient. We conclude that specific comprehensive undertakings are necessary to offer protection to the public and to facilitate the restoration of public confidence in the professions.

Professionalism

Professionalism and ethics are integrally linked. All health professionals have an obligation to demonstrate a thorough understanding and hold to a high level of practice of the ethics and virtues of care. Professionals serve the public, and members of the public have great personal needs that they give over to a professional in that time of need. The professional then uses specialized education, skills, experience and judgment in caring for the client.

All definitions of professionalism embody responsibilities and privileges for the professional that relate to society, by which members are to abide.[12] The power differential between professional and client is a key component and predicates the professional's responsibilities and privileges to the benefit of the client.[13,14]

None of these concepts are new. Both Plato and Hippocrates recognized that a good doctor-patient relationship was essential to achieve the goals of care. Plato wrote that the best clinical medicine is practiced when "scientific knowledge is combined with a personal, trusting and professional relationship between doctor and patient."[15]

The American Medical Association published its first Code of Medical Ethics in 1847. It reads more like a social contract detailing the rights and responsibilities for physician interaction with, not just the patient, but the relationship between other physicians and the community at large. Physician conduct occupies only a small part of the code.[16]

Harvard medical educator William Peabody stated in 1925: "The significance of the intimate personal relationship between physician and patient cannot be too strongly emphasized, for in an extraordinarily large number of cases, both diagnosis and treatment are directly dependent on it."[17] Optimal clinical care can only be achieved with a close, caring and safe relationship between doctor and patient.

More recently the American Board of Internal Medi-

cine has undertaken multiple initiatives to define professionalism in 2004.[18] Others have joined in advocacy of this pursuit.[19] One reason for the increased awareness and interest in professionals' ethics in the last decade is a growing concern and increased recognition from regulators and the public that unprofessional behavior by a physician or any health care provider causes great damage both to the individual abused and to the reputation of all the professions.

Our present society has been formed by accepted standards, mores and values over the past several decades. Moral decisions of right and wrong are now considered personal, subjective and relative to a given situation. This moral relativism contrasts sharply with the principles of professionalism.[20,21] Professions have written codes of conduct, ethics and behaviors in order to guard against aberrant behaviour by individual members.[22] If the changes in society's moral standards affected the professions, there would be an erosion of the high standards demanded of professionals.

While practicing in an ethical manner is not an option, the law, through legislation, regulations and standards, can only go so far in setting out what the minimum threshold is. This is often described in terms of what is forbidden in the professional-client encounter. While the law does not attempt to establish precise optimal performance, professionalism demands that individual members strive for and maintain excellence in both their clinical expertise and in the delivery of practice via humanism, empathy and compassion.

Social contract

Social contract theory emphasizes the mutual rights and obligations of citizens and those in authority. The public interest is served by practitioners who act with altruism, compassion, empathy, primacy of the patient (fiduciary relationship) and a commitment to excellence. This is the glue that forms the social contact between the professional and patient.[23]

Though the role of the professions in society has always been altruistic (specialized knowledge used for the benefit of others), the reality of modern times is that problems have arisen that detract from the professional's role and work. Historically, the three most prestigious professions, medicine, the law and the priesthood were held up as exemplars of achievement and ones that other social groups could emulate. But all three groups have struggled with ethical failures, inadequate self-regulation and much media scrutiny resulting in a troubling erosion of public trust.[6]

Many jurisdictions describe the various kinds of abuse that a professional must take care to avoid inflicting on a client. These include financial, emotional, physical and sexual abuse. All kinds of abuse cause damage to individuals and are malevolent acts. This contrasts with beneficence: an act of charity, mercy and kindness. Beneficence is actively doing good to others and invokes a wide array of moral obligation. It strives for the best care while ensuring not doing anything harmful. *Primum non nocere* ("first, do no harm") is an oath taken by health practitioners, and while designed to avoid things harmful as part of the ethical tenet non-malfeasance, embraces the ethic of beneficence proactively. The overriding intent is to always ensure net benefit over harm.[24]

Boundary inattention by the professional is a serious omission. It is not possible for a patient to discern that engagement in any activity that constitutes abuse by a professional could merit consent. In these situations, the power differential between the parties makes consent impossible. Even if the inappropriate activity is initiated or suggested by the patient, the party in the vulnerable position is not capable of legitimately consenting. No one willingly consents to being abused.

Boundaries

A boundary is the line separating both parties thereby distinguishing a therapeutic relationship between professional and patient with those other relationships that are casual, personal and familial. The key and foundational aspect of the doctor-patient relationship is for the professional to set and then maintain a healthy boundary, for it is a functional boundary that enables the caregiver to work towards an optimal clinical outcome. Conversely, a boundary violation causes *sequelae* to all parties.[25,26] There can be a delicate aspect to boundary setting. What makes this delicacy sometimes difficult is reconciling the physician's role as a professional providing expert clinical care while embracing his or her own persona with that patient as another social being in community.

The call to maintain clear professional boundaries is one that has been heard from ancient times. What is currently changing is that health care is becoming less rigid

and formalized with health care providers being urged to focus on developing just and respectful relationships with patients, rather than adhering to rules based systems of ethics.[27,28] Chiropractic has a reputation for superior communication is patient care. This may put the practitioner at an increased risk of crossing a patient's boundary by excessive self-disclosure or by gaining an inappropriate degree of patient familiarity. This is recognized as leading to boundary violations with the very real potential for patient abuse, often sexual.[29]

The difference between a crossing and violation is usually one of degree. With some exceptions, a boundary crossing is inappropriate but does not subject the client to harm. A violation is not just inappropriate but subjects the patient to harm or the potential of harm. Boundaries are the key component of the clinical relationship which, when in balance, rightly positions the practitioner in the position of power, trust and authority, and the patient in the weaker and more vulnerable, subordinate position.[28,29] Effective management of this power differential is an essential convention allowing the provider the opportunity to use his or her specialized skills and experience in facilitating the patient's healing response.

Boundary violation

Boundary violations are acts that breach the core intent of the professional-patient commitment. They occur when the practitioner violates the covenant to always and without exception act only in the patient's best interest, and instead consciously or unconsciously exploits the patient to meet personal needs. While unequivocally clear boundaries in the practitioner-patient relationship exist solely for the patient's safety and protection, the professional also derives enormous benefit from the establishment and maintenance of mutual boundaries, as they safely provide the limits on what is expected by each party. Altering these limits produces ambiguity, uncertainty and confuses the patient. By protecting the patient, protection is reciprocated back to the practitioner.

Sexual abuse

Sexual abuse is legally forbidden by all jurisdictions and for all disciplines. It is the most egregious form of offence that a professional inflicts on a patient.[30,31] Any type of romantic or sexual activity represents the most serious boundary violation as it is highly detrimental to the patient's health and well-being. Shame, guilt, depression, post-traumatic stress disorder, addiction and suicidal tendencies have all been reported following sexual abuse.[25] Such patients are seriously harmed in their ability to form social relationships and in their ability to enjoy intimacy, quite apart from their difficulties in trusting future health care providers.

A practitioner not understanding the potential risk with a more casual clinical approach may risk a boundary violation that becomes sexually abusive. Personalizing is self-disclosure to the degree that it damages the professional-client relationship and causes harm.

In an attempt to understand the mechanism for a poorly maintained boundary leading to violations and abuse, some practitioners are clearly at risk: those whose basic emotional needs are unmet. Since by nature we are wired for intimacy, it is essential that the practitioner's deepest and most intimate personal needs are met outside of, and quite apart from, those people met in professional work. When a practitioner experiences difficulty in personal relationships with intimates, patients are at risk of being targeted. Since health care is recognized as a high stress vocation, it is therefore a high risk domain with the potential for patient abuse ever present.[9]

Some have queried as to how someone who has achieved such a high pinnacle of education and position within their community would, by word or deed, harm someone who is in the weak and vulnerable position.

A small number of practitioners behave in a predatory way and sexually exploit patients.[25] Mental illness is another cause of abuse with diagnoses including mania, psychoses and addiction. All of these factors represent a profound impairment of the professional's judgment. Even an emotionally healthy practitioner with poor communication skills risks a patient misinterpreting that performing a health care procedure was not in their best interest, and may report such to the regulating authorities.

Whenever and however the abuse scenario occurs, the dysfunction reverses the usual and customary relationship, wresting the caretaking role from the practitioner and giving that over to the patient, who ends up attempting to care for the professional.

A recommended solution

We propose that for the healing professions to fulfill their social contract with society there are four fundamental

undertakings which all health care practitioners must be subject. We make specific proposals to the chiropractic profession, as representing one of the high-risk groups, to proactively pursue at all levels of engagement with the public, embracing openness and transparency.[32]

Traditional reliance on jurisdictional regulatory colleges, boards and associations for public protection is not optimal, based on the late stage nature of the regulator's involvement. This approach attempts to offer "curative" protection to the public against abusive professionals' behaviors, as the disciplinary actions taken in such cases are more "reactive" to disciplinary complaints, usually occurring late in the process. This does not dissuade the public's distrust in the professions as identified groups who are to be wholly trusted.

We propose the chiropractic profession recognize that much earlier "preventive" intervention is the only substantive approach in ameliorating future cases and reversing the trend to abuse, as follows:

1. Undergraduate instruction in ethics, boundaries and the prevention of specific sexual abuse is rigorously taught in all chiropractic colleges. The Council on Chiropractic Education standards must be changed to state explicitly that curricular content must serve this end.[33] The current requirements of both US and Canadian CCE standards are too broadly defined and subject to interpretation.
2. All jurisdictions must ensure zero tolerance for abuse, with strict and absolute disciplinary measures for chiropractors found guilty of sexual abuse, with a victim friendly process while engaged with regulatory protocols;
3. All jurisdictions must mandate periodic continuing education for risk management in ethics, boundaries and the prevention of sexual abuse. There also needs to be training on patient communication and informed consent, with this postgraduate ethics education being contingent on continued registration;
4. Jurisdictions must financially support the involved parties with pyschotherapeutic counseling for victims, and remediation for involved practitioners (when deemed appropriate) for continued licensure.

Undertaking number one: Undergraduate education

The need for teaching ethics and professionalism to young chiropractors is based on the changing shift in moral attitudes in Western society. Conventional community values that were once held as inviolable have been subjected to the effects of moral relativism, which began its influence in the 1960s.[34,35]

Today's student has been raised in a climate of entitlement, permissiveness and materialism. Materialism has defined Western values as one of the pivotal defining characteristic of our modern society. Our society craves achievement and success to the point of excess. This contrasts sharply with the principles of professionalism and can be burdensome for educators, as the teaching of ethics in professional curricula is a relatively new field of study.

While the content of the ethics and professionalism curriculum produces a number of specific goals and objectives,[36] there are three pivotal competencies forming the *set* that every chiropractic student must demonstrate understanding of and competence in:

1. Professionals are held to higher standards than the general public;
2. The health practitioner holds the position of power and trust, with the patient being more weak and vulnerable;
3. The responsibility to maintain healthy and functional boundaries in all clinical encounters rests exclusively with the practitioner.

The *setting* for these three then follows:

1. Professionalism and ethics are key cornerstones that underscore all other content for chiropractic students acquiring basic science knowledge and clinical competence;
2. The public demands that chiropractic educators advocate for and uphold the principles of professionalism, codes of conduct, behaviors and ethics, and mentor students in the application of these tenets.[37]

The *set* and *setting* support the applied learning objectives of altruism, compassion, empathy, primacy of the patient and commitment to excellence, to the more focused goals of professional ethics, setting of boundaries and the prevention of abuse of all kinds.

The recommendation for a comprehensive systematic course on ethics and professionalism to health care students in all disciplines was made years ago, yet the only two published studies that have surveyed ethics curricula in health care were in medicine and graduate nursing pro-

grams.[38–41] These studies found no standardization in US educational institutions with some US medical schools offering almost no ethics content for students. (For example, one medical school totaled two hours in ethics content.)[38] Since no other health care disciplines have been studied, their curricula are unknown. Those published surveys in medicine and nursing revealed that there is no standardization in either content or learning objectives. Medical and nursing schools (and it is assumed other health care colleges) have apparently developed their curricula in an isolated, internal and anecdotal manner with little regard for the larger health care community. Some ascribe this paucity in ethics education to be primarily responsible for the increase in complaints made to regulatory bodies.[9]

The US Council on Chiropractic Education mandates content for ethics, but is described in very general terms. The January 2007 CCE requirements state in Section 2, Subsection O: Ethics and Integrity, Part (1) Attitudes, "the student must demonstrate an ability to" with this stem applied to six domains. Only one of the domains mentions sexual boundaries and the wording is not only ambiguous, but is applied to student inter-relationships, with nothing specified for future doctor-patient relationships. The Canadian CCE standards are almost identical in their wording. Neither the American nor Canadian CCE requirements specify contact hours, course objectives, teaching methods and assessment in the ethics curriculum for chiropractic students in the doctor of chiropractic program.

The need for improved standards is obvious. Minimum standards for contact hours, specific goals and objectives and assessment protocols must be established for all health care educational institutions.[42] As there are ethical issues unique to each specialty, each discipline must add its specialized content in cooperation with other disciplines. This is congruent with the current trend in health care to integration of all disciplines for the benefit of the patient, as the patient journeys through the clinical encounter.

Most institutions employ periodic curricular review. The external institutional review protocol offers a superior method of curricular reform and allows for enhanced communication between multiple educational and regulatory parties.[43,44] This is not a complicated process.

There is both anecdotal and published evidence that even students recognize the need for ethics education and that they perceive it to be important. Educators who fail to ascribe a high priority to the value of teaching ethics and professionalism have been described as "silent conspirators who vicariously inflict harm on future patients".[45] Students benefit from theoretical content being parlayed into the reality of clinical practice, with all parties benefiting from the recognition and reinforcement of positive behaviors during the educational process.[46]

Second undertaking: Zero tolerance regulation

Once a chiropractic student learner has successfully transitioned out of professional education and has fulfilled all licensing requirements, he or she is then subject to the rules of practice set out by their jurisdiction. Since there is overwhelming evidence that sexual abuse profoundly damages a patient, the only just response to a practitioner found guilty of abuse must be decisive, strict and just.[47]

All state and provincial legislators, regulators and professional associations have a duty to ensure existing laws, statutes and regulations adequately protect members of their public who have been subject to abuse. There is credible evidence that some jurisdictions and some disciplines are less than adequate in applying disciplinary measures to practitioners.[10]

Health law expert Rodgers examined the College of Physicians and Surgeons of Ontario in its approach to complaints of sexual abuse and reported on lenient penalties, institutional resistance, and remarkably that only one in twenty of those cases involving allegations of a physician sexually abusing a patient ever reached the disciplinary stage. This is despite the strict legislation governing regulated providers in the province.

Rodgers states reasons for this discrepancy. There is a lack of reporting by regulated health professionals, even though they are legally duty bound to report to the regulatory authority when there is reason to believe that a patient has experienced abuse, suggesting that there is non-compliance from members of the profession. Secondly, only one percent of public reporting of any kind of physician misconduct proceeded to a disciplinary hearing. The trend to quasi-criminal burden of proof and zealous attempts by counsels of accused doctors to access a complainant's private records was described as re-abusive. While anecdotal communication with officials of the College of Chiropractors of Ontario would indicate that the chiropractic profession's ratio of complaints to discipline is less disparate, there is no published evidence for confirmation.

All state and provincial legislators, regulators and professional associations have a duty to re-commit themselves to examining whether existing laws, statutes and regulations adequately protect members of their public who have been subject to abuse. We suggest that cultural inertia in both a reluctance to hold fellow members to account and institutional barriers in implementing disciplinary protocols are able to be remediated.

Third undertaking: Continuing education

Following the work established from the educational and enforcement undertakings, jurisdictions must then regularly require continuing education to their members. In order for a chiropractic practitioner to maintain practice competency, there must be periodic retraining in the area of ethics, boundaries and the prevention of sexual abuse, and that this retraining be conditional for continued licensure. While this post-graduate content is similar to that taught during undergraduate instruction, the ongoing discourse on ethics and professionalism in the academic setting versus the reality of practice offers greater insight to those already engaged in practice.

While all professionals commit to life long learning and updating their clinical skills, few jurisdictions have moved to mandate ethics post-graduate education to their members. For example the Province of Saskatchewan requires chiropractors to undergo 4 hours post-graduate training every two years for ethics and boundaries risk management. Currently there are only two Canadian provinces and twelve American states that require any type of ethics content in their continuing education for chiropractic registrants.[48]

Fourth undertaking: Remediation and amends

When these undertakings are established, the health care professional will have been subject to education on boundaries and ethics, firstly as a student and then as a licensed practitioner. For the very small minority who are disciplined for ethical failures, jurisdictions will set out what the grounds for remediation and license retention are. In particular, when a practitioner has been found guilty of sexual abuse, jurisdictions must specify the remediation process's terms and conditions. Some cases would be deemed remediable, and for those practitioners, counseling should be mandated as one of the conditions for continuing in practice. Some jurisdictions already have just such a protocol for practitioners having been found guilty of patient abuse.

Many professional groups offer services to their practitioners sometimes termed professional health programs.[49] While the intent of these programs is directed primarily towards the impaired practitioner, all types of compulsive and unprofessional behaviors are included. Both regulatory and professional associations should feature the services of the assistance programs to their members, with particular attention on their benefits and the grounds for a mandated referral, without practitioner consent.

Victims of sexual abuse are entitled to counseling assistance to deal with the damage caused by their violation. Some jurisdictions currently offer this support for assisting with the cluster of physical and mental problems that result from abuse. This is an important part of protecting the public, albeit from a reactive position, and one that the professions can employ as a means of restoring public trust and confidence.

Conclusion

That victims of sexual abuse and their family members suffer serious effects is not in dispute. The damage is deep and lasting. Making amends is a most worthy, important and just goal for all professional associations and regulators. No professional group is currently offering its practice members and the public a program that is comprehensive, proactive and preventive. This is a timely opportunity for the chiropractic profession to lead.

The profession has a history of success despite difficulties and persecution from within the *status quo* health care system. The twenty-first century features a move towards integration in health care that reduces the silo mentality of the disciplines, helping the patient in facilitating access to optimal care. There is a palpable critical mass emanating from chiropractic academia in moving the profession into a more credible position of cultural authority in the manual methods of health care, complementing the already well accepted public's understanding and use of the skills of its practitioners.

The opportunity for the profession to act in offering protection to public members is real and justified. The comparison to the lack of action, as seen in the studies done on the medical profession in Ontario, furthers our call to this vital profession on society's health care team.

Protecting the public starts early and continues for the practicing professional as the means; with the end realized by healthy interactions, with all parties deriving benefit. What we propose here is the most comprehensive, thorough and detailed approach yet to be undertaken by any group, and offers the greatest degree of protection to all parties.

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Low Back Disorders. Evidence-Based Prevention and Rehabilitation
Stuart McGill
Human Kinetics, Champaign, Illinois, 2007
Hardcover, 328 pages $70.95 (CDN)
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This text attempts to identify the causes of back problems and outlines how to prevent or eliminate them. Much like a patient advancing through Dr. McGill's stages of rehabilitation, the text follows a logical progression with subsequent chapters building on previously established concepts. The early chapters review the functional anatomy and injury mechanisms of the lumbar spine while challenging many commonly held beliefs and laying the foundation for the rest of text. The middle section outlines how to reduce the stressors that can cause low back disorders with guidelines for both worker and employer. The final chapters focus on a Five-Stage Back Training Program, beginning with identifying faulty movement patterns utilizing provocation tests then progressing to building stability and endurance using variations of Dr. McGill's "big three" exercises.

The text's strength lays in the author's research background and the labs that he has developed, which he frequently relies upon when determining spinal loads and when suggesting preventative or rehabilitative strategies. From a chiropractic perspective, a discussion on the role of manipulation in rehabilitation would have been valuable. Little is said about chiropractic other than noting that a small group of patients may benefit from initial mobilization while warning that many make the mistake of trying to mobilize an already unstable joint. Regardless, this text offers a systematic and evidence-based approach to addressing low back disorders that should be read in its entirety and then used as a reference tool by practitioners incorporating exercises into their treatments.

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This handbook is designed for the health care provider who treats common musculoskeletal (MSK) conditions in the primary care setting. It is not a comprehensive text for all musculoskeletal conditions; rather it aims to provide busy clinicians with an easy to use, point of care reference.

The text contains an abundance of diagrams and figures and is organized into fourteen chapters, emphasizing basic anatomy, red flags, common clinical presentations and management. In the appendix, the authors have devised many clever algorithms and work sheets, which are downloadable, easy to use and can conveniently serve as a component of a patient's medical record.

The information is current and well referenced, but not void of limitations. For example, the Neck Pain Task Force from The Decade of the Bone and Joint Task Force was omitted in the cervical spine section in chapter two. There was little promotion of interdisciplinary care and comments on alternatives to mainstream conservative management were reserved.

Despite its few limitations, I would recommend this book to the busy primary care clinician as well as any medical or athletic training student. The review of each joint by section ushers in the necessary basics to formulating a broad differential diagnosis and appropriate management strategies. For the clinician, the text serves as a good concise reminder about diagnosis and management of MSK complaints.

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