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Profile – Dr. John Z. Srbely, DC, PhD



Dr. John Z. Srbely, DC, PhD
University of Guelph

The CCRF is delighted to announce that Dr. John Srbely, DC, PhD has joined the Editorial Board of the Journal of the Canadian Chiropractic Association.

Dr. Srbely holds the “CCRF Professorship in Neurophysiology and Spine Mechanics” at the University of Guelph in Ontario. He is an Assistant Professor in the Department of Human Health and Nutritional Sciences, in the College of Biological Sciences.

Dr. Srbely’s research interests focus on the neurophysiology of myofascial pain, more specifically the neurophysiologic mechanisms of central sensitization and the impact of these mechanisms on the clinical presentation and pathophysiology of musculoskeletal pain. This research will substantiate the important role of chiropractic manipulation and manual therapy in the treatment of chronic and myofascial pain.

Dr. Srbely is actively collaborating with world renowned physicist Dr. John Bush at the Massachusetts Institute of Technology (MIT) in the investigation of the biophysical aspects of myofascial and chronic pain. In addition, he collaborates with Dr. Leah Bent at the University of Guelph and Dr. Jim Dickey at the University of Western Ontario.

In 2005, Dr. Srbely received the CCA Young Investigator Award and in 2006 he received the Graduate Scholarship Award in the Department of Human Health and Nutritional Science at the University of Guelph.

More recently, Dr. Srbely was awarded a prestigious Canadian Arthritis Network (CAN) 2009 Pilot Grant in the amount of \$48,100 for his project entitled “Effects of ultrasound on pain and function in osteoarthritis” and is a Network Investigator for the Canadian Arthritis Network.

The Canadian Arthritis Network (CAN) is a not-for-profit organization that supports integrated, trans-disciplinary research and development. CAN is the single point of contact that links 170 of Canada’s leading arthritis researchers and clinicians, 45 Canadian academic institutions, The Arthritis Society, the Canadian Institutes of Health Research’s Institute of Musculoskeletal Health and Arthritis, and government.

Slipped capital femoral epiphysis (SCFE) detected in a chiropractic office: a case report

Peter Emary, BSc, DC*

Objective: *To report on a case of slipped capital femoral epiphysis (SCFE), which is a somewhat rare condition but one that can present in a chiropractic clinic, particularly one with a musculoskeletal scope of practice.*

Case: *This is a single case report of a 16-year-old adolescent male patient who presented with an 18-month history of hip pain. Radiographs originally ordered by the patient's family physician were read by the medical radiologist as "unremarkable." The family physician diagnosed the patient with tendonitis.*

Treatment: *After reviewing the radiographs and examining the patient, the chiropractor suspected a SCFE that was confirmed with a repeat radiographic examination. The patient was referred back to his family physician with a diagnosis of SCFE and recommendation for orthopedic surgical consultation. The patient was subsequently treated successfully with surgical reduction by in situ pinning.*

Conclusion: *The prognosis for the SCFE patient when diagnosed early and managed appropriately is good. The consequences of a delay in the diagnosis of SCFE are an increased risk of further slippage and deformity, increased complications such as avascular necrosis and chondrolysis and increased likelihood of degenerative osteoarthritis of the involved hip later in life. The diagnosis and appropriate management of SCFE is where the chiropractor has an important role to play in the management of this condition.*
(JCCA 2009; 53(3):158-164)

Objectif : *Faire état d'un cas d'épiphysiolyse fémorale supérieure (EES), un état de santé relativement rare, mais qui peut se présenter dans une clinique de chiropratique, en particulier celles qui se spécialisent dans les traitements muscosquelettiques.*

Cas : *Il s'agit en l'espèce d'un rapport sur un dossier d'un adolescent de 16 ans qui présente un historique de douleurs aux hanches, une coxalgie, qui perdure depuis 18 mois. Les radiographies commandées au départ par le médecin de famille ont été interprétées par le radiologiste comme « n'ayant rien de particulier ». Le médecin de famille a posé un diagnostic de tendinite sur le jeune patient.*

Traitement : *Après un examen des radiographies et du patient, le chiropraticien a soupçonné une ESS, qui a été confirmée par de nouvelles radiographies. Le patient a été envoyé chez son médecin de famille avec un diagnostic d'ESS et une recommandation de consultation en chirurgie orthopédique. Le patient a été traité avec succès grâce à une réduction chirurgicale qui a consisté en un brochage in situ.*

Conclusion : *Le pronostic d'un patient souffrant d'une EES est juste quand le diagnostic est posé rapidement et géré de manière convenable. Les conséquences d'un retard de diagnostic amènent un risque accru de glissement et de malformation, des complications accrues, notamment une nécrose avasculaire, une chondrolyse et, plus tard dans la vie, une probabilité renforcée d'ostéoarthrite dégénérative de la hanche affectée. Le diagnostic et la gestion compétente de l'ESS*

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KEY WORDS: slipped capital femoral epiphysis, SCFE, hip, adolescent.

illustrent le rôle important que joue le chiropraticien dans la gestion de cette affection.
(JACC 2009; 53(3):158–164)

MOTS CLÉS : épiphysiolyse fémorale supérieure, ESS, hanches, adolescent.

Introduction

Slipped capital femoral epiphysis (SCFE) is defined as a posterior and inferior slippage of the proximal femoral epiphysis (femoral head) on the metaphysis (femoral neck), occurring through the epiphyseal growth plate during the early adolescent growth spurt.¹ In the United States, the incidence of SCFE for children between the ages of 9–16 years has been reported as 10.80 cases per 100,000 children.² The incidence rate has also been reported as being significantly higher in boys (13.35 cases per 100,000 children) versus girls (8.07 cases per 100,000 children). SCFE is known to be strongly associated with obesity in children and adolescents.^{1,3} In a retrospective review, investigators found that 81.1% of children with SCFE studied had a Body Mass Index (BMI) above the 95th percentile (i.e. clinically obese) compared to only 41.3% of controls ($P < 0.0001$).³ The significance of obesity is that it can increase the shear stress across the growth plate leading to slippage of the femoral head inferiorly and posteriorly on the femoral neck in the direction of the weight-bearing force.

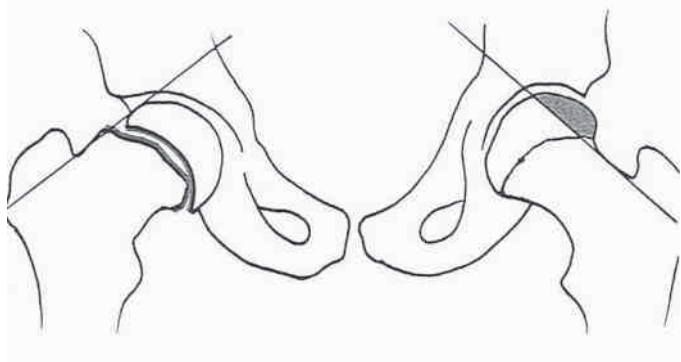
The SCFE patient can present to a chiropractic clinic with a variety of clinical presentations including lower back or hip pain, a painful limp, knee pain or little to no symptoms. The classic symptoms of SCFE include hip, groin or proximal thigh pain but a minority of patients may present with distal thigh or knee pain.^{1,4} In a retrospective study,⁵ it was found that 15% of patients presented clinically with knee pain and 85% presented with hip pain. When the patient presents with knee pain and does not present with hip pain, the clinician may overlook SCFE as a cause, instead focusing the examination to the knee joint. This in turn may lead to a delay in diagnosing a potential SCFE. A delay in diagnosis can lead to further slip of the femoral epiphysis on the femoral neck and progression of deformity.⁶

Degenerative osteoarthritis (OA) of the hip in patients

with SCFE typically develops gradually over several decades. The risk of OA increases and occurs at an earlier age of onset according to the severity of the SCFE, thereby reiterating why an early diagnosis is so important.^{1,7} The most severe complication that can result from a delayed diagnosis is damage of the arterial supply to the femoral epiphysis leading to avascular necrosis (AVN).^{6,8} Patients with AVN exhibit a more rapid osteoarthritic hip joint deterioration and require reconstructive procedures such as total hip replacement earlier in adulthood. Chondrolysis or acute cartilage necrosis occurs in approximately 5 to 7% of SCFE cases.⁸ The incidence of chondrolysis increases with increasing slip severity, thereby again reinforcing the importance of an early and accurate diagnosis. In approximately 50% of these cases, the hip joint regenerates. In other cases, the chondrolysis may progress leading to degenerative OA and/or debilitating pain requiring surgery. Therefore, SCFE should always be considered in the differential diagnosis when a child or adolescent patient presents clinically with a history of an intermittent limp and/or hip, thigh or knee pain. The prognosis is good in early diagnosis of SCFE.^{1, 6–8}

When the clinician suspects or is investigating for a potential SCFE, the examination should include a focused assessment of the hip joint. Physical examination including range of motion (ROM) and orthopedic testing typically will reveal limited and painful hip ROM with internal rotation, flexion and abduction.¹ Radiographically, SCFE is characterized by the presence of widening and blurring of the margins of the epiphyseal plate, loss of height of the femoral epiphysis and non-intersection of Klein's line, a line drawn tangentially along the lateral femoral neck, with the lateral aspect of the femoral epiphysis (Figure 1).⁹ The standard radiographic views to be taken include AP (anterior to posterior) with the patient weight bearing and Frog-leg (patient's femur externally

Figure 1 Diagram showing Klein's line. A normal Klein's line is drawn on the right of the diagram showing intersection with the lateral aspect of the femoral epiphysis. An abnormal Klein's line is on the left depicting a slipped capital femoral epiphysis (SCFE). (Source: Reprinted with permission from T.R. Yochum and L.J. Rowe, *Essentials of Skeletal Radiology*, 2nd ed., p. 719, J.P. Butler, © 1996 Williams & Wilkins.)



rotated) radiographs. Traditional medical management of SCFE is in situ surgical pinning of the femoral epiphysis to the femoral metaphysis.^{4,10} Surgical pinning is designed to stop further slip progression and deformity thereby reducing the risk and degree of osteoarthritis later in life.

Presented here is a case of an undiagnosed SCFE that with proper examination and radiographic investigation was subsequently detected in a chiropractic office.

Case Report

History

A 16-year-old Caucasian adolescent male presented with a chief complaint of right-sided hip/lower back pain of 18 months' duration. The onset of pain was insidious. Dejerine's Triad (i.e. pain with coughing, sneezing or bearing down during a bowel movement) was negative. The patient denied any neurological symptoms. Standing up from a seated position, walking, bending forward at the waist and lying on his right side were all provocative. The patient denied any palliative factors. The severity of

pain was graded as an 8 on a visual analog pain scale of 10, with 10 being the worst possible pain. The patient denied any radiation or referral of the pain. The frequency of pain was intermittent and tended to be worst first thing in the morning. The patient denied any ominous findings such as unexplained weight loss/night pain, fever/night sweats, blood loss or bowel/bladder dysfunction.

A radiologist's report of AP and Frog-leg radiographs taken at a medical imaging facility seven months earlier noted "minimal widening of the right femoral epiphyseal plate." In conclusion however, the films were subsequently read as "unremarkable" (Figure 2). The radiologist recommended a follow-up x-ray if the symptoms persisted. The patient's family physician diagnosed the patient with tendonitis. On close inspection of the radiographs, a mild slip of the femoral epiphysis on the metaphysis can be seen when measured with Klein's line. There is also widening of the epiphyseal plate and the right epiphysis appears smaller than the left.

The patient's past musculoskeletal history included a fall onto the tailbone from a six-foot wall four years prior. The patient received physiotherapy for this injury and had not received any other treatment for his current chief complaint. The patient's mother had a history of bilateral SCFE with surgical reduction (via in situ pinning) as an adolescent. She was also a patient at the chiropractic clinic for other musculoskeletal ailments and subsequently brought her son in for evaluation and a second opinion.

Examination Findings

Physical examination revealed a well-developed, well-nourished endomorphic male with a slight antalgic lean to the left. Bilateral subtalar overpronation was also noted on postural examination. Motion and static palpatory examination revealed joint restriction/malposition of the sacroiliac joints, bilaterally. Specifically, the posterior superior iliac spine (PSIS) was in an anterior-superior malposition (flexion restriction) on the right and posterior-inferior on the left (extension restriction). Prone leg length check revealed a functional short leg on the left. The lumbar range of motion (ROM) was restricted in active flexion and extension with pain on extension. The right hip joint ROM was restricted and very painful in passive flexion and internal rotation.

Orthopedic testing was positive for right hip joint pain with Hibb's (i.e. patient prone and knee is passively

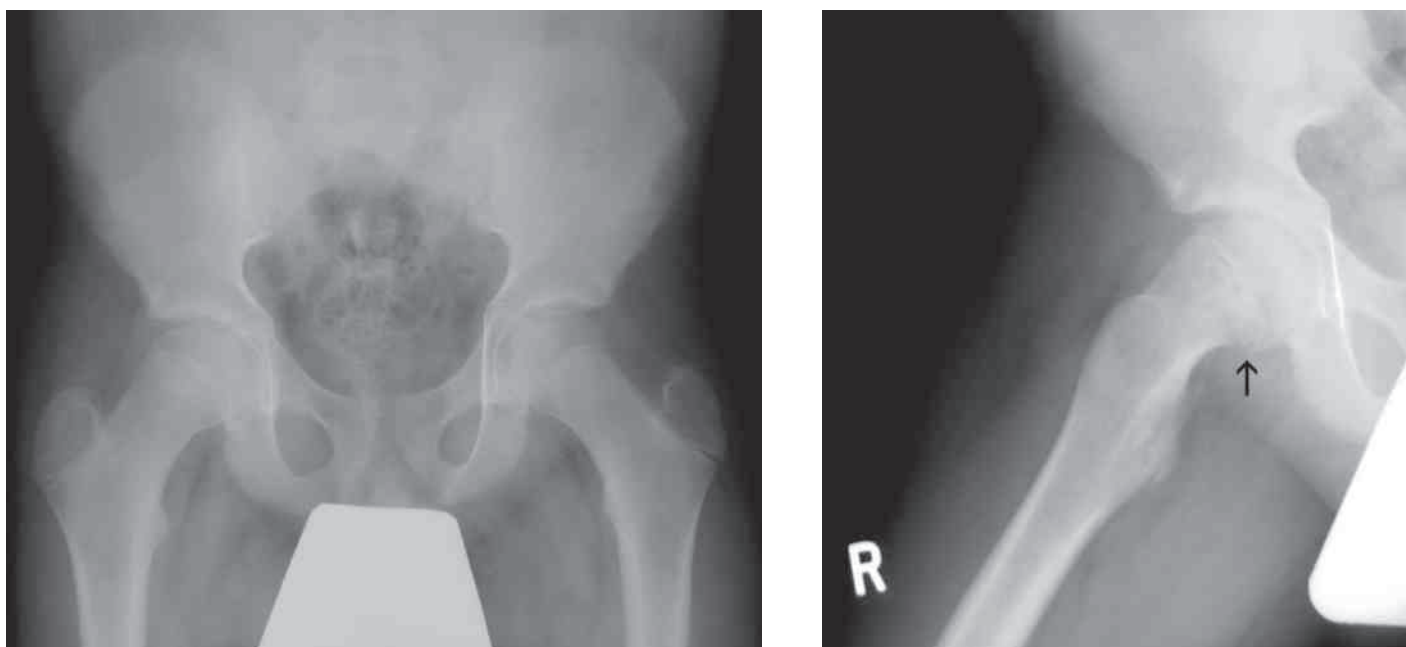


Figure 2 AP pelvis and Frog-leg right hip radiographs taken at a medical imaging facility seven months prior to presentation to the chiropractic clinic. The radiographs were read as “unremarkable” by the medical radiologist. On close inspection, the radiographs reveal mild SCFE of the right hip. (Note the small arrow drawn and pointing to the inferior aspect of the femoral epiphysis on the Frog-leg view.)

flexed approximating calcaneus with gluteal region), Yeoman’s (i.e. patient is prone and hip joint is passively extended while practitioner also applies pressure to the ipsilateral sacroiliac joint) and Fabere-Patrick’s (i.e. patient is supine and hip joint is passively abducted while the femur is in an externally rotated position). Supine leg length testing using Allis’ sign revealed no gross anatomical leg length discrepancy. Orthopedic testing including Kemp’s, Nachlas’ and Ely’s were all negative for hip and sacroiliac joint pain.

AP and Frog-leg radiographs were then taken at the chiropractic clinic (Figure 3). Measurement using Klein’s line (depicted on films) revealed posteromedial displacement of the capital femoral epiphysis on the metaphysis of the right femur. This displacement was more pronounced on the Frog-leg view of the patient’s right hip. Other radiographic findings included a smaller right capital femoral epiphysis when compared to the left side and mild thickening of the capital epiphyseal growth plate of

the right femur. The patient was diagnosed with a slipped capital femoral epiphysis (SCFE) of the right femur.

Plan of Management & Results

The patient was referred back to his family physician with a recommendation for orthopedic surgical consultation. Following a second radiographic examination at the request of the orthopedic surgeon, the medical radiologist subsequently confirmed the SCFE (Figure 4). The patient was then successfully treated with surgical reduction via in situ pinning of the right femoral epiphysis.

Discussion

The typical management for SCFE once it is diagnosed is surgical reduction by pinning the slipped femoral epiphysis to the metaphysis in situ.^{1,4,10} Because surgery is the treatment of choice for SCFE, there is very little scientific literature on conservative treatment approaches including chiropractic management. In general it is taught in

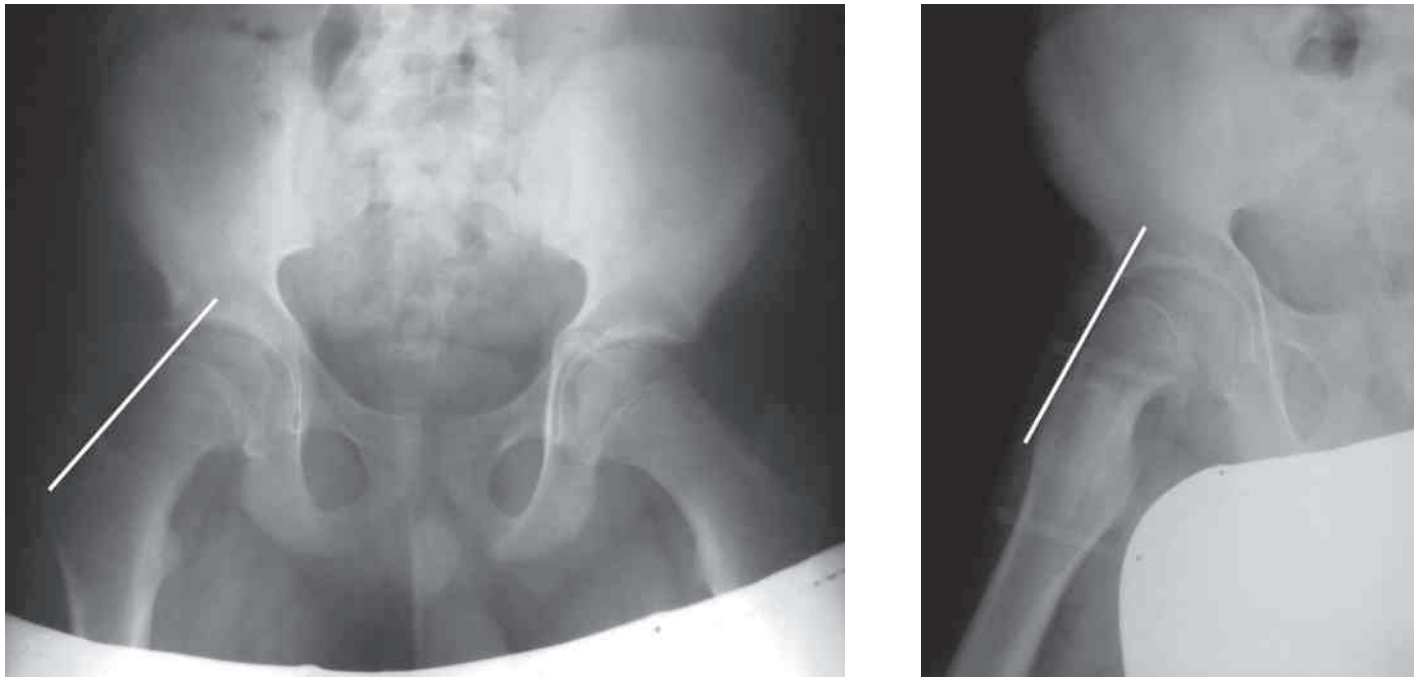


Figure 3 *AP pelvis and Frog-leg right hip radiographs taken at the chiropractic clinic revealing a SCFE of the right hip. (Klein's line is depicted on both films.)*

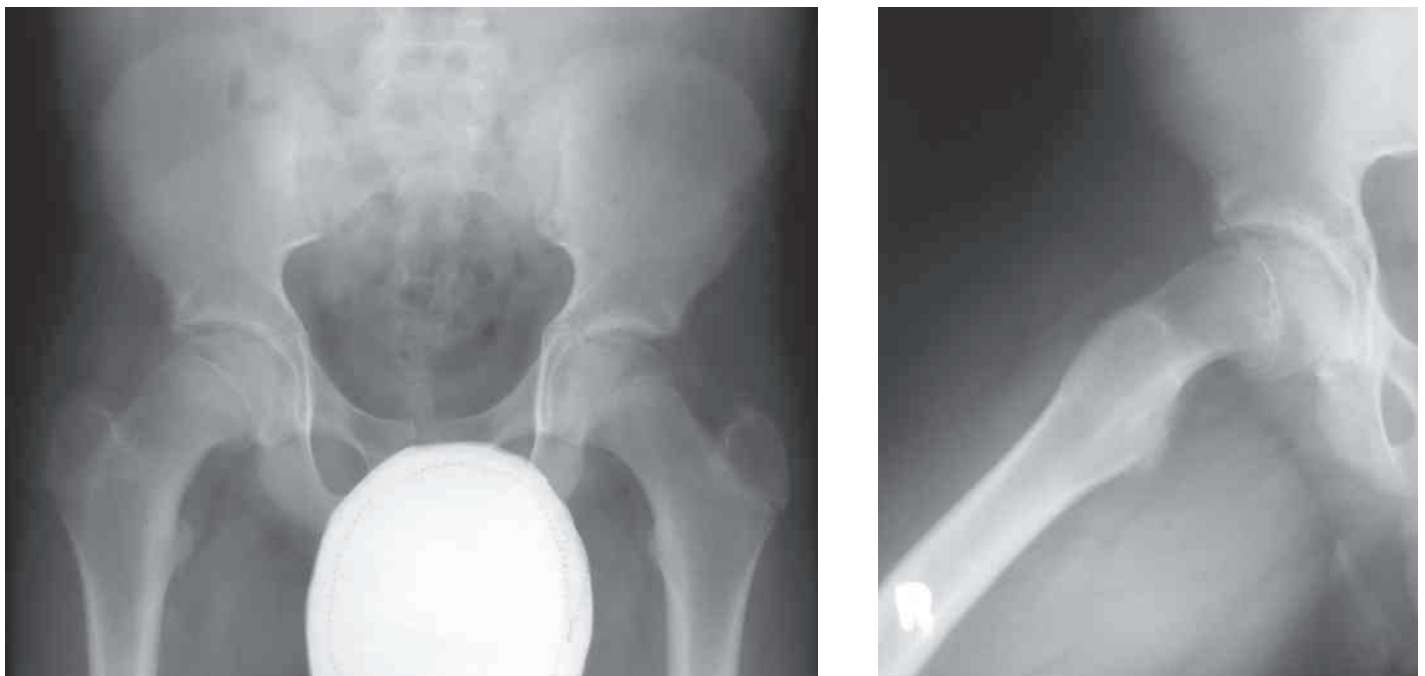


Figure 4 *Repeat AP pelvis and Frog-leg right hip radiographs requested by the orthopedic surgeon and taken at a medical imaging facility to confirm the SCFE.*

chiropractic that SCFE is a contraindication to high-velocity, low-amplitude (HVLA) manipulation (i.e. long axis distraction manipulation) of the hip joint. The contraindication is due to the potential increased risk of damaging the arterial supply to the femoral epiphysis leading to avascular necrosis (AVN).

In the medical literature, the use of manipulation in combination with surgical procedures for SCFE is controversial, particularly in cases of acute slips.¹¹ Studies have shown complications with AVN and chondrolysis in 20 to 31% of patients who underwent preoperative manipulation.^{7,12,13} In contrast, only 6% of patients who did not undergo manipulation prior to surgical fixation developed AVN.⁷ Conversely, research has also shown that preoperative manipulation can be safe^{14,15} and when an acute slip is reduced early (<24 hours), the AVN risk may actually decrease.¹⁴ This is because during an acute slip, the metaphysis displaces superolaterally and the femur rotates externally, causing twisting or kinking of the major arteries (i.e. the posterosuperior retinacular and lateral epiphyseal vessels) supplying the epiphysis.¹⁴ In an angiographic study, Maeda and colleagues¹⁶ showed that the superior retinacular artery circulation was regained after reduction. They concluded that the vascular damage may occur during the initial injury, before reduction, and that manipulative reduction does not necessarily lead to AVN. In addition, other research studies have shown that traction to reduce the SCFE prior to surgical fixation is safe and effective.^{17,18} However, given the risks of manipulation-associated AVN and chondrolysis, HVLA manipulation of the hip joint in a chiropractic office should continue to be taught as contraindicated for the SCFE patient. The most appropriate course of action for the chiropractor is surgical referral.

Post-operative treatment of patients with SCFE typically includes non-weight bearing of the involved hip as the patient remains in crutches for four to six weeks.^{1,4} Surgeons often prescribe gentle toe touching exercises for the patient as well while in crutches followed by a gradual return to normal daily activities after the minimum four to six week period. Once the epiphyseal growth plate has closed, weight bearing and contact sports can be resumed. It is unclear what role the chiropractor can play in the immediate and/or long-term post-operative treatment of patients with SCFE as no research has been done in this area. The chiropractic clinician's

best clinical judgement should be used when treating patients with a history of surgically reduced SCFE.

Besides the risk of complications with AVN and chondrolysis, the prognosis of children and adolescent patients with SCFE who are diagnosed early and surgically treated is good.^{1,4} The major long-term consequence of SCFE, particularly with a delay in diagnosing the condition, is the likelihood of degenerative osteoarthritis of the involved hip. The degree of degenerative arthritis typically depends upon the severity of the SCFE, hence the importance of an early diagnosis. Kocher et al.¹⁹ found that in their study of 196 SCFE patients, the median delay in diagnosis was 8.0 weeks. A longer delay in diagnosis was associated with greater slip severity and identified in patients with primarily knee/distal-thigh pain (compared with those with primarily hip/proximal-thigh pain). Other studies have also suggested that knee or distal thigh pain is a risk factor for delay in diagnosis.^{5,20,21} Mild slips being missed on radiographs by inexperienced surgeons or by radiologists can also delay the diagnosis.²⁰ Treating osteoarthritic symptoms is possibly one way in which the chiropractor could play a role in the long-term management of patients with a history of SCFE. At this point in patient management, HVLA long axis distraction of the arthritic hip joint could be more safely considered. Again however, the clinician's best clinical judgement should be used.

Conclusion

SCFE is a somewhat rare condition but can present in a chiropractic office, particularly one with a musculoskeletal scope of practice. When present, SCFE is typically seen in adolescents during their early growth spurt. The classic symptoms are hip or groin pain but a minority of SCFE patients may present with only knee pain. The clinical presentation may or may not include a history of trauma and/or a painful limp. Physical examination findings typically include painful hip joint ROM in internal rotation, flexion and abduction. The characteristic plain film radiographic findings utilizing the standard AP and Frog-leg radiographic views include widening and blurring of the margins of the epiphyseal plate, loss of height of the femoral epiphysis and non-intersection of Klein's line with the lateral aspect of the femoral epiphysis. The most appropriate plan of management for a patient with SCFE is referral to an orthopedic surgeon for in situ sur-

gical pinning. Early diagnosis of SCFE is important as this reduces the risk of further slippage of the femoral epiphysis, risk of complications such as AVN and chondrolysis and degree of degenerative osteoarthritis in the involved hip later in life.

Presented in this case report was an undiagnosed case of SCFE. It was detected in a chiropractic clinic through proper clinical examination and radiographic evaluation. The patient was referred back to his family physician with the diagnosis and a recommendation for orthopedic surgical referral. The patient was subsequently treated successfully with surgical reduction of the SCFE by in situ pinning. The diagnosis and appropriate management of the SCFE patient is where the chiropractor has an important role to play in the management of this condition. More research is necessary to determine the role, if any, that a chiropractor can play in the immediate and/or long-term management of the SCFE patient, particularly post-operatively.

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Temporomandibular joint: conservative care of TMJ dysfunction in a competitive swimmer

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Objective: To detail the progress of a patient with TMJ dysfunction and headaches due to swimming, who underwent a conservative treatment plan featuring soft tissue therapy, spinal manipulative therapy, and rehabilitation.

Clinical Features: The most important features were initial bilateral temporal headaches and persistent left sided TMJ pain brought about by bilateral breathing while swimming. Conventional treatment aimed at decreasing hypertonic muscles, increasing hyoid mobility, improving TMJ mobility, resolving cervical restrictions, and improving digastric facilitation.

Intervention and Outcome: The conservative treatment approach utilized in this case involved soft tissue therapy, hyoid mobility treatment, TMJ mobilization, spinal manipulative therapy, and digastric facilitation. Outcome measures included subjective pain ratings, range of motion, and motion palpation of the cervical spine.

Conclusion: A patient with bilateral temporal headaches and TMJ pain due to bilateral breathing while swimming appeared to be relieved of his pain after three treatments of soft tissue therapy, hyoid mobility treatment, spinal manipulative therapy, and digastric facilitation.

(JCCA 2009; 53(3):165-172)

Objectif : Expliquer en détail les progrès d'un patient souffrant du dysfonctionnement d'une articulation temporomandibulaire (ATM) et de maux de tête reliés à la natation, à qui l'on a prescrit un traitement conservateur comprenant un travail des tissus mous, une manipulation rachidienne et une réadaptation.

Caractéristiques cliniques : La plus importante manifestation du dysfonctionnement se présentait d'abord sous forme de céphalées temporales bilatérales et de douleur persistante ATM du côté gauche, causée par la respiration bilatérale pendant la natation. Le traitement conventionnel visait à adoucir les muscles hypertoniques, accroître la mobilité hyoïdienne, améliorer la mobilité ATM, éliminer les contraintes cervicales et améliorer le fonctionnement du muscle digastrique.

Intervention et résultat : La méthode de traitement conservateur utilisé dans le présent cas a consisté à centrer le traitement sur les tissus mous, la mobilité hyoïdienne, la mobilité ATM, la manipulation rachidienne et le travail du muscle digastrique. L'indicateur des résultats a inclus des cotes subjectives de classification de la douleur, la portée du mouvement et la palpation du mouvement de la colonne cervicale.

Conclusion : Un patient souffrant de céphalées temporales bilatérales et de douleurs ATM attribuables à la respiration bilatérale pendant la natation semble être soulagé de sa douleur après trois traitements d'une thérapie des tissus mous, d'un traitement de la mobilité hyoïdienne, d'une manipulation rachidienne et d'un

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KEY WORDS: temporomandibular, joint, headache, manipulation

Introduction

The temporomandibular joint (TMJ) is a complex junction in the human skull incorporating disk, masticatory muscles, and cervicocranial innervation. The prevalence of TMJ pain in the general population is reported to be 25%.¹ Common signs associated with TMJ discomfort include popping, clicking, muscle tenderness, joint tenderness, and decreased opening of the jaw.¹ This joint has also been suggested to be a key propagating factor in oral and cervical disorders as well as headaches. TMJ pain commonly occurs with capsulitis, synovitis, meniscal derangement, tendonitis, degenerative joint disease, and infection.² The main movements which the TMJ is responsible for are the opening and closing of the mouth. Proper opening mechanics involves both mandible depression and chin retrusion. Alternatively mouth closing includes mandible elevation and chin protrusion.²

The National Board of Chiropractic Examiners (NBCE) 2005 survey of 2574 chiropractors in the USA confirms that TMJ pain or Temporal Mandibular Disorder (TMD) is a condition that is commonly seen. Their data rated TMD complaints as being a condition that 'sometimes' (26–50%) presents to a chiropractors office. In fact, the 2003 paper by Raphael *et al* reported that in their survey of women with TMD, that 22% of them chose complementary alternative therapies, which included chiropractic.³

Early signs of TMJ dysfunction vary from one patient to another, however commonly reported findings include: headache and facial pain, impaired jaw mobility, clicking or crepitus, pain in the TMJ and ears, masticatory muscle pain, "stuffy" sensation in the ears, eustachian tube dysfunction, and dizzy spells.⁴

Other predisposing factors can include joint specific issues such as joint laxity, anatomical variation, capsular or muscular inflammation, repetitive motion, and static articular stress.

traitement facilitant le fonctionnement du muscle digastrique.

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MOTS CLÉS : temporomandibulaire, articulation, mal de tête, manipulation

An aquatic sport which can lead to TMJ pain is swimming. To date there have not been any investigations to assess the prevalence of TMJ dysfunction in swimmers. The majority of reported swimming injuries include shoulder, neck, and back injuries due to repetitive overuse and microtrauma brought on by poor technique and biomechanics.^{5–9} In order to maximize force production while in the water swimmers must position themselves in uncommon anatomical positions that subject the athletes to repetitive strain of numerous structures and tissues in the upper limb and spine.^{5,9} In fact, the neck can be subjected to sustained and repetitive movements which can lead to overuse injury. Fifty-five (55%) of total cervical movement (most prominently rotation) is provided by the atlanto-axial joint (C1-C2), which houses the trigeminal spinal tract subnucleus and C1-C2 dorsal horns.⁵ It is not surprising that the neck and its related structures can cause radiating pain to the shoulder and facial structures. In the older swimmer, disc dysfunction and spondylosis may also impinge on nerve roots at these levels as well as C4, C5 and C6 resulting in radiating pain to the shoulder joint and beyond. Such an injury would make it difficult to swim due to the additional load placed on the cervicocranial structures.⁵

The number of strokes a freestyle swimmer takes in a practice is considered to be approximately 2500. Assuming they are taking a breath every three strokes, this translates into the swimmer turning their head over 800 times per workout.⁵ This is further complicated if the majority of the swimmers breaths are unilaterally (only rotating the head in one direction for breathing in a front crawl) as it could lead to muscle imbalances. Such dysfunctions can be further irritated by postural alterations such as forward head carriage. Repetitively turning the head from the axis of rotation at C1-C2, into a stressed position while breathing, can cause the neck to adopt a hyperextended and rotated position. It has been suggested

that the overuse of a hyperextended cervical spine can predispose the swimmer to cervicogenic headaches.⁵ Thus bilateral breathing (breathing to the left when the right arm is extended overhead and to the right when the left arm is extended overhead) during the front crawl is promoted in swimmers from an early age to enhance muscle balance.

The term for a headache occurring during physical activity is called “benign exertional headache.” Although swimming headaches are rare, they are often described as sudden, severe, exploding, and pulsating.^{10,11} It has been suggested that vascular factors are involved in the pathogenesis of swimming headaches.¹⁰ Increased levels of CO₂ in the blood, due to insufficient ventilation while swimming, could possibly give rise to cerebral vasodilatation, resulting in increased intracranial pressure leading to an exertional headache.¹⁰ Another possible explanation for swimming induced headaches could be neuronal irritation. Cervicogenic headaches while swimming may also be the result of nerve entrapments in hypertonic cervical muscles brought on by the repetitive rotation and hyperextension of the neck. Such a mechanism could also be used to explain a TMJ dysfunction brought on by swimming via relay through the previously mentioned trigeminal spinal tract subnucleus and C1-C2 dorsal horn transitional zone.

The purpose of this case report was to describe a patient who experienced TMJ pain and headaches during swimming while training for a triathlon. The patient underwent a successful, simple, non-invasive chiropractic treatment plan using manual procedures and rehabilitative training for the TMJ musculature as well as undergoing technique and postural education for their swimming stroke.

Case Report

This case report involves a 31 year old male recreational triathlete who developed headaches and TMJ pain while attempting to incorporate bilateral breathing into his free-style swimming training regime. Initially the patient was breathing every 2 or 4 strokes only rotating his head to the left side. Breathing bilaterally every 3 strokes introduced an additional right sided rotation breathing. On his first day of initially attempting to bilaterally breathe the patient experienced a bilateral temporal headache after his swim which was relieved by AdvilTM. Two days later

while attempting to bilaterally breathe for the second time, the patient experienced another bilateral temporal headache (again relieved by AdvilTM) and left sided jaw pain while in the pool. The next day while attempting to bilaterally breathe for the third time the patient experienced a mild headache, extreme jaw pain, and an inability to open his mouth more than 50% which prompted the patient to present for treatment.

The patient was a physically fit health care professional who reported to work-out daily (either swimming, biking, running, or weightlifting, each 2–3 times per week). He denied any previous incidences of TMJ pain or dental issues, but did report previous cervicogenic headaches as a student, that resolved with postural exercises. No previous motor vehicle accidents were reported however the patient acknowledge that he suffered several concussions in his youth playing minor sports. Occasional knee discomfort associated with his run training was noted however the primary complaint was his jaw pain and dysfunction which was aggravated by his swim training.

The subject presented with decreased hyoid mobility (less lateral motion from left to right) and a dysfunctional active mouth opening pattern where pterygoid hypertonicity/jaw jut was prominent. No headache or neck pain was noted at this time, but bilateral TMJ pain (with the left side greater than the right) was reported at the initial assessment. The subject rated his TMJ pain 7 out of 10 on Visual Analog Scale (VAS), while Neck Disability Index was zero out of 50. The centric relation protrusion test (TMJ compression) and biting/jaw clenching did not reproduce pain. Motion palpation revealed the left TMJ to be subjectively hypermobile while the right TMJ was found to be hypomobile. A cervical spine screen found right rotation painful and decreased by 25% while left rotation was full but painful at end range. Bilateral restrictions were found with motion palpation at C0, C1, and C2. Jackson’s, Spurling’s, and Cervical Compression tests (as described by Vizniak’s Clinical Chiropractic Handbook) were all found to be negative for facet joint and nerve root involvement, however left Kemps test was found to cause pain on the left at C1-C2 without radiation. Soft tissue palpation revealed tight and tender sternocleidomastoid (SCM), upper trapezius, levator scapula, superior and inferior oblique, rectus capitis minor, lateral pterygoids and masseter muscles bilaterally. Deep neck flexors were also found to be weak, as indicated by an

endurance test in which the patient could only maintain a chin tucked position for 10 seconds and reported the sensation of a headache “coming on” at the conclusion of the test.

Treatment

The patient was treated with 3 sessions of soft tissue therapy consisting of Active Release Technique® (ART®) to the SCM, upper trapezius, levator scapula, superior and inferior oblique, and rectus capitis minor muscles (see Figure 1); hyoid mobility treatment done passively with the patient lying supine and the slack taken out on the hyoid bone by pushing lateral to medial in both directions until resistance was encountered (see Figure 2); TMJ mobilization done passively taking out the joint slack and rotating the joint in a figure eight like motion (see Figure 3); spinal manipulative therapy was performed by rotary adjustment to C1-C2 (see Figure 4); and digastric exercises were accomplished by an isometric facilitation, every other day over the course of 1 week. Additionally the patient was instructed to continue digastric facilitation exercises by placing the tongue on the roof of his mouth while opening his jaw (see Figure 5) and deep neck flexor exercises (chin tucks) at home 2 to 3 times daily (see Figure 6). The patient returned to the pool 1 week later with a swimming coach for stroke assessment and reported no pain. These interventions combined with 1 week of rest resulted in relief from headaches and TMJ pain as the patient resumed his biweekly swim training with a VAS of zero out of 10. At follow up one month later the patient reported no reoccurrence of headache or TMJ pain, exhibited an improved mouth opening pattern and full range of TMJ and cervical spine motion. He also demonstrated an improved deep neck flexor endurance test to 45 seconds, and VAS remained zero out of 10.

Discussion

The three main categories of TMJ disorders are myofascial pain, internal derangement, and degenerative destruction.² The myofascial category is the most common and often involves pain not only in the muscles of mastication but also muscles of the neck and shoulders.² A number of muscles can be involved with movement of the TMJ, however it has been suggested that the most important are the digastricus, masseter, and lateral pterygoid.² (see Figure 7) The primary action of the digastricus is to aid in open-



Figure 1 Active release technique for the SCM.



Figure 2 Hyoid mobility treatment.

ing of the mouth, whereas the masseter muscle is chiefly responsible for closing the mouth. The masseter is assisted in this task by the medial pterygoid and temporalis muscles. The lateral pterygoids bilaterally stabilize the TMJ and contribute to protrusion of the chin during mouth opening.² Manual treatments for relaxation, facilitation, and mobilization of these muscles have been shown to be successful in dealing with TMJ pain.²



Figure 3 *Mobilization of Hypomobile TMJ.*

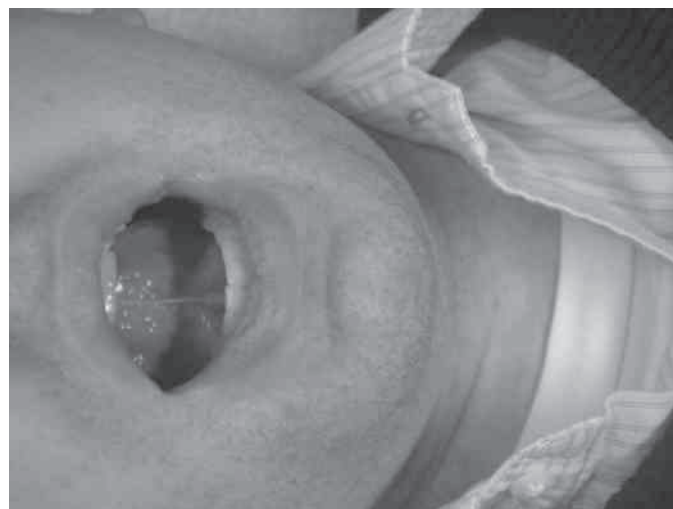


Figure 5 *Digastric facilitation exercise.*



Figure 4 *Spinal manipulation therapy.*



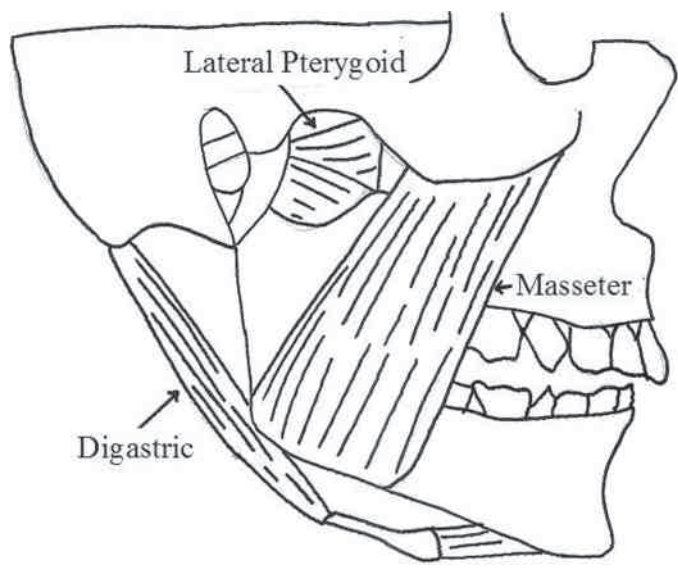
Figure 6 *Deep Neck flexor exercise.*

Postural alterations have also been associated with TMJ disorders as individuals with an anterior head carriage typically display protrusion of the chin and hyperextension of the cervicocranial junction.² Prolonged static maintenance of this posture can cause lengthening of the deep neck flexors and coupled shortening of the suboccipital muscles. Furthermore, the masseter muscles can become hypertonic due to the increased gravitational challenge, whereas the antagonistic digastricus muscles

are often found to be inhibited in people with this posture. Strength and performance of the TMJ and cervicocranial junction are thus compromised making this region less stable and prone to injury.²

The upper cervical spine (C1 and C2 spinal segments) is also implicated in TMJ disorders. The dorsal horns of this level of the spinal column represent a transition zone between the trigeminal spinal tract subnucleus (cranial nerve V) of the brainstem and the rest of the spinal cord.¹²

Figure 7 Important muscles of mastication. Lateral Pterygoid, protrusion of the chin. Masseter, closing of the mouth. Digastric, opening of the mouth.



Cranial nerve V contains 3 divisions: ophthalmic, maxillary, and mandibular. The mandibular division innervates the lower lip, cheek, teeth, and anterior two-thirds of the tongue, plus the skin of the lower jaw and the side of the head.¹² The TMJ is specifically innervated by the masseteric and auriculotemporal branches of the mandibular nerve.¹³ It has been reported by Morch et al. that the C1 and C2 dorsal horns receive extensive primary afferent inputs from the lateral aspect of the face and from nerves of the craniofacial muscles such as those of the mandibular division of cranial nerve V supplying the masseter, temporalis, and anterior digastric muscles.^{13,14} Afferent convergence patterns have been implicated as an important process underlying pain referral in conditions such as TMJ disorders.^{13,14} It has also been documented that upper cervical dorsal horns receive nociceptive inputs from deep craniofacial tissues and act as a critical relay center in craniofacial nociceptive reflexes.^{12,13} Previous studies have shown the involvement of the trigeminal spinal tract subnucleus and C1 dorsal horn to be an important relay site of deep and cutaneous nociceptive craniofacial information to higher brain centers.¹⁴ These two structures also

act as a significant interneuronal relay site for jaw reflex responses to deep noxious stimuli. These features suggest that the trigeminal spinal tract subnucleus and C1-C2 dorsal horns may act as one integrative functional unit to process nociceptive information from craniofacial structures such as the TMJ.¹²

Patients with TMJ disorders often have histories that reveal predisposing and complicating factors that can significantly contribute to their condition, such as muscle imbalance and upper cervical spine joint dysfunction.¹⁵ One predisposing factor to consider in every TMJ patient is hypertonic sternocleidomastoid (SCM) muscles. In fact, trigger points in the SCM muscle can be used as an objective indicator for orofacial and cervicocranial disorders.¹⁵ Chronic over activity of the neck flexors such as the SCM will cause an inhibitory weakening of the deep neck flexors and lead to a forward head posture seen with cervicocranial disorders. Tight SCM muscles can also lead to heterotopic pain in the form of temporal headaches, which is another common finding with TMJ pain. If left untreated this can lead to not only TMJ dysfunction but also compromise such functions as speech, swallowing, chewing, and respiration.¹⁵

When considering a swimmer with TMJ pain, stroke mechanics are recommended to be investigated with the assistance of a coach in order to avoid relapses and to ensure the athlete is performing with optimal biomechanical advantage. It is important to note that common swimming drills such as kicking with a flutter board can cause the neck to be put into a position of hyperextension for prolonged periods of time and thus should be avoided in athletes who have cervical pain. Improving or maintaining ideal posture and technique during practice may have long term benefits for the athlete.⁵ Athletes with neck pain and decreased range of motion with tight cervical muscles will often experience relief of their symptoms from mobilizations or manipulation to the cervical spine.⁵ Despite bilateral breathing causing the complaint in this patient, bilateral breathing during swim practices should be encouraged as breathing only to the favored side leads to muscular imbalances within the neck (especially with rotation). These muscular imbalances can be aggravated by forward head carriage, as the axis of rotation changes, resulting in greater extension and side bending of the cervical spine to compensate for the decreased rotation. Alternatively, breathing to the unfav-

vored side may not rotate the body enough, potentially contributing to over-rotation of the neck and subsequent discomfort.¹¹ While often overlooked, scapula stability is also important in neck function and postural education. Even more important however is the role of the deep neck flexors, longus colli and longus capitis. Rehabilitative treatment for these muscles should focus on endurance exercises to improve the ability to contract over time.⁵

The 2000 publication by Skaggs and Liebenson describes 4 clinically useful tests for diagnosing and treating TMJ dysfunction which were used in this case.² The first test, Centric Relation Protraction Test, is a structural assessment test. It is designed to place the disc-condyle complex in the most stable position. A positive test indicates malposition of the disc-condyle complex and suggests a structural pathology with poor prognosis to conservative care. Possible causes of pain include disc dislocation, osteoarthritis, and capsulitis.² The remaining 3 tests are functional assessment tests. The second test, Mouth Opening Pattern Test, involves observing the patients chin while they open their mouth, paying special attention to the initiation of movement. A positive test is protrusion of the chin during the initiation of opening or limited opening range of motion, and indicates over-activity and tension of the masseter or lateral pterygoid muscles. Treatment (postisometric relaxation) focused on lateral pterygoids and involves passively opening the patients mouth and resisting their gentle attempt to poke the chin out. On relaxation, the clinician takes out slack in a posterior direction of chin retrusion to lengthen the muscle. Treatment (postisometric relaxation) focused on masseter muscles involves passively opening the patients mouth (down and back) while resisting the patients gentle attempt to close the mouth. On relaxation, the patient is asked to simulate a yawn, during which time, the clinician follows the mandible to the next barrier of resistance and the procedure is then repeated.² The third test, Hyoid Mobility Test, is done passively with the patient lying supine. The practitioner takes out the slack on the hyoid bone by pushing lateral to medial in both directions until resistance is encountered. A positive test is little or no springing of the bone or a distinct asymmetry of palpable tension and indicates increased tension in the digastric muscle on the ipsilateral side. Treatment (postisometric relaxation) focuses on the digastric muscle. The clinician repositions the patient's

mouth open with the chin in retrusion, contacting the hyoid on the blocked side. The clinician then attempts to close the patient's mouth and instruct the patient to resist closure. On relaxation the clinician follows the release of hyoid to next barrier and then repeats.² The fourth and final test, TMJ Mobility Test, is an active test done with light palpation of the disc-condyle complex just anterior to the tragus of the ear. This test assesses for symmetry in the translation of the condyles while the patient slowly opens and closes their mouth several times. Subjectively the clinician can appreciate either hypo or hypermobility of the TMJ. Treatment to a hypermobile joint involves connective tissue release techniques such as Active Release Technique, whereas a hypomobile joint is recommended to be treated via mobilizations. This is done by contacting the molars of the affected side with the thumb. Joint slack is taken out with long axis distraction and the practitioner gently rotates (clockwise or counterclockwise) the TMJ in a figure eight like motion for up to 20 seconds.²

Conclusion

Headaches in swimmers have been previously documented, however to our knowledge this is the first case where a TMJ dysfunction has been reported and treated in a swimmer.^{10,11} The causes of TMJ complaints are believed to be multi-factorial and include postural alterations that can lead to hypo/hypertonic muscles and cervical spine restrictions, visceral insufficiency, and neuronal irritation. Conventional treatment aims at decreasing hypertonic muscles, increasing hyoid mobility, resolving cervical fixations, and improving digastric facilitation to enhance mouth opening patterns. Furthermore, the 2004 Cochrane review concluded there was weak evidence for the use of stabilisation splint therapy for reducing pain severity and was neither worse nor better than other active interventions.¹⁶ More recently, the conservative care paper by Vinjamury *et al.* found the effectiveness of manual treatment for TMD to be both safe and effective.¹⁷ In this case, a patient with bilateral temporal headaches and TMJ pain due to bilateral breathing while swimming appeared to be relieved of his pain after having three manual treatments and through incorporating digastric facilitation exercises and deep neck flexor exercises into their exercise regime. As a result, a prospective study to investigate TMJ dysfunction treatment through conservative manual therapies is suggested.

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Neck pain and disability outcomes following chiropractic upper cervical care: a retrospective case series

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Objective: *To investigate the use of an upper cervical low-force (UCLF) chiropractic procedure, based on a vertebral alignment model, in the management of neck pain and disability by assessing the impact on valid patient outcome measures.*

Design: *A retrospective case series.*

Methods: *Consecutive patient files at a private chiropractic practice over a 1-year period were reviewed for inclusion. Data for the first visit, pre- and post-adjustment atlas alignment radiographic measurements, baseline and 2-weeks NDI (100 point) and verbal NRS (11 point) were recorded. The data were analyzed in their entirety and by groups comparing <30% vs. >30% post adjustment atlas alignment changes.*

Results: *Statistically significant clinically meaningful improvements in neck pain NRS ($P < 0.01$) and disability NDI ($P < 0.01$) after an average of 13.6 days of specific chiropractic care including 5.7 office visits and 2.7 upper cervical adjustments were demonstrated. There were no serious adverse events. Cases with the post-adjustment skull/atlas alignment measurement (atlas laterality) that were changed more than 30% on the first visit toward the orthogonal alignment predicted a statistically and clinically significant better outcome for NDI in 2 weeks.*

Conclusions: *UCLF chiropractic instrument adjustments utilizing a vertebral alignment model are promising for the management of patients with neck pain based on assessment using valid outcome measures. (JCCA 2009; 53(3):173-185)*

Objectif : *Enquêter sur le recours à la procédure chiropratique de la manipulation cervicale supérieure de faible intensité (UCLF), fondée sur le modèle de l'alignement vertébral, dans la gestion de la douleur au cou et de l'incapacité fonctionnelle en évaluant les conséquences des critères valables d'efficacité pour les patients.*

Concept : *Une rétrospective de séries de cas.*

Méthodes : *On a effectué une révision des dossiers médicaux des patients, sur une période d'un an, dans une clinique chiropratique privée. On a consigné les données portant sur la première visite, les dimensions sur les radiographies de l'alignement de l'atlas, avant et après l'ajustement, la base de référence, les deux (2) semaines de NDI (100 points) et le NRS verbal (11 points). Les données ont été analysées dans leur intégralité et par groupes, en observant <30 % c. >30 % des changements à l'alignement de l'atlas après ajustement.*

Résultats : *important au plan statistique, significatif au plan clinique, on a démontré des améliorations sérieuses à la douleur au cou, NRS ($P < 0.01$), et à l'incapacité fonctionnelle, NDI ($P < 0.01$), après une moyenne de 13,6 jours de traitement chiropratique spécifique, y compris 5,7 visites au bureau et 2,7 ajustements cervicaux supérieurs. On n'a observé aucun effet secondaire défavorable. Pour les cas affichant une mesure d'alignement après ajustement au crâne/atlas (latéralité de l'atlas), qui ont été modifiés plus de 30 % à la première visite, vers un alignement orthogonal, on a*

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KEY WORDS: chiropractic; neck pain; evidence-based outcomes; neck disability index (NDI); validity; orthospinology; upper cervical

Introduction

Neck pain affects two thirds of people at some point in their lives and is almost as common as low back pain.¹ The point prevalence of neck pain for North America is somewhere between 13–22.2%, with high-intensity low-disability pain at 10.1% and disabling neck pain affecting 4.6% of the population.^{1,2} Chiropractors frequently care for patients with neck pain using varying techniques or procedures. They typically use spinal manipulative therapy (SMT) to address a segmental joint hypomobility within the cervical spine as determined by joint motion palpation and endplay assessment.³ Such manipulation involves a specific spinal segmental contact, passive lateral flexion and rotation of the head and neck to the point of increased joint tension followed by a high-velocity low-amplitude (HVLA) thrust. The thrust has been measured at 100 Newtons and is usually accompanied by and audible sound theorized to occur from cavitation.⁴

Recent systematic reviews of HVLA-style spinal manipulative therapy have shown that there is moderate to high-quality evidence that HVLA is better than placebo for chronic neck pain, better than general medical care and about the same as rehabilitation.^{5,6} However, there has been considerable controversy regarding the safety of HVLA manipulation in the cervical spine^{7,8} but a recent study shows concerns may be unfounded.⁹

Chiropractors also use other forms of spinal manipulation aside from HVLA to care for patients suffering from neck pain. Upper cervical low-force (UCLF) procedures, in particular, use a low-force thrust (on the order of 9–13 Newtons in some cases) and require no lateral flexion or

démontré une amélioration supérieure aux plans statistique et clinique pour le NDI en deux semaines.

Conclusions : L'instrument d'ajustement chiropratique UCLF, combiné à un modèle d'alignement vertébral, semble prometteur pour la gestion des patients souffrant de douleurs au cou si on se fie à l'évaluation des critères valables d'efficacité.

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MOTS CLÉS : chiropratique; douleur au cou; résultats fondés sur l'expérience clinique; douleur du rachis vertical (NDI); validité; orthospinologie; rachis vertical

rotation of the head and neck or joint cavitation for the management of neck pain and disability. Many UCLF procedures are based on the Grostic model of upper cervical analysis, which was developed in the late 1930s and early 1940s.¹⁰ The care can be delivered by hand or hand-held and table-mounted instruments. Grostic, Orthospinology, Atlas Orthogonal, Advanced Orthogonal and National Upper Cervical Chiropractic Association (NUCCA) are some of the named techniques that are UCLF procedures. These systems use the supine leg check to test for functional leg length inequality (FLLI) as one of the main clinical assessments along with a radiological analysis for the quantification of upper cervical alignment.^{11–13} The Grostic model hypothesizes that a neuromusculoskeletal link exists between the upper cervical spine, bilateral spinal skin temperature regulation asymmetry, postural asymmetry and FLLI.¹³ The supine leg check determines when an upper cervical adjustment should be given and the x-ray analysis determines how to deliver the adjustment based on alignment measurements and the observed resultant alignment after the first adjustment. The supine leg check has demonstrated clinical validity as a stand-alone test for recurring back pain,¹⁴ exhibited high (ICC>0.9) agreement among examiners and the inter-examiner reliability was good at 0.7.¹⁵ However, the validity of using supine leg length asymmetry change following an atlas adjustment as a measure of improved neurological function is mostly unknown. FLLI may be linked to increased latencies found on somatosensory evoked potential (SEP) tests of the common peroneal nerve at the cortex.¹⁶ The removal of FLLI (i.e. a

balanced supine leg check) coupled with a change in upper cervical alignment toward the orthogonal position on post-adjustment radiographic analysis following upper cervical chiropractic intervention, is thought to indicate the absence or improvement of biomechanical and neurological dysfunction within the cervical spine. The measurement of atlas alignment relative to the skull (atlas laterality) from x-rays demonstrates good to excellent reliability^{17–22} (0.83 to 0.99 R) with 1 exception²³ (range of error 2°); however, its measurement is 2-dimensional, representing anatomical relationships in only 1 plane of motion with the validity unknown. A premise of many upper cervical chiropractic techniques is that it is the maintenance or “holding” of the upper cervical alignment correction after an adjustment that allows the patient to improve, not just the manipulation procedure.

Since the adjusting technique and post-adjustment analysis do rely on radiographs, the procedure may introduce some risk due to the exposure to ionizing radiation. This procedure uses at least 3–4 additional cervical x-ray views in order to achieve optimal results. Groups using UCLF procedures advocate methods to limit the risk of exposure to radiation, including the use of lead foil filters in addition to the collimator and internal filters to significantly minimize radiation to more sensitive tissues like the brain, eyes and thyroid. A recent study indicates the total radiation for UCLF x-rays are estimated from 136 to 211 milliroentgens (mR) at skin entrance when using lead filters. This compares similarly to a standard 2 view cervical series without lead filters at 178 mR.²⁴

Are the UCLF X-rays dangerous? Wall et al. indicates the risk band for radiography to the head, neck and joints is minimal with a risk range of between 1 in a million and 1 in 100,000.²⁵ The thyroid gland may be the most sensitive tissue to radiation that is exposed to the largest dose with the current study’s radiographic procedures. The life time age-adjusted background risk for developing thyroid cancer is 0.79%.²⁶ Preston et al. provides information that is used to express the elevated relative risk (ERR) using a single formula: $ERR = 0.57 \times Dose \times EXP(-0.037(ae - 30) - 1.51n(\text{age}/70))$, where “ae” means age at exposure and “age” indicates attained age.²⁷ Another study using atomic bomb survivors found the relative risk per Gray (ERR/Gy) was not significantly elevated among the cervical cancer patients and atomic bomb survivors studies exposed after age 15. There was a 7.7 ERR/Gy (one Gray

is approximately 100,000 mR) and an excess absolute risk per 10⁴ person years (PY) Gy (EAR/10⁴ PY Gy) of 4.4 for those exposed before age 15.²⁸ For the exposure ages 5–9 and 10–14 the modifiers were 0.5 and 0.2 respectively indicating significantly reduced risk with increasing age at exposure. The U.S. Environmental Protection Agency (EPA) has a formula for estimating mortality risk from radiation for thyroid cancer as well.²⁹ Biological Risk from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006) provides a lifetime attributable risk (LAR) of thyroid cancer incidence for age and gender from a single exposure to 0.1 Gy (approximately 10,000 mR).³⁰ The LAR varies significantly with age at exposure with decreasing age having larger LARs. The LAR for females is higher than males.

Chiropractic could base its methods on scientific data using information demonstrated in practice through clinical research.³¹ The purpose of this study is to assess the impact of the UCLF procedure on pain levels and disability ratings in a population of neck pain patients seen in a private practice setting. A second goal is to examine the predictive value and risk of taking post x-ray alignment measurements by determining if patients who receive a more completely reduced upper cervical spine misalignment on the first visit experience better clinical improvement. The hypothesis is that a statistically and clinically significant improvement occurs following UCLF chiropractic procedures. Also, a better outcome is predicted within 2 weeks when the first chiropractic atlas adjustment more completely reduces upper cervical vertebral alignment toward the orthogonal configuration. These data are necessary to begin to address the question: “Are there any benefits for patients suffering from neck pain following the application of UCLF chiropractic procedures?”

Methods

Criteria for Inclusion

This study was an outcome-based analysis that reviewed consecutive patient files over a 1-year period. In order to be selected the patient’s file must have met the following inclusion criteria:

1. A chief complaint of neck pain
2. Completed the Neck Disability Index (NDI) on the first visit

3. Re-evaluation date after approximately 2 weeks but not to exceed 30 days
4. Have a numeric pain rating score (NRS) on the same dates as the NDI
5. Have had detectable supine leg length alignment asymmetry
6. Radiographic findings indicative of upper cervical misalignment based on the Grostic model

Cases were excluded if there were confounding examination or history findings such as laminectomy at C2 or gross congenital or traumatic malformations in the upper cervical spine that would affect the measurement system.

Data for the first visit, pre- and post-adjustment atlas alignment radiographic measurements, baseline and 2-week NDI (100 point) and verbal NRS (11 point) were recorded. To determine the percent of change for atlas alignment, the net difference was divided by the baseline measurement with the quotient converted to a percentage. Data were tabulated and analyzed using Excel spreadsheets with the data analysis toolpack (Microsoft Corp, WA). Student t-tests, Mann-Whitney test and Chi-square test were used for statistical comparisons. Statistical tests were two-sided and P-values less than 0.05 were considered significant. The data were analyzed in their entirety and by groups comparing <30% vs. >30% post adjustment atlas laterality changes.

Criteria for Chiropractic Adjustment

Each patient completed an application for care, consultation, informed consent, privacy policy notification, examination, x-rays and spinal adjustment on the first visit. The consent form and privacy statement include the notification that patient data may be used for research purposes, but that in no case will it be possible to identify any patient associated with these data. The examination consisted of standard orthopedic, neurological, range of motion and chiropractic tests. The chiropractic examination involved palpation of the joints and muscles for resistance to joint motion, the level of tenderness, the presence of inflammation and postural analysis in the standing and supine positions.^{32,33}

Radiographic examination

Radiographic procedures were performed on the first visit if exam findings suggested the presence of red flags or

upper cervical chiropractic dysfunction. Each patient included in the study received a minimum of 5 x-rays: lateral cervical, vertex, 2 nasium cervical views (before and after the first chiropractic adjustment) and either an A-P cervical or an A-P open mouth view. The cervical x-rays were used for pathology and chiropractic radiographic analysis to provide specific adjustments based on the Orthospinology technique procedures and to determine upper cervical alignment change following the first adjustment. Radiation exposure was minimized through the use of high-speed films, rare earth screens, lead filters, and a lead apron. Lead filters for the nasium views reduced radiation to the eyes, skull, and brain by an average of 95.1% per nasium. The area from C1 to C3 was filtered achieving a 90.4% average reduction of radiation per nasium while an area from C4-T1 had no filtration.³⁴

Intervention

Chiropractic Adjustments

Chiropractic care was provided at each visit and included only upper cervical adjustments as dictated by the supine leg check for patients with neck pain. Supine leg length asymmetry and upper cervical adjustments were performed according to the Orthospinology procedure. Orthospinology is a technique system that is based on the research of John F. Grostic, D.C. It provides methods of determining a patient's eligibility, an x-ray analysis that quantifies relative upper cervical vertebral alignment and a formula that calculates a pathway for the adjustment. The adjustment force can be delivered by hand and hand-held or table mounted instruments. The system provides a protocol for post-adjustment physical re-evaluation and analysis of vertebral alignment measurement changes on the first visit. This allows the doctor to assess the results of the adjustment and modify future adjustments if necessary.³⁵

Though the current study looks only at atlas laterality, many other measurements are used to deliver the adjustment. Atlas and axis rotation relative to the skull, the atlas alignment relative to the axis (lower angle), the relationship of directions and magnitudes of the upper and lower angles as well as the architecture of the atlas and axis joint surfaces are just a few. For adjustment, patients were placed in a side-lying position with the head's mastoid resting on a solid mastoid support headpiece.

Upper cervical adjustments were delivered with a sole-noid-driven stylus, hand-held instrument (Laney instrument) with less than a 1/16" excursion. The thrusts were administered along a lateral to medial vector as determined by the Orthospinology procedure x-ray analysis. The thrusts were high-velocity in nature, with little depth and are estimated at 2 pounds-force plus the pre-load against the skin and 2–3 milliseconds in duration.³⁶ Audible sound from the joint was not observed on any patient.

Outcome Assessments

The Neck Disability Index (NDI) was used at the first visit and following approximately two weeks as the primary outcome measure and captures the patient's perceived disability that results from their neck pain (100-point scale). An 11-point verbal numeric pain rating scale (NRS) for pain was used on a visit-by-visit basis.

Data Collected

The following factors were recorded from each patient file.

- Baseline and 2-week NDI
- NRS on each visit
- First visit pre- and post-adjustment chiropractic radiographic analysis data
- Time between the onset of the current episode of symptoms and the initiation of care
- Days between Pre and Post NDI and NRS scores
- Patient's Age
- Patient's Gender
- Number of visits between baseline and post evaluations
- Number of positive supine leg checks which indicates the number of upper cervical adjustments given between the pre and post evaluations

The hypothesis is that a better outcome should occur when the first chiropractic atlas adjustment changes atlas laterality by more than 30% toward the orthogonal upper cervical alignment. C1 laterality is defined as the side of the acute angle and magnitude in degrees away from 90°, of the angle formed by the atlas plane line and the central skull line. The atlas plane line is constructed through points at the right and left intersections of the inferior posterior arch and the lateral masses of C1 on the nasium

view. The central skull line is determined from the nasium view by curve fitting (by template or computer) the first 1–1.5 inches of the right and left lateral aspect of the skull above the squamosal suture. Alignment reduction toward the orthogonal position is expressed as "percentage of correction." The percentage of correction is either 0 or a positive number for initial correction estimates; however, the means will be used for final comparisons. Essentially, these x-rays reduce a complex 3-dimensional structure into 2 dimensions and the analysis measures angular relationships between the 2 dimensional structures and does not purport to measure alignment in 3 dimensions.

Results

Sixty-six cases met the inclusion and exclusion criteria and were selected for the study. A total of 309 case files were reviewed with care beginning between August 1, 2004 and July 31, 2005. One hundred ninety-two had low back pain, 49 had some combination of neck pain, mid back pain, low back pain, extremity pain, headache, third-party contract exclusions or absent follow-up data. Two cases had significant structural abnormalities, one congenital and one surgical.

The data for 66 patients were tabulated and then divided into 2 groups, based on the percentage of atlas alignment change after the first chiropractic adjustment. Group 1 had <30% correction and Group 2 had >30% correction. The baselines of the variables and care delivery factors are summarized and show no differences between the groups (Table 1).

Data analysis revealed statistically significant and clinically meaningful improvements for both NDI and NRS. No serious adverse events occurred. The average baseline NDI with the standard deviation was 35.1 (SD 16.4) and post-care NDI was 14.3 (SD 9.9). This represents a 20.8-point improvement (59.2%), which is both statistically ($p < 0.01$) and clinically significant (>10 points). The average time between the first and second NDI was in 13.6 (SD 4.4) days with 5.7 (SD 1.4) office visits and 2.7 (SD 1.5) C1 adjustments. The average pre-adjustment NRS was 5.89 (SD 2.0) and the post-care NRS was 1.76 (SD 1.3), a 70.1% improvement ($p < 0.01$). The average percentage of correction for C1 laterality was 48%. The pre-C1 laterality average was 2.83° (SD 2.20) and the post laterality was 1.48° (SD 1.74) ($p < 0.01$) (Table 2). Cases

Table 1 The baselines of each group's variable characteristics are statistically no different

Variable	All Cases	<30% Atlas Alignment Change Group	>30% Atlas Alignment Change Group	p-value from paired t-test
n	66	13	53	
Age	48.3 ± 14.7	55.5 ± 18.4	46.5 ± 13.3	0.095*
Episode Onset <4 weeks (%)	56.1	46.2	58.5	0.422**
Neck Disability Index	35.1 ± 16.4	33.8 ± 15.0	35.4 ± 16.9	0.733
Verbal Numeric Pain Rating	5.89 ± 2.05	5.92 ± 2.6	5.89 ± 1.9	0.963
Days between outcome measurements	13.6 ± 4.4	13.7 ± 2.8	13.6 ± 4.7	0.916
Female (%)	72.7	69.2	73.6	0.770
<i>Care Delivery Factors</i>				
# Office Visits	5.7 ± 1.4	6.1 ± 1.3	5.7 ± 1.4	0.308
# Atlas Adjustments	2.7 ± 1.5	2.8 ± 1.3	2.7 ± 1.6	0.248
Atlas Laterality (Degrees)	2.83 ± 2.20	3.08 ± 2.21	2.76 ± 2.21	0.653

* Although the t-test demonstrated 0.122, the Mann-Whitney test (0.095) is more appropriate for age due to the distribution not being normal.

** Chi-square test.

Table 2 Pre- and Post-care NDI, verbal NRS and radiographic atlas alignment

Variable	Pre-care Mean (SD)	Post-care Mean (SD)	p-value from paired t-test
Neck Disability Index (100-point scale)	35.1 ± 16.4	14.3 ± 9.9	< 0.01
Verbal Numeric Pain Scale (11-point scale)	5.89 ± 2.05	1.76 ± 1.29	< 0.01
Atlas Laterality (Degrees)	2.83 ± 2.20	1.48 ± 1.74	< 0.01

with a chronic onset were very similar showing base-lines / 2-week follow-up NDI and NRS scores of 32.9 (SD 13.9) / 15.0 (SD 9.7) and 5.48 (SD 1.84) / 1.79 (SD 1.21) respectively. Also the days 13.8 (SD3.7) and the number of visits / adjustments 5.9 (SD 1.1) / 2.8 (SD 1.6) were comparable as well as the atlas alignment changes 2.66° (SD 1.90) / 1.48° (SD 1.62). All were statistically and clinically significant.

Subgroup analysis found 13 cases with <30% reduction of atlas laterality (Group 1) and 53 with >30% (Group 2). (Table 3) Group 2 had a statistically and clinically meaningful better outcome for NDI at 2 weeks, compared to Group 1 (Table 4). Both groups showed improvement in the 2-week verbal numeric pain rating score. Group 2 showed more improvement on the average than group 1 (net improvement 4.24/10 vs. 3.69/10 re-

Table 3 Distribution of atlas laterality corrections

% C1 Correction	Case Frequency	Category %
0	4	6.06%
1 to 30	9	13.64%
31 to 60	21	31.82%
61 to 90	12	18.18%
>90	20	30.30%

spectively), but the difference was not statistically or clinically significant.

Discussion

The data in this study indicate that a clinically and statistically significant improvement in valid outcome measures for neck pain and disability occurred following approximately 2 weeks, 6 visits and 3 UCLF adjustments based on the Grostic model. Furthermore, a superior outcome for disability may be linked to a threshold of improved upper cervical alignment. Of the 2 outcome measures, NDI was seen to improve more when the 1st adjustment produced more reduction of atlas laterality. The extent of atlas laterality change did not affect the outcome assessed by NRS for pain; however, in that both groups of patients had the same clinically meaningful improvement in NRS.

These results are interesting when contrasted with other reports in the literature that used similar outcome measurements in patients with neck pain of various onsets treated with a variety of chiropractic procedures reporting similar follow-up periods.³⁷⁻⁴² Although varying patient populations and study designs make a direct comparison for effectiveness impossible, it stimulates questions that could be further investigated using well designed prospective studies. Table 5 lists the results of the current study and articles found in the literature. Studies reported using

the 100-point NDI scale are converted to the 50-point NDI scale for consistency (Table 5).

Three prominent differences between some of the above studies and the current study are the number of adjustments, the length of time between outcome measures and the percentage of patients that achieved a “normal” NDI score. The current study used approximately the same number of adjustments as the reported number of visits (4th visit) in Rubinstein, et al., however, the current study demonstrates a clinically significant change for NDI (>5/50 or 10/100) and NRS (>2 points). Also the current study shows 34.8% of cases achieved a normal NDI (<5 or <10 for the 50 or 100 point scale, respectively) from a baseline of 3%, a 31.4% net gain (Table 6). Rubenstein demonstrates 19% at the 4th visit from a baseline of 7.4%, a net gain of 11.6%.³⁷ Differing patient populations could explain this variance therefore a direct comparison for efficacy is not possible. The present study’s design reports fewer adjustments and a shorter follow-up period than McMorland,³⁹ Giles,^{40,41} Wood, Colloca and Mathews⁴² with similar or better-improved outcome levels. The current study’s data indicate the average patient had almost 6 office visits over a period of two weeks followed by re-evaluation. Using functional leg length asymmetry as a guide for when a patient required an atlas adjustment reduced the average number of adjustments to just below 3, yet clinical outcomes are parallel to other reports in the literature. Even though the patient was examined, it was determined that they did not need an adjustment on each visit. Typically, without using the supine leg check, a patient would receive an adjustment on each visit. These data show that the number of adjustments (dosage) was reduced by 52.6% relative to the number of visits (Figure 1).

Reducing dosage and utilizing UCLF procedures may be significant when determining risk to the patient for two reasons. First, the adjusting procedure itself may entail less risk. There is no rotation of the patient’s head and

Table 4 Comparison of NDI and NRS net differences between <30% vs. >30% Atlas laterality correction groups

Outcomes	<30% C1 Correction Group			>30% C1 Correction Group			D	Sig.
	Baseline	2 Week	Δ	Baseline	2 Week	Δ		
NDI	33.8	21.1	-12.7	35.4	12.7	-22.8	10.1	0.010
NRS	5.92	2.23	-3.69	5.89	1.64	-4.25	0.56	0.241

Table 5 Summary of the current study and some of the articles in the literature that use NDI to report the progress of patients following various techniques of chiropractic care reporting similar time periods. For consistency, the data is converted to the 50-point scale if it were originally reported using the 100-point scale by dividing by 2

Study	Baseline NDI	2-Week NDI	4-Week NDI	Net Change	Net Change %	Number of manipulation / adjustments
Current Study (N = 66)	17.5 (Converted to 50 point)	7.2 (Converted to 50 point)		-10.3 (Converted to 50 point)	59%	2.7 Range (1 to 7)
Rubinstein et al. ³⁷ (N = 529)	12.0 (50 point)	8.0 (50 point)		-4.0 (50 point)	33%	3 to 9 @ 4 th visit 8 days-6 weeks
Hurwitz ³⁸ (N = 336)	13.2 (50 point)	9.7 (50 point)		-3.5 (50 point)	27%	No Data
McMorland and Suter ³⁹ (Neck Pain Only Group) (N = 43)	18.5 (50 point)		9.0 (50 point)	-9.5 (50 point)	51%	12 tx over 4 weeks
Giles and Muller ⁴⁰ Manipulation Group (N = 23)	16.0 (Converted to 50 point)		11.0 (Converted to 50 point)	-5 (Converted to 50 point)	31%	6 tx over 3-4 weeks
Giles and Muller ⁴¹ Manipulation Group (N = 18)	13 (Converted to 50 point)		8.5 @ 9 weeks (Converted to 50 point)	-4.5 (Converted to 50 point)	38%	2 tx per week up to 9 weeks (18)
Wood et al. ⁴² Activator Group (N = 15)	15.9 (Converted to 50 point)		6.8 (Converted to 50 point)	-9.1 (Converted to 50 point)	57%	8
Wood et al. ⁴² Manual Thrust Group (N = 15)	13.4 (Converted to 50 point)		5.5 (Converted to 50 point)	-7.9 (Converted to 50 point)	59%	8

very limited lateral flexion. The adjustment is delivered with the patient's neck in a nearly neutral posture in the side lying position. The joints are not taken to tension prior to the thrust; the thrust is of lower magnitude and does not produce cavitation of the joints. Hence, the light-force technique might avoid the perceived or theorized mechanism of "vertebral artery dissections due to intimal tearing as a result of over-stretching the artery during rotational manipulation."^{43,44} Second, assuming any risk for stroke is similar per adjustment technique, simply reduc-

ing the dosage (number of adjustments) should also reduce the risk of stroke proportionately if there is a causal relationship. Little research is available in the published literature at this time for any side effects from UCLF techniques or similar procedures. The authors of 2 randomized controlled studies using upper cervical adjustments comparable to the procedure in the current study report no adverse effects.^{45,46}

The results of the current study are very similar to the findings of Grostic and DeBoer⁴⁷ concerning the magni-

Table 6 The current study's NDI histogram tables (100 point scale)

Baseline NDI	Frequency	Category %
None (0–8)	2	3.0
Mild (9–28)	26	39.4
Moderate (29–48)	26	39.4
Severe (>50)	12	18.2
2-Weeks NDI	Frequency	Category %
None (0–8)	23	34.8
Mild (9–28)	38	57.6
Moderate (29–48)	5	7.6
Severe (>50)	0	0.0

tude in degrees of pre- and post-adjustment alignment average values (2.63/1.43 vs. 2.83/1.48) and the average percentage (47 vs. 48%) of atlas laterality correction. They also resemble some of the results found by Eriksen, in that a larger improvement in upper cervical alignment demon-

strated a statistically better outcome, although Eriksen used a more stringent 50% x-ray correction to define his patient groups.⁴⁸ He demonstrated a 40.5% average correction of all measured alignment components. Eriksen also found that patients with higher percent corrections on the first visit had a decreased need for follow-up visits. The current study only had 2 weeks of data so it would be difficult to make any conclusions about the need for follow-up care. The current study improves on Eriksen's by using the patient-centered outcomes (NRS and NDI) as measures of clinical improvement. These findings support the validity of Grostic's alignment model and the goal of reducing atlas laterality toward the orthogonal configuration.

What is the risk from the required radiographic procedures? The ERR for thyroid cancer is calculated using the current study's average age at exposure of 48.3 with a range of 24 to 72 years, the attained age of 72 and the formula developed from Preston et al.²⁷ The ERR is 0.0006 with a range of 0.0014 to 0.0002. Combining the ERR with the background risk of 1 equals 1.0006 with a range of 1.0014 to 1.0002. Using the lifetime background risk of developing thyroid cancer in the U.S. at 0.79%²⁶ mul-

Figure 1A Shows the frequency distribution (dosage) of adjustments required while using the upper cervical alignment model and the supine leg check. (N = 66)

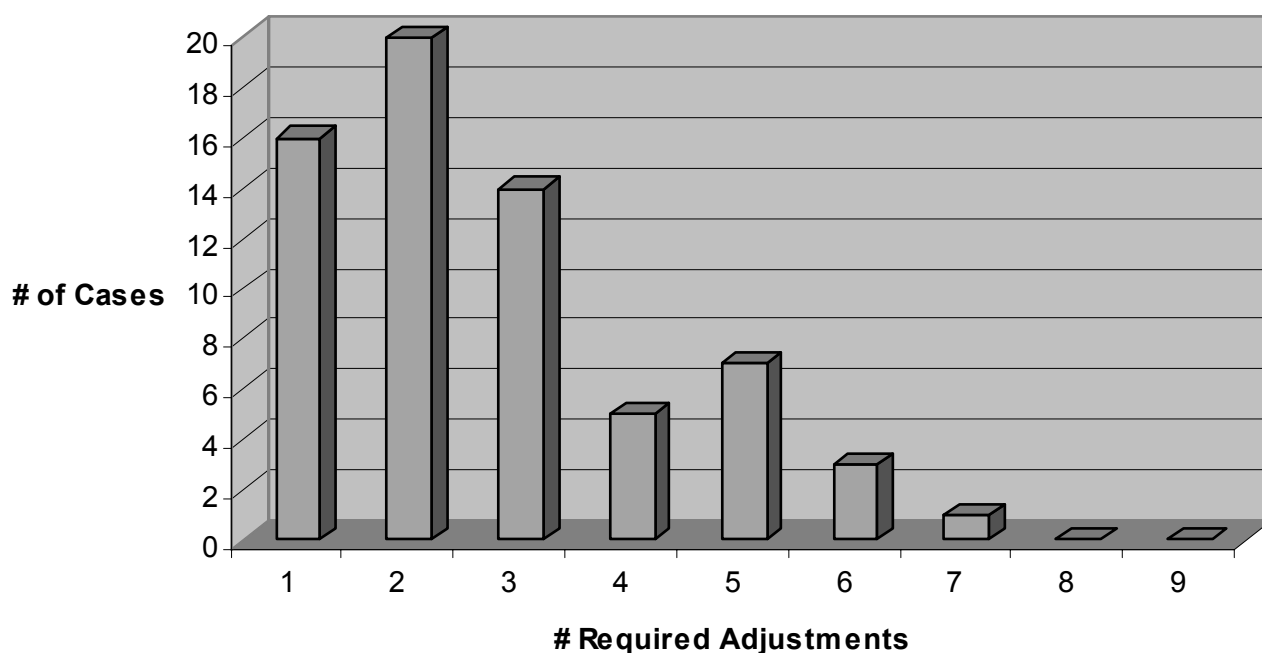
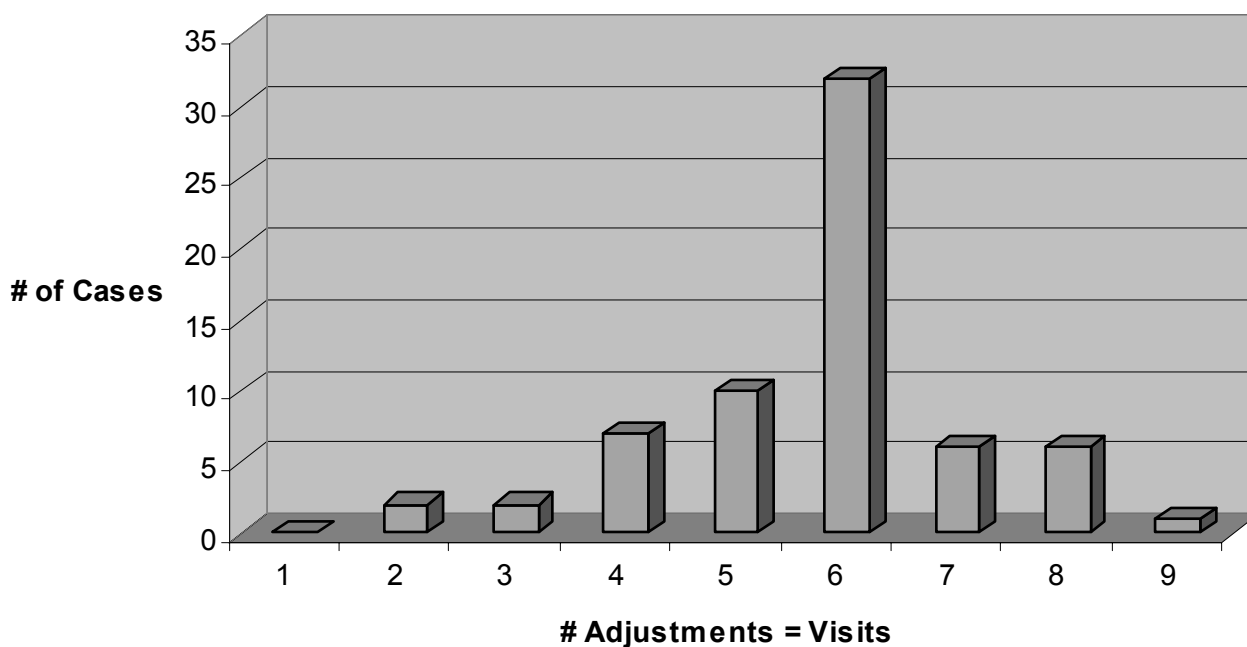


Figure 1B Demonstrates the frequency of the current study's visits and would equal the number of adjustments without using the upper cervical alignment model and the supine leg check. The premise of using the supine leg check is to eliminate unnecessary upper cervical adjustments. It follows that a patient may not receive an adjustment on each visit but will be examined to see if an adjustment is needed. The clinical utility of the supine leg check might be demonstrated by comparing the modes of each graph. The most frequent combination was 6 office visits but only 2 upper cervical adjustments indicating the supine leg check was negative or balanced on 4 visits. (N = 66)



multiplied by 1.0006 (1.0014 to 1.0002) we find a total risk after UCLF X-rays is 0.7905% with a range of 0.7911% to 0.7902%. Based on the findings of Ron, et al.²⁸ there is no significantly elevated excess relative risk from thyroid cancer for those exposed after age 15 to a 211 mR dose of radiation. The thyroid cancer mortality risk estimate using the U.S. Environmental Protection Agency (EPA) formula²⁹ for a 211 mR dose is 0.68 per one million person years. Using linear interpolation of the BEIR VII Phase II³⁰ data and the average age for the current study ($48.3 \pm SD14.7$), an exposure of 211 mR results in an LAR for thyroid cancer incidence of 0.0283 per an exposed population of 100,000 for a male (0 to 0.443, 95% CI) and 0.120 for a female (0 to 2.384, 95% CI). According to the above studies the elevated risk from thyroid cancer is either zero or very small due to radiation exposure to the patient from UCLF X-rays.

The data from the current study indicate patients with neck pain experience improvement following UCLF procedures. Analysis of the data stimulates additional research questions. Should upper cervical alignment be considered when delivering a cervical adjustment? Does using the upper cervical alignment model and the supine leg check eliminate unnecessary adjustments and as a result, reduce the dosage? Will using UCLF decrease risk or side effects and improve patient satisfaction? Can implementation of UCLF procedures reduce health care costs for those suffering from neck pain and disability? Additional research is necessary to investigate these questions.

Study Limitations

The results of this study should be read with some caution. A definitive determination of cause and effect cannot be accomplished using this type of study. Weak-

nesses include having no control group and being retrospective. A prospective study would be stronger. There were no follow-up data for longer than 2 weeks largely because the majority of patients were released from active care before 4 weeks. The doctor was not blinded during the application of the mediating variables, so unintentional bias cannot be eliminated. A blinded X-ray analysis would improve the design for future studies. The small sample size increases the likelihood of sampling error. Unknown confounding variables might explain the observations in this study. The majority of the patients in the current study had histories of chronic neck pain with acute, sub-acute and chronic onsets of episodes. Differences in age and onset are complicating co-variables, making it impossible to compare effectiveness to results reported in other studies. Although the ages for our comparison groups were not statistically different at baseline, lower ages did show a weak trend for larger improved NDI scores. A prospective RCT could minimize confounding variables and should use experienced upper cervical technique practitioners.

Conclusion

The data supports the alignment model's predictive validity by suggesting that a threshold of altered atlas alignment toward the orthogonal configuration following the first adjustment was associated with a better outcome in 2-weeks for disability from neck pain. The risk associated with UCLF X-rays is minimal for the current studies demographics. UCLF chiropractic instrument adjustments utilizing a vertebral alignment model are promising for the management of patients with neck pain based on assessments using valid outcome measures.

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Nutrition and muscle protein synthesis: a descriptive review

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Background: *Doctors of Chiropractic frequently give therapeutic exercise and nutritional advice to patients. Skeletal muscle's role in health and disease is underappreciated. Creating synergy between protein consumption and exercise promotes protein synthesis and may impact patient outcomes.*

Objective: *To review the literature describing protein metabolism and exercise as it relates to the practice of chiropractic health care.*

Method: *The PubMed and Web of Science databases were searched using the key terms protein metabolism, protein synthesis, exercise, whey, soy, and resistance training in various combinations. Limits excluded the use of papers that were not based on human subjects, included infants or disease, or were published before 1988. Thirty papers were ultimately included for analysis.*

Discussion: *The amount, type and timing of protein consumption all play critical roles in promoting protein synthesis. The intracellular mechanism behind protein synthesis has many interrelated, interesting components.*

Conclusion: *An adaptation to exercise (protein synthesis) can be enhanced by controlling the type of protein, the amount of protein consumed and the timing of protein consumption. Doctors of Chiropractic may impact patient outcomes by using empirical evidence about protein consumption and exercise to maximize protein synthesis.*

(JCCA 2009; 53(3):186-194)

Données fondamentales : *Les praticiens en chiropratique recommandent souvent à leurs patients des exercices thérapeutiques et des conseils sur la nutrition. On sous-estime le rôle que jouent les muscles squelettiques dans la santé comme dans les maladies. Créer une synergie entre la consommation de protéines et l'exercice favorise la synthèse des protéines et peut avoir des répercussions chez le patient.*

Objectif : *Passer en revue la documentation décrivant le métabolisme de la protéine et l'exercice et la façon dont le tout est relié à la pratique des soins de santé en chiropratique.*

Méthode : *On a effectué une recherche des bases de données du PubMed et du Web of Science en utilisant les mots clés « métabolismes de la protéine », « synthèse de la protéine », « exercice », « lactosérum », « soja » et « entraînement contre résistance » ainsi que des variantes de ces derniers. On a exclu les documents ne s'appliquant pas aux êtres humains, ceux portant sur des enfants ou des personnes malades, ou qui avaient été publiés avant 1988. Trente documents ont été finalement inclus dans l'analyse.*

Discussion : *Le volume, le type et le moment de la consommation de protéines jouent tous des rôles essentiels dans la promotion de la synthèse de la protéine. Le mécanisme intracellulaire à l'origine de la synthèse de la protéine a plusieurs composantes intéressantes, qui sont interreliées.*

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KEY WORDS: protein, synthesis, metabolism, exercise, chiropractic

Introduction

Doctors of Chiropractic commonly prescribe exercise and provide nutritional advice to patients. The National Board of Chiropractic Examiner's 2005 Job Analysis of Chiropractic Report found that 89% of chiropractors surveyed used nutritional counseling, therapy, or supplementation.¹ In addition, over 98% used corrective or therapeutic exercise within their practice of chiropractic. With regard to "Health Promotion and Wellness Care Procedures," 98.3% of chiropractors instructed patients about physical fitness/exercise promotion and 97.7% provided instruction about nutritional/dietary recommendations. Exercise prescription and/or nutritional advice, whether possessing therapeutic or wellness intent, is given with the expectation of change. Doctors and patients expect exercise to result in a positive adaptation. The desired change is fundamentally an anabolic response to synthesize protein while minimizing protein catabolism. Overtly, clinicians assess changes in strength, endurance, and/or function. The overt clinical changes are due, at least in part, to cellular changes. Whether or not the desired change occurs depends greatly on a synergistic relationship between diet and exercise. This review focuses on nutritional interventions that optimize adaptation through protein synthesis.

Method

The literature search included the use of the Web of Science and PubMed databases. Multiple combinations of the following key words were used in the search: *protein metabolism, protein synthesis, exercise, whey, soy, and re-*

Conclusion : Une adaptation à l'exercice (synthèse de la protéine) peut être améliorée en limitant le type de protéines, le volume des protéines consommées et le moment de la consommation des protéines. Les chiropraticiens peuvent avoir une incidence sur les résultats pour le patient en utilisant une preuve empirique sur la consommation des protéines et l'exercice pour maximiser la synthèse des protéines. (JACC 2009; 53(3):186–194)

MOTS CLÉS : protéine, synthèse, métabolisme, exercice, chiropratique

sistance training. This led to an initial yield of several hundred papers. When the search was limited to studies with human subjects, excluding those dealing with infants or disease (e.g. HIV) and those articles published prior to 1998 (unless their content was highly significant and seminal in establishing a line of evidence), the final yield was thirty articles on this topic.

Discussion

The primary objective of this review is to describe protein metabolism and exercise as it relates to the practice of chiropractic health care. The spine does not consist solely of bone. Skeletal muscle plays a pivotal role in providing the spine with support, movement, proprioception and endurance. When patients engage in exercise, whether it is aerobic or resistance, muscle breaks down and rebuilds protein in response to the stimulus. New empirical evidence exists that can optimize the relationship between stimulus and response. As stated previously, most Doctors of Chiropractic incorporate exercise and nutrition in practice. Recognizing and applying empirical evidence on how the type, timing and amount of protein intake influences adaptation can help doctors and patients achieve optimal results.

Importance of Skeletal Muscle

The function of skeletal muscle can be underestimated by assigning it the mere role of "moving the body." Skeletal muscle is the primary reservoir of amino acids for other tissues. In fact, skeletal muscle amino acid reserves are the only storage depot capable of large losses without

compromising the ability to sustain life.² When blood glucose falls, amino acids are the liver's primary gluconeogenic substrate. The digestive tract's rapid turnover of cells requires a continual supply of amino acids. Nitrogen contained within amino acids is a vital component of DNA and other molecules necessary for cell maintenance and replication. Tissue demands for amino acids become critical in times of stress, such as sepsis, cancer, or traumatic injury. Muscle export of amino acids can result in large protein losses or sarcopenia. Recovery from future disease or trauma may be greatly hindered by sarcopenia.³ This is of special concern for geriatric individuals that may fail to recover from disease largely as a result of sarcopenia. They become too frail and cease to thrive. Elderly individuals have a much more difficult time adding muscle;⁴ therefore, caution should be taken to preserve lean mass throughout life. Arts found the biceps brachii and quadriceps femoris muscles' mean thickness of healthy 90-year-old men to be similar to that of 5-year-old children.⁵ This is of concern when one considers the added weight an adult must carry during activities of daily living. Wolf's review³ has a more complete discussion of skeletal muscle's underappreciated role in health and disease. Doctors of Chiropractic should appreciate the value maintaining lean mass throughout life and understand the role of exercise and nutrition in protein synthesis.

This paper describes the impact of nutrition and exercise on protein synthesis. Resistance exercise is a powerful signal that can be augmented by the amount, timing and type of protein consumed. The mechanism behind protein synthesis is complex and fascinating. A more complete understanding of this topic may allow the chiropractic physician to develop more effective strategies for increasing or preserving skeletal muscle throughout life.

Resistance Exercise, Nutrition and Protein Synthesis

Skeletal muscle is continually breaking down and synthesizing protein. If muscle is going to maintain its mass, the net level of protein balance must equal zero. If muscle is going to gain mass, protein synthesis must exceed protein breakdown. While it may be common to view resistance training as a powerful stimulus for protein synthesis, it is also important to recognize that it is a signal for protein

breakdown. Phillips et al.⁶ has shown that resistance exercise results in increased muscle net protein balance for 24–48 hours. Both protein anabolism and catabolism increase after exercise, but the increase in anabolism is relatively larger, causing the net muscle protein balance to be positive. In his experiment, Phillips et al.⁶ used 8 sets of 8 concentric and eccentric muscle actions at 80% of each subject's single repetition maximum effort. The participants in the study were allowed to consume meals prior to and after the exercise. This is important, as later research showed a lack of protein synthesis after exercise when nutrition was absent.⁷ Esmarck et al.⁸ resistance trained 2 groups for 12 weeks and showed that a control group receiving no nutrition for 2 hours post-exercise decreased lean body mass while those consuming 10gm of protein immediately after exercise increased lean mass.

Both protein anabolism and catabolism are evident after resistance training. Yet, if nutrition is absent after exercise, protein synthesis can be reduced or absent. The amount of protein consumption is an important consideration for maximizing the rate and duration of protein synthesis. Borsheim et al.⁹ showed that 6 gm of mixed amino acids elevated protein synthesis after exercise. In the same experiment, 6gm of essential amino acids doubled protein synthesis, leading the researchers to conclude that non-essential amino acids were not required to promote protein synthesis. The role of non-essential amino acids in protein synthesis remains controversial. Cuthbertson et al.¹⁰ showed an oral dose of 10 gm of essential amino acids maximally stimulated protein synthesis and hypothesized that this would occur by eating the equivalent of 6 oz of meat, fish, eggs or milk in a single meal. Phillips et al.¹¹ stated that 25 gm of a quality source of protein (milk products, meat and eggs) contain approximately 10 gm of essential amino acids and should maximally stimulate protein synthesis after exercise.

Timing of Protein Consumption

The timing of protein consumption is critical for increasing protein synthesis. Immediate post-exercise consumption of protein stimulates protein synthesis while waiting as little as 2 hours after the exercise blunts the response.⁸ Rasmussen et al.⁷ found elevated protein synthesis in those consuming 6 gm of essential amino acids post-exercise in comparison to a control group. Protein was consumed either 1 or 3 hours after the exercise. In contrast

to Esmark et al.,⁸ there was no difference in protein synthesis rates in the 1- or 3-hour post-exercise groups. Tipton et al.¹² found a larger anabolic response when a carbohydrate and protein drink was consumed prior to exercise than if it were consumed immediately after exercise. In this experiment, 6gm of essential amino acids were consumed by both groups either before or after resistance training. They theorized that larger blood flow and amino acid delivery to the muscle during exercise was the reason for the observed increased protein synthesis.

Type of Protein

The type of protein consumed may also be an important factor in stimulating protein synthesis. Both soy and whey protein supplementation have been shown to increase lean mass and strength in comparison to a placebo.¹³ Candow et al.¹³ showed this with 6 weeks of resistance training in young adult humans. Anthony et al.¹⁴ found both whey and soy protein supplements promoted skeletal muscle protein synthesis more than a carbohydrate-only supplement. They noted greater intracellular signaling (phosphorylation of S6K1 and mTOR) in the group receiving whey protein compared to the soy group. Intracellular signaling will be discussed in more detail below. Anthony et al.¹⁴ used aerobic conditioning and rats in their experiment; however, this may not parallel resistance training in a human population. Wilkinson et al.¹⁵ also demonstrated both soy and milk protein's ability to increase net protein balance in humans after resistance training. They found greater fractional synthesis rate of protein and greater net muscle protein balance after milk ingestion in comparison to soy. The subjects in their experiment consumed 18.2 grams of protein shortly after exercise. Morifuji et al.¹⁶ showed whey protein supplementation in comparison to casein caused a decrease in the activity of hepatic lipogenic enzymes and increased lipogenic enzyme activity in muscle. Whey protein may give skeletal muscle an advantage in allowing it to store more energy (fat) needed for protein synthesis. It may also decrease hepatic production of fat and be helpful in combating obesity.

Tipton et al.¹⁷ published a thought-provoking study comparing the ability of casein and whey protein to stimulate skeletal muscle anabolism in response to resistance exercise. Both casein and whey are milk proteins, but whey remains soluble in the stomach and is more rapidly emptied into the small intestine. Casein exits the stomach

more slowly. They found whey protein elevated plasma and intracellular leucine levels greater than casein or the control group. Whey protein increased intracellular leucine concentration by 110% 1 hour after consumption. The whey group also had higher serum insulin concentrations after consumption. The casein group had 35% greater phenylalanine uptake in comparison to the whey group. Phenylalanine uptake positively correlates to protein synthesis. This was not a long-term study that looked at muscle accretion. The authors concluded that both casein and whey stimulate an anabolic response in muscle after exercise, but it is equivocal whether one offers an advantage over the other.

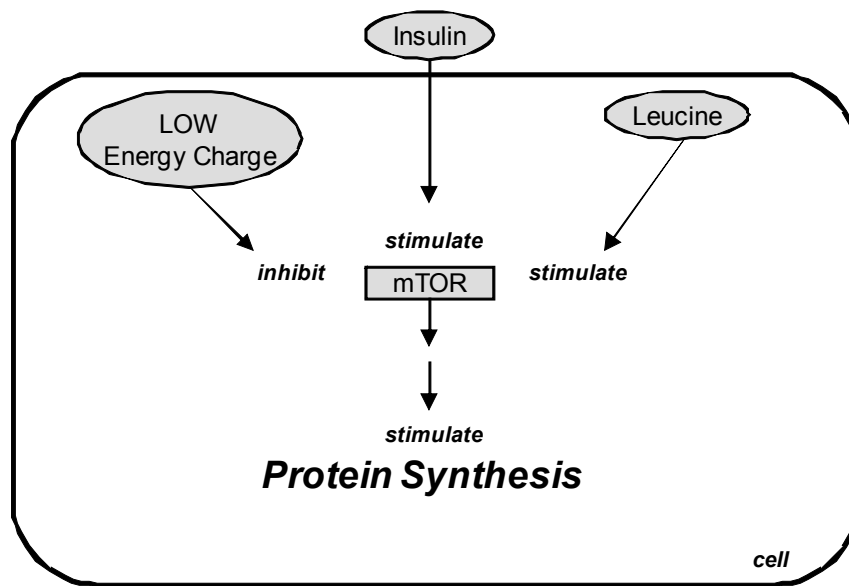
Typical measurement of protein synthesis usually involves skeletal muscle's import and export of the amino acid, phenylalanine.¹⁸ Skeletal muscle has the ability to oxidize six amino acids (leucine, isoleucine, valine, aspartate, asparagine, and glutamate). Import of these amino acids does not directly correlate to their addition in protein structure. Phenylalanine is an essential amino acid that muscle cannot oxidize. Its uptake and incorporation into muscle is assumed to be an accurate indicator of muscle protein synthesis.¹⁸

Intracellular Signaling

The results from Tipton et al.¹⁷ open a complex discussion regarding intracellular signaling and protein synthesis. Leucine, found in higher amounts in whey protein, is not just a building block in protein synthesis, but an important intracellular signal directing skeletal muscle to translate protein. A complete review of intracellular signaling is beyond the scope of this review; however, Proud¹⁹ provides a more in-depth review of the mechanisms involved in cellular protein synthesis. The following is a brief look at potential signals for increasing protein synthesis in skeletal muscle. Three key components of signaling include: the energy status of the muscle cell, insulin, and the amino acid leucine (figure 1).

Changes in the rate of protein synthesis begin prior to changes in mRNA content.²⁰ This implies a posttranscriptional mechanism plays a predominant role in activating protein synthesis. The variables affecting transcription are many, but the cell's energy charge, insulin, and leucine seem to be very important. During exercise, the cell's energy charge or abundance of ATP (adenosine triphosphate) is reduced. The mammalian target of rapamycin (mTOR)

Figure 1 Key Components of Intracellular Signaling



is seen as a “master regulator” of translation within the cell.¹⁹ There are 2 types of mTOR subunits: mTORC1 and mTORC2. When ATP levels are depressed, AMP activated protein kinase (AMPK) is activated. AMPK phosphorylates an intermediary molecule (TSC2) which turns off mTORC1 signaling. Bolster et al.²¹ have shown a negative correlation between AMPK activation and phosphorylation of mTOR and other key signaling molecules (S6K1, and 4E-BP1).

Lowering cellular ATP levels reduces protein synthesis within the cell. This seems to make sense as protein synthesis demands a great deal of energy. Adding 1 amino acid during the translation process requires the breakdown of 4 ATP molecules.¹⁹ Protein synthesis may require approximately 485 kilocalories per day in a muscular, young male and approximately 120 kilocalories per day in an active, elderly woman.³ After a good night’s sleep without consuming food, protein synthesis is decreased by 15–30 percent.²² Feeding cells after exercise allows them to maintain a high energy charge and promote ongoing protein synthesis.

Resistance exercise changes the energy status of skeletal muscle. Koopman et al.²³ documented changes in muscle glycogen and lipid levels after resistance training.

A single bout of resistance exercise reduces muscle glycogen levels in both type I and II fibers. In the experiment, 8 sets of 10 repetitions of leg presses followed by 8 sets of 10 repetitions of leg extensions lowered glycogen content by 23, 40, and 44% in type I, IIa and IIx fibers respectively. Intramuscular triglyceride (IMTG) levels were reduced by 27% in type I fibers, but remained constant in type IIa and IIx fibers. Type I fibers’ IMTG levels returned to baseline after 2 hours of post-exercise rest. Type II fibers are responsible for most of the hypertrophy seen after resistance training.^{24,25} They also suffer a greater energy drain during resistance exercise. Nutrition and intracellular energy availability substantially impact muscle protein metabolism.

Carbohydrate consumption and insulin secretion play an indirect role in skeletal muscle protein synthesis. Insulin activates the phosphoinositol-3-kinase (PI3K) pathway that causes skeletal muscle’s glucose transport protein (GLUT4) to translocate to the sarcolemma and, therefore, permits glucose to enter the cell.²⁶ In short, insulin replenishes glucose for the cell. Within the PI3K pathway, a protein (Akt) is activated that stimulates mTOR. Akt also phosphorylates and inactivates glycogen synthase kinase (GSK-3) which allows the activation of

eukaryotic initiation factor 2B (eIF2B). Both mTOR and eIF2B stimulate protein synthesis. Yet, elevated insulin levels do not increase protein synthesis in the absence of high amino acid concentrations.²⁷ Biolo et al.²⁷ hypothesized that prior experiments failed to show elevated protein synthesis in response to insulin because insulin cleared blood amino acids into other cell types creating hypoaminoacidemia during the trials. In the presence of hyperaminoacidemia, insulin appears to promote protein synthesis by aiding the amino acids' entry into cells and through tangential signaling resulting from the PI3K pathway.

Leucine is likely the most influential amino acid concerning skeletal muscle protein synthesis. Amino acids, especially leucine, stimulate the secretion of insulin from the pancreatic β cells.²⁸ The liver lacks branched-chain-aminotransferases and therefore lacks the ability to significantly oxidize branched-chain amino acids, including leucine. Consumption of branched-chain amino acids leads to elevated blood leucine levels reaching peripheral tissues, including skeletal muscle. Leucine directly stimulates mTOR as well as indirectly stimulating mTOR through its promotion of the insulin cascade.²² The Tipton et al.¹⁷ finding that whey protein greatly increases plasma and intramuscular leucine may explain the potential anabolic effect of whey consumption. Whey protein consumption elevates leucine; leucine directly and indirectly stimulates protein synthesis through mTOR.

To achieve the best response to exercise, Doctors of Chiropractic should recognize the timing of protein consumption, the type of protein consumed and the amount of protein consumed all play a significant role in promoting adaptation through protein synthesis.

Excessive Protein Consumption

Concerns of excessive protein consumption are valid. Deamination of amino acids results in the production of ammonia. Ammonia is toxic, particularly to the central nervous system. The major route for the excretion of ammonia is the creation and excretion of urea. It is possible to consume protein in excess of the body's ability to deal with it. Rudman et al.²⁹ found the maximal rate of urea excretion to be $55 \text{ mg urea N} \cdot \text{h}^{-1} \cdot \text{kg}^{-0.75}$. In their review of dietary protein intake in humans, Bilsborough and Mann³⁰ state that an 80kg individual could deaminate up to 301 grams of protein per day. At the levels previ-

ously cited^{7,9,11} as eliciting maximal rates of protein synthesis, amounts greater than 300gm per day would be absolutely unnecessary. Yet, Phillips¹¹ et al. review of excess protein consumption does not find damning outcomes for consumption of up to 3 gm of protein per kilogram of body mass. More dietary protein has been related to increased peak bone mass, but has not been related to progressive decline in kidney function. Continued research concerning excess protein consumption is warranted, but only flawed reasoning would conclude a need of over 300 gm of daily protein.

Conclusion

Empirical evidence is highlighting the important role protein consumption plays in stimulating protein synthesis after resistance exercise. Multiple sources of protein promote protein synthesis after exercise, but only those with essential amino acids elevate synthesis. Milk proteins are apparently more effective than soy proteins.¹⁵ Whey protein may promote important cellular signaling changes through its ability to elevate plasma and intracellular leucine.¹⁷ Whey protein also promotes intramuscular accumulation of triglycerides while inhibiting hepatic accumulation of fat.¹⁶ Carbohydrate consumption may be important in facilitating intracellular signaling through insulin and by elevating and maintaining the cell's energy status. Yet, it is important to recognize that significant protein synthesis is unlikely with a carbohydrate-only supplement. Consuming protein prior to and after the exercise seems to be warranted.¹⁸ Ten grams of essential amino acids or twenty-five grams of a complete protein are sufficient to maximally stimulate protein synthesis.¹¹ Type, timing and amount of protein are all factors in maximizing muscle mass.

There is still much to discover that will help in promoting health and wellness. We are beginning to develop a greater appreciation for skeletal muscle's role in health-care. Recognition of the need to create synergy between the exercise and diet is critical. Many chiropractic physicians give nutritional advice and exercise to patients. Recognizing and applying the synergistic relationship between exercise and diet may help achieve better adaptations to exercise. For Doctors of Chiropractic, the adaptation may be seen in objective measures of patient strength, endurance, or functional ability.

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Chiropractic practice in military and veterans health care: The state of the literature

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Objective: *To summarize scholarly literature that describes practice, utilization, and/or policy of chiropractic services within international active duty and/or veteran health care environments.*

Data Sources: *PubMed, the Cumulative Index to Nursing and Allied Health Literature, and the Index to Chiropractic Literature were searched from their starting dates through June 2009.*

Review Methods: *All authors independently reviewed each of the articles to verify that each met the inclusion criteria. Citations of included papers and other pertinent findings were logged in a summary table.*

Results: *Thirteen articles were included in this study. Integration of chiropractic care into military or veteran health care systems has been described in 3 systems: the United States Department of Defense, the United States Department of Veterans Affairs, and the Canadian Forces.*

Conclusion: *Chiropractic services seem to be included successfully within military and veteran health care facilities. However, there is a great need for additional written evaluation of the processes, policies, practices, and effectiveness of chiropractic services in these environments.*

(JCCA 2009; 53(3):194-204)

Objectifs : *Résumer la littérature scientifique décrivant la pratique, l'utilisation, et/ou les politiques des services chiropratiques, en pratique active et/ou dans l'environnement des soins de santé des vétérans à l'échelle internationale.*

Sources de données : *Les outils de recherche suivants ont été recherchés depuis leur création jusqu'au mois de juin 2009 : PubMed, 'Cumulative Index to Nursing and Allied Health Literature' (CINAHL), et 'Index to Chiropractic Literature'*

Méthodologie : *Chaque auteur a révisé chacun des articles afin de déterminer ceux qui rencontraient les critères d'inclusion. Les citations et autres résultats pertinents sont résumés dans un tableau.*

Résultats : *Treize articles ont été retenus. Trois systèmes décrivent l'intégration des services chiropratiques dans le système de santé des militaires ou des vétérans : le Département de la Défense des États-Unis, le Département des Affaires des Vétérans des États-Unis et les Forces Armées Canadiennes.*

Conclusion : *Les soins chiropratiques semblent être bien intégrés au sein du corps militaire ainsi que celui des vétérans. Cependant, l'évaluation du processus, des politiques, de la pratique et de l'efficacité des services chiropratiques dans ces environnements demeure nécessaire.*

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KEY WORDS: Chiropractic; Military Medicine; Hospitals, Veterans; Military Personnel

MOTS CLÉS : Chiropratique, Médecine Militaire, Hôpitaux, Personnel Militaire

Introduction

The use of various forms of complementary and alternative medicine (CAM) continues to grow internationally.¹ Eisenberg and colleagues² defined CAM as: “Interventions not taught widely at US medical schools or generally available at US hospitals.” Popular CAM practices include: herbal remedies, yoga, acupuncture, and chiropractic.¹ Chiropractic care has been used reportedly by 7.4%¹ to 11%³ of the general American adult population, representing approximately 190 million office visits per year and about 30% of all CAM practitioner visits.⁴ Smith and colleagues recently reported that as much as one third of United States (US) Navy and Marine Corps personnel utilize some form of CAM.⁵

Recently, there has been increased interest in how doctors of chiropractic may be integrated within military and veteran healthcare facilities.⁶ More than a decade has passed since Lott’s⁷ postulation in the journal *Military Medicine* regarding how, or if, chiropractic services would be integrated into the military health care system. Starting in 1995, a 3-year demonstration program showed successful inclusion of the service in 10 different US Department of Defense (DoD) sites.⁸ The service is currently available at 49 military treatment facilities across the United States,⁹ and continues to expand.¹⁰ More recently, in 2004, chiropractic care was introduced into the US Department of Veterans Affairs (VA)¹¹ and is now available at 36 VA facilities. In Canada, chiropractic care is currently offered at 1 military hospital.¹²

Despite the availability of numerous published articles regarding chiropractic care and the chiropractic profession in general, the number of writings about chiropractic care specifically included within the military/veteran setting is unknown. Since chiropractic care is the primary CAM practice now included within military and veteran hospitals, a survey of existing literature may assist practitioners in the art of evidence-based practice, guide administrators in the practice of evidence-based health care, focus future research efforts, and ultimately benefit military and veteran patients. Knowing how chiropractic care is utilized within these environments may aid with quali-

ty improvement and assist decision makers to determine if further inclusion of chiropractic services is warranted. The purpose of this study was to identify and summarize scholarly literature that describes chiropractic practice, utilization, and/or policy included within international active duty and/or veteran health care systems, and to provide suggestions for how to increase research productivity from these unique environments.

Methods

Search Strategy

PubMed and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched using EBSCOhost Web. The Index to Chiropractic Literature (ICL) was reviewed directly at its site (www.chiroindex.org). Searches for all databases were from the starting dates of each through June 2009. In PubMed we combined the term “*chiropractic*” with a variety of terms relevant to the topic (Table 1). “*Complementary medicine*” and “*alternative medicine*” were also combined with other terms (Table 1) in an effort to broaden the search and capture all relevant publications. The same strategy was used with CINAHL. Pertinent hits were verified against the previously recorded relevant citations (ie, those that met inclusion criteria) from the PubMed search; these were noted as “new hits” in Table 1. This procedure was used for the ICL search, verifying results from the ICL against both PubMed and CINAHL. We searched for additional articles by reading the references found in the articles retrieved, searching our personal libraries, and by contacting authors who have published in this area.

Inclusion/Exclusion Criteria

All languages and research designs from any country, and only articles from peer-reviewed scholarly journals, were included in the search. Commentaries from non-peer reviewed sources (eg, trade magazines) and other non-scholarly sources were excluded, as were writings not specific to the reported use of chiropractic or of chiropractic in military or veteran facilities. Abstracts of

Table 1 Search terms and results.

Search Terms	PubMed Search			CINAHL Search			ICL Search		
	Total Hits	Potentially Relevant Hits	New Hits	Total Hits	Potentially Relevant Hits	New Hits	Total Hits	Potentially Relevant Hits	New Hits
chiropractic + military	13	9	8	70	4	0	26	4	0
chiropractic + navy	2	1	0	2	1	0	2	1	0
chiropractic + sailor	1	1	0	0	0	0	0	0	0
chiropractic + marines	1	1	0	0	0	0	0	0	0
chiropractic + marine	6	3	2	4	1	0	2	2	0
chiropractic + air force	3	0	0	4	0	0	97	0	0
chiropractic + airman	1	1	0	1	1	0	0	0	0
chiropractic + army	5	3	0	10	1	0	5	0	0
chiropractic + soldier	2	2	1	1	1	0	1	0	0
chiropractic + coast guard	1	1	0	1	0	0	6	0	0
chiropractic + Department of Defense	1	1	0	2	1	1	65	7	0
chiropractic + Department of Veterans Affairs	9	4	5	66	6	1	65	8	0
chiropractic + veterans	14	6	1	90	6	2	15	6	0
chiropractic + veteran	14	4	0	6	2	0	3	2	0
alternative medicine + military	56	13	10	17	6	0	17	2	0
complementary medicine + military	35	6	1	2	4	0	17	2	0
alternative medicine + veterans	75	10	6	5	7	2	3	1	0
alternative medicine + veteran	58	2	0	1	1	0	0	0	0
complementary medicine + veteran	36	0	0	0	0	0	0	0	0
complementary medicine + veterans	40	0	0	6	2	1	3	1	0
TOTAL			34			7			0

conference proceedings were not included due to the high rate of conference presentations that never reach full publication.^{13,14} Articles were considered for final inclusion

if they described practice, utilization, and/or policy of chiropractic within active duty and/or veteran health care environments.

Methods of Review

The search process was conducted by the primary author; co-authors were asked to contribute citations with which they were familiar but which might be missing from the list created by the primary author. Abstracts of the citations that obviously or possibly met the review criteria were saved. The full papers of each abstract were then retrieved. Each article was independently reviewed to verify that it met the inclusion criteria. Papers that did not meet the criteria were discarded and a note was made as to why they were excluded. Once a paper was included, the citation, study design, principal findings, and other pertinent notes were logged in a summary table (Table 2). Quality scoring was not performed as the articles reviewed were descriptive and not homogenous.

Results

Forty-three potential articles were identified (41 from literature searches and 2 from colleagues published in this topic area) and 13 were acceptable for review,^{12,15-26} thus 30 papers^{5,7,27-54} had been excluded. Reasons for exclusion are presented in Table 2. The most common reason papers were excluded was because they described the use of CAM amongst military or veteran beneficiaries, but included no breakdown of the utilization of chiropractic care from the larger set of CAM practices. Also, it was not made clear whether the chiropractic care included in the CAM practices discussed was provided at a designated military or veteran health care facility or if chiropractic care was obtained from outside sources. Two papers with apparent US military/veteran and chiropractic relevance that were excluded were those by Lott⁷ and Coulter³³ and this deserves further explanation. Lott's paper predated the inclusion of chiropractic services in the DoD or VA environments and was a commentary forecasting how the service might be included; it was excluded because it did not discuss actual working settings. Coulter's paper was a critique of a VA study that investigated the use of VA care vs. fee-for-service spinal manipulation performed by chiropractors for veterans with low back pain. This paper was excluded because it did not involve the use of chiropractic care within the VA setting.

Integration of chiropractic care into military or veteran health care systems has been described in 3 systems: the DoD, the VA, and the Canadian Forces. The predominance of papers is from the US. A summary of the in-

Table 2 Reasons for excluding papers from this review.

Reason	Reference Number
Not about chiropractic care	5,27-32,34-42,46,49-54
Not about chiropractic care in military/veteran setting	5,7,27-30,33,35-37,39-54

cluded articles is presented in Table 3. Three cross-sectional studies, 1 descriptive educational study, 3 surveys, 3 case reports, and 3 commentaries comprise the literature on the topic of chiropractic care in military or veteran health care.

Dunn and colleagues¹⁸ authored the first paper to describe a VA chiropractic clinic along with some demographics of its patients, most of whom had received medical or physical therapy management prior to chiropractic care. This is predictable, as many VA patients have chronic disorders. The overwhelming majority of patients (82%) were referred for chiropractic care because of low back complaints, were male (88%), an average age of 55 years, and most of the consults originated from primary care. Previous treatments included: medical management (n = 67); physical therapy (n = 49); chiropractic (n = 19); acupuncture (n = 4); surgeries (n = 3); massage therapy (n = 2). Fifty percent of the patients had service-connected disability.

Dunn and Passmore²³ followed up on this study in 2008 and rendered essentially the same findings, but also included data on veterans with a diagnosis of post traumatic stress disorder (PTSD), revealing that 16% of the patients in the sample had this diagnosis. The number of lumbar cases referred to chiropractic care dropped by 16% compared to the first study.

More recently, Dunn and colleagues²⁵ followed up on the PTSD/musculoskeletal pain connection and analyzed baseline and discharge pain and disability scores for veterans with both neck and low back regions and for those patients with and without PTSD. They found that patients with PTSD experienced significantly lower levels of score improvement than those without PTSD, suggesting that the success of conservative forms of management for veterans may be limited by the presence of PTSD.

Due to the large number of consults referred to their VA clinic, Dunn and Passmore²¹ offered suggestions for managing the influx of new consults and commented on

Table 3 Summary of studies reviewed.

Citation	Study Design	Principal Findings
Dunn et al ¹⁸	Cross-sectional study	<ul style="list-style-type: none"> • First paper to describe a VA chiropractic clinic • Most consults originated from primary care • 82% were seen for a lumbar complaint
Dunn & Passmore ²³	Cross-sectional study	<ul style="list-style-type: none"> • Follow-up study to the one listed above • 16% of patients had a diagnosis of post traumatic stress disorder • 72% were seen for a lumbar complaint
Dunn et al ²⁵	Cross-sectional study	<ul style="list-style-type: none"> • Patients with PTSD experienced significantly lower levels of neck and low back pain and disability score improvement than those without PTSD, suggesting that the success of conservative forms of management for veterans may be limited by the presence of PTSD
Dunn ¹⁶	Descriptive study	<ul style="list-style-type: none"> • First paper to describe chiropractic training in VA or DoD facilities • Described the development and implementation of a chiropractic intern training program at a VA facility
Boudreau et al ¹²	Survey	<ul style="list-style-type: none"> • First report of Canadian military hospital offering chiropractic care • Most referrals were for low back pain and axial musculoskeletal complaints • Reported high levels of satisfaction from patients (94%) and referring providers (80%)
Dunn ¹⁷	Survey	<ul style="list-style-type: none"> • No difference in demographics, income, job satisfaction, or career success were detected between interns participating in a rotation through two US naval hospitals compared to interns who did not
Dunn ²⁰	Survey	<ul style="list-style-type: none"> • Compared academic affiliations, internship programs, staffing, physical plant properties • intern selection, duration, weekly hours, and number of interns at 4 VA chiropractic programs
Green et al ¹⁹	Case report	<ul style="list-style-type: none"> • First clinical study about chiropractic care in DoD • Case report of coordinated multidisciplinary treatment of a US Marine pilot with low back pain.
Green et al ²²	Case report	<ul style="list-style-type: none"> • Described a previously unreported type of sacral synchondrosis and chiropractic methods and multidisciplinary approach used to diagnose and manage a US Marine's low back pain
Passmore & Dunn ²⁶	Case report	<ul style="list-style-type: none"> • Described the use of spinal manipulation for a female veteran with a diagnosis of cervical angina
Dunn & Passmore ²¹	Commentary	<ul style="list-style-type: none"> • Proposed 6 strategies that could potentially help reduce wait times for appointments, encourage appropriate consultation requests from gatekeepers, optimize clinic efficiency and maximize clinical effectiveness in an effort to improve the provision of the chiropractic benefit at VA facilities
Johnson et al ²⁴	Commentary	<ul style="list-style-type: none"> • Described integration of chiropractic services and the potential public health opportunities for chiropractors in military and veteran treatment facilities
Green et al ¹⁵	Commentary	<ul style="list-style-type: none"> • Described how health care providers within DoD and VA treatment facilities refer to and work collaboratively with chiropractors who work at the same facility

efficiencies that may be used in the VA system to maximize the use of chiropractic care.

Dunn¹⁶ was the first to report on training opportunities for chiropractic students in VA or DoD medical treatment facilities. He provides a description of the development of a chiropractic intern training program at the Western New York VA and how it was implemented. Additional training opportunities developed at 2 naval hospitals at the time were also discussed. No program evaluation was reported, however. Further information regarding the growing VA training opportunities was provided by Dunn in 2007.²⁰ This paper described the process that is used to establish an affiliation agreement between VA and academic institutions and provided a comparison of such affiliations, programs, facilities, and other parameters for those VA hospitals with chiropractic training programs.²⁰

There is 1 paper published pertaining to DoD chiropractic training programs.¹⁷ In this survey study, interns who had participated in a rotation through a US naval hospital were compared to interns who did not have this opportunity. A variety of variables were considered, but the focus was on whether there was a significant difference in career quality of life indicators, such as job satisfaction and income once these interns were in active professional practice. No such difference was present.

Two case reports pertaining to the use of chiropractic care and active duty US military members have been reported by Green and colleagues.^{19,22} Both of these cases report the interdisciplinary clinical management of cases of low back pain, one for a jet fighter pilot¹⁹ and the other for an enlisted US Marine with a rare sacral anomaly.²² There is 1 case report about a veteran receiving chiropractic care, wherein a female veteran who presented with chest pain was managed in an interdisciplinary manner and eventually had resolution of her symptoms with cervico-thoracic spinal manipulation.²⁶

Despite chiropractic care being included in the DoD, VA, and Canadian Forces for a number of years, what chiropractors do, how they function within military or veteran health care centers, and suggestions for how other health care providers might work with chiropractors was only published in 2009.¹⁵ Finally, some interest in how chiropractors who work in military and veteran hospitals might become involved in public health efforts has been reported by Johnson et al.²⁴

We found only 1 paper from outside the US that discussed the use of chiropractic care in military or veteran facilities in Canada. Boudreau et al¹² surveyed military patients and physicians regarding their satisfaction with chiropractic services at the 1 location in Canada where chiropractic care is included at a military or veteran treatment facility. The response rate was 67.6% (69 of 102) for patients, and 83.3% (10 of 12) for physicians. In each group, the majority of respondents (94.2% of military personnel and 80.0% of referring physicians) reported satisfaction with chiropractic services. The authors also reported that most patients were referred for chiropractic care for low back pain and that referring physicians preferred to make chiropractic referrals for axial, musculoskeletal complaints.¹²

Discussion

Main Findings

Our primary finding that little published research exists on chiropractic care within veteran or military integrated health care delivery systems is surprising, since chiropractic services have been part of the military medical system for over 14 years in the US and 9 years in Canada. The 13 papers identified and reviewed represent initial reports of chiropractic integration with veteran and military medicine in the areas of education, clinical care, clinical processes, and public health.

The literature on this topic is entirely descriptive in nature, which we feel is appropriate given that this is a nascent area of investigation by the profession. If one were to use the Oxford Centre for Evidence-Based Medicine levels of evidence⁵⁵ to categorize the included studies, then the level of evidence generated from these integrated environments would be levels 4 and 5 on a scale from 1 to 5 with 5 being the lowest score. Clearly, while the efforts achieved thus far are noteworthy, there is much more work to establish an evidence base pertaining to effectiveness, best practices, or policy specific to the active duty and veteran population cared for in integrated health care systems where chiropractors are working.

Practice, Utilization, and Policy

Based upon these 13 papers, we offer a glimpse of chiropractic services within military and veteran settings. Chiropractic patients include those who may not have

experienced prior chiropractic care and typically access chiropractic services through primary care providers. Chiropractic care is provided at the same facilities where other healthcare services are provided. Patients tend to have musculoskeletal complaints but may have other complicating factors (eg, post traumatic stress syndrome). There are high levels of patient satisfaction with chiropractic care in the practices described. Chiropractic care of patients tends to be integrated and multidisciplinary in nature. An exception to this may be Canada, where many patients are referred to chiropractors typically at the patient's request; military personnel may access care only by referral, often when other treatments have been unsuccessful. No data are available concerning utilization or referral protocols. There are educational programs that provide experiences for interns in the VA and DoD environments and there are many opportunities for doctors of chiropractic to participate in public health initiatives in the DoD and VA.

Musculoskeletal problems are common in the military, both at home and in combat theater⁵⁶⁻⁵⁸ and affect service members across many occupational specialties.⁵⁹ Given that providers in military and veteran settings refer patients to chiropractic services for musculoskeletal problems, chiropractors have the potential to contribute in a very positive manner to relieve this huge health care burden. However, at this time it is unclear how often chiropractic services are utilized within a given facility. It is unreported if patients who receive multidisciplinary care have better outcomes than those only receiving one type of care. No clear reports of policy or cost effectiveness were found in this review. Without specific data to state otherwise, it is assumed that access to care varies widely across jurisdictions, especially where there are competing models for the care of musculoskeletal disorders. Studies that explore collaborative models would be particularly useful, especially if those studies examined a number of sites in different countries. This short series of articles demonstrates that inclusion of chiropractic within the military healthcare system is possible and may be beneficial for certain disorders; however, more details are needed to produce reproducible and robust summaries.

Increasing Research Capacity

More information about the implementation of chiropractic services as a health care benefit in the DoD, VA,

Canadian Forces, and other countries is needed. Analysis will require systematic assessment; health care administrators and policy makers will need to know whether or not chiropractic care is effective in these environments, for what conditions it might be effective, if it represents a good expenditure of funds, and posit other relevant queries. Unfortunately, as of this writing, no published evidence in the peer reviewed literature was found that sheds light on these questions. If the prevailing state of chiropractic services is to be evaluated, further data need to be explored and results published. Important areas for future inquiry will include assessment of structures of care (e.g., models of clinical implementation and provider training and characteristics), processes of care (e.g., clinical practices and procedures; provider workload and productivity; process of integration), and outcomes of care (e.g., clinical outcomes and cost effectiveness).

Specific research questions to consider might include the following. Are components of chiropractic care effective in improving the management of spinal conditions in military and veteran populations? Is there a clinical prediction rule that would best determine when chiropractic consultation would likely be of most benefit to a patient with a particular problem who presents to a primary care manager? In what measurable ways does adding a chiropractic clinic contribute to system performance, quality, or military readiness? If chiropractic care is provided on-station, does it reduce utilization of other services and thus improve access to these services? For what conditions is chiropractic care most effective and cost effective in the military and veteran populations? Is chiropractic utilization, frequency of treatment, and use of adjunctive therapies reasonably uniform within each health care system? These and other metrics can be used to guide the decision-making process of our health care system. In order to meet these research needs, we suggest that the issues of training, time, funding, and collaboration be addressed.

Training: The majority of chiropractors currently in these environments are not formally trained as researchers or authors. This may explain why so few studies appear in the current review. To be effective, practitioners will need to be trained in the methods of research and scholarly writing, and develop mentorships with experienced authors at their facilities. Alternatively, health care facilities will need to put high priority on these skill sets when

assessing future chiropractors as provider candidates. Further, training in grant writing will be necessary to secure adequate funding to conduct the advanced studies, and/or seasoned researchers will have to be secured to aid in this process.

Time: Sufficient time needs to be set aside for research activities. For example, chiropractors in the DoD are hired or contracted for patient care and 100% of the practitioner's professional workload is dedicated to duties relating to clinical concerns. A similar situation exists at the Archie McCallum hospital in Nova Scotia. As a result, even if a practitioner is trained in research methods and scientific writing, no time is allowed to engage in this activity. Some precedent for allowing research activities to occupy a percentage of a given chiropractor's duty requirements is provided in the VA system. Publication and scholarly activity are elements of the VA Chiropractic Qualification Standards utilized for rank and promotion; this offers incentive for providers to engage in constructive writing on the subject of chiropractic practices. For research productivity to exist, time must be allocated.

Funding: Funding is an essential component associated with the successful completion of research studies. In addition to intramural funding already available at some facilities, grants will need to be secured from outside the system and through collaborative efforts with outside investigators. Attracting the interest of seasoned, non-chiropractic researchers may largely be influenced by the availability of funding. The VA Office of Research and Development has issued a request for applications on chiropractic care research; at the time of this writing, one project has been funded and another is in review. External funding from sources such as the National Center for Complementary and Alternative Medicine, Canadian Institutes of Health Research, and Canadian Chiropractic Association may also be available. Additionally, private foundations, such as the Samuelli Center for Research on Integrative Medicine in the Military, may be sources of additional support. At the time of this writing, the Samuelli Institute has funded one VA project and two DoD projects, with subsequent studies under consideration. Additional funding sources need to be identified and secured to complete research projects.

Collaboration: Larger data-driven studies require the time, money, and resources to which most individual practitioners do not have access. Military and veteran hospitals have some personnel and resources (departments of research and investigation, institutional review boards, medical writers, etc.) available to assist in the research effort. Chiropractic practitioners in these hospitals can form a working relationship with these resources. In addition, working with universities or external research departments can provide the means necessary to implement and complete complex endeavors, such as clinical trials and case control studies. In many instances research agendas develop from successful clinical collaborations where providers come to know one another and learn about one another's health care. When collaboration is missing the impetus to deepen research question is also missing, so such research may be difficult to launch.

Limitations

Several limitations exist with the current study. Few articles were found in this search, thus, caution should be used in drawing absolute conclusions from the results. It is possible that internal or unpublished studies exist that provide more details that would help to answer our research question; however, with no ability to access such reports, this paper only reports literature that is publicly available. We have heard anecdotes about chiropractic care being available in other countries, such as Israel, but were unable to locate any peer-reviewed sources of such information. Some efforts at investigating various aspects of chiropractic in military or veteran environments may be reported in conference abstracts. Since we excluded conference abstracts from the study, we may have missed some information. However, there are many conference presentations that are never published, which essentially means that such endeavors are not actual evidence that one can use in the process of evidence-informed health care practice and policy. A final note on conference abstracts is that they often contain preliminary data that are sometimes rushed off to a conference chair during the eleventh hour prior to a submission deadline; material written in a hastened manner may contain inaccuracies and misinform the evidence. Therefore, while we may have missed a few research efforts in abstracts, we feel we are justified in not including them. Further, the level of evidence for the 13 papers included in this review is

comprised of cross-sectional studies, surveys, case reports, and commentaries; thus, the generalizability of the data may be limited.

Conclusion

Our review of the literature revealed 13 studies that might guide future chiropractic practice or policy in the military or veteran health care environment. This paper provides a summary of early reports of how some chiropractic services have functioned successfully in military and veteran health care facilities. Chiropractors work within a multidisciplinary healthcare environment, manage neuromusculoskeletal and other complaints, work with primary care providers, and have high levels of patient satisfaction. This study points to the need for additional high quality documentation. In order to develop a process for evaluating chiropractic services in military and veteran integrated health care delivery systems, more published research is needed. We suggest that in order to develop a greater literature base, additional training, time, funding, and collaboration are needed.

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Robert Goddard Young, DC, ND: Searching for a better way

Douglas M. Brown, DC*

This biographical study tracks the life of Robert Goddard Young; a member of the Canadian Memorial Chiropractic College's (CMCC) Class of 1950. The paper begins with an overview of Robert Young's origins, his childhood and early training, moves to his tour of duty in World War II, followed by his education at CMCC, before converging on the core of this matter; Robert Young's professional career, which spanned over half a century. Now in his twilight years, the paper ends with a discussion on the substance of Dr. Young's largely-forgotten contributions.
(JCCA 2009; 53(3):205-214)

KEY WORDS: Robert Young, biography

Background

Robert Young was born in Toronto on March 13, 1921, and raised in his family's home at 994 Ossington Avenue. His father, William Robert Young, came from Gore Bay, on Manitoulin Island, Ontario, working as a blacksmith to build ferry boats that plied the waters between the Island and the mainland. After moving to Toronto, William Young joined IBM Canada, where he served with distinction as an inventor and senior executive for 25 years. Probably his most important contribution was modifying and refining the punch card tabulating machines invented by Herman Hollerith, which were the precursors of present day computers. "Bob" remembers his father building equipment in the basement of their house and calls him "a creative genius." [Interview, Young by Brown, Nov. 14, 2007]

Cette biographie retrace la vie de Robert Goddard Young; un membre du Canadian Memorial Chiropractic College's (CMCC), classe de 1950. Le document commence avec un aperçu des origines de Robert Young, son enfance et le début de sa formation, sa période de service pendant la Deuxième Guerre mondiale, suivie par sa formation au CMCC, avant de se concentrer sur le cœur du sujet; la carrière professionnelle de Robert Young, s'est étendue sur un demi-siècle. Maintenant, au crépuscule de sa vie, la biographie se termine par une discussion sur la substance des contributions en grande partie oubliées du Dr Young.
(JACC 2009; 53(3):205-214)

MOTS CLÉS : Robert Young, biographie

When he was five years old, his father gave Bob an electric car; sparking a lifelong interest in electronics. At age 13, he built a radio that could pick up programs as far off as Cuba; at 17 he was designing pharmaceutical manufacturing equipment; and by 19, was creating surveillance equipment for police departments and governments.¹ Bob attended Humber West Public School and received his senior matriculation diploma from Runnymede Collegiate before accepting a job in Malton, with the National Steel Car Company of Hamilton, Ontario, assembling bombers for the Royal Canadian Air Force (RCAF).

The Royal Canadian Air Force

By 1942, Bob was studying electrical engineering at the University of Toronto, but left to enlist in the RCAF. At

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Figure 1 Robert G. Young, RCAF 1942–1945.

the time he was 6' 3" tall, very strong and weighed over 200 pounds. Unfortunately, he was about to endure three traumatic mishaps that would compromise his vitality. During induction procedures, Bob suffered an adverse reaction to a vaccination for Scarlet Fever, which disabled him for weeks. Then, studying to become a bomber pilot, both his eardrums were accidentally ruptured, while training in a high altitude pressure chamber. This dramatically altered his balance and depth perception, making it impossible for Bob to handle a plane properly. His last practice flight was disastrous. Coming in for a landing, Bob was unaware that he was 50 feet above the ground. The plane crashed to the airfield, smashing the landing gear, the propeller and Bob's dreams of becoming a pilot.

Demoted to groundcrew, Bob began correspondence courses in radar electronics and instrumentation through the Scottish University Co-operative, to qualify as a "Leading Aircraftman" for the Canadian Coastal Command in places such as Goose Bay, Labrador, the Artic Circle, Gander, Newfoundland and Mont Jolie, Québec. His first job was "converting the electrical systems of British aircraft to the American style ... which had not been accomplished previously. Next his expertise was utilized to perfect an advanced form of electronic surveillance for other branches of the service."²

Leading Aircraftman Young was taking off on a routine flight from Mont Jolie when he inadvertently stepped on an improperly secured escape hatch. Dropping through the floor, he landed on the tarmac and was struck by the plane's rear wheel. Luckily, he was not cut in half as had been the case in similar incidents, however, he received a serious low back injury which affected his legs and compromised his ability to walk. Although hospitalized for several months, Bob's recuperation was negligible. One day, when hobbling to the canteen with the aid of two canes, Bob was stopped by a Mustang fighter pilot in the United States Air Force who happened to be a chiropractor in civilian life. The pilot offered to help, gave Bob an adjustment and soon after, to everyone's surprise, his condition began to improve.

CMCC

Following an honourable discharge from the RCAF, Bob traveled home from Québec to Toronto, by train. Entering the Marshalling Yards in the Exhibition grounds, he noticed a large billboard on Lakeshore Boulevard, announcing a new chiropractic college (CMCC) which had opened at 252 Bloor Street West, on September 18, 1945. He remembered his serendipitous encounter with the American fighter pilot in Mont Jolie who had introduced him to the benefits of chiropractic and decided to investigate what CMCC had to offer. Bob talked to the registrar, John A. Henderson, DC, and entered the second class, in September 1946. Enrolment at CMCC was much larger than expected for the first two years, due to the influx of World War II veterans returning to civilian life, whose tuition and modest living expenses were paid by the Canadian Department of Veterans Affairs (DVA). Of the 239 individuals who graduated from CMCC in 1949 and 1950, over 80% had served in the Armed Forces.

In the 1950s students received instruction in four different methods of spinal correction: MERIC; Specific Upper Cervical; Logan Basic; and Carver. A. Earl Homewood, DC, was a charter member of the faculty, teaching anatomy, palpation and Carver technique. Dr. Homewood had graduated from the University of Natural Healing Arts in 1941, where he was taught the structural approach of Willard Carver, LLD, DC, which encompassed the whole body. Homewood recalled that “As students we were never allowed to forget the value of structural correction ... Great stress was laid upon the ability to utilize the dynamic adjustive thrust and control exact depth and direction, with every effort made to apply the impulse with exactitude ...”³

Homewood was fascinated by the interaction between the structure of the body and its internal organs, via the nervous system. His book, “The Neurodynamics of the Vertebral Subluxation,” contains a neurological explanation of the mechanics by which somatic distortions (subluxations) can produce visceral dysfunction and tissue change.⁴ Bob, with his background in engineering and electronics, gravitated toward Homewood’s approach and they developed a lasting, mutually supportive friendship.

At CMCC, Bob’s early training was useful. Electrotherapy machines were costly and his colleagues had little money, so Bob taught them how to build a device which delivered Faradic, Sinusoidal and Galvanic currents. These were cumbersome appliances, meant to be used in a clinical setting, but some of his pals lugged them out on house calls when they first entered practice. Predictably, their Class President, Edgar Reinhart, gave Bob the nickname “Galvani.” This was somewhat prophetic as Luigi Galvani (1737–1798), an Italian physician and physicist, has been described as a skilled teacher and the first scientist to appreciate the relationship between electricity and life. (Wikipedia)

Professional Career

One hundred and twenty-five classmates graduated with Dr. Robert Young, in May 1950. That number would not be surpassed until the mid 1970s, when CMCC was located on our expanded second campus at 1900 Bayview Avenue. Upon graduation, Young immediately opened a private practice in the west end of Toronto; purchasing three adjoining properties on Dundas Street West, at



Figure 2 *Robert Goddard (as he was then known) publicity photo, Associated Motion Pictures of New York, NY and Hollywood, CA, c. 1973, when he was cast in bit-parts, as an MD, in several movies, while studying medicine and psychiatry for 4 years, at Fremont College, Ceritos, CA.*

Burnhamthorpe Road. On that day, Young began his “search for a better way” to serve his patients by developing instruments and techniques for the detection, analysis and correction of any joint dysfunction which interferes with normal nerve expression, particularly in the spine.

X-Ray

The first piece of equipment Young needed for his office was an X-ray unit. He quickly discovered that major manufacturers were unwilling to sell to chiropractors and besides, their machines were unsuited to our needs.



Figure 3 Dr. Robert Goddard demonstrating AP and Lateral full body X-rays.

Using a workshop in the lot behind his office, he founded the International X-ray Co., Inc., to design and manufacture his own apparatus, which he first sold to chiropractors and then to hospitals, throughout North America. In the early 1950s Young attended a meeting of the Radiological Society of North America, in Chicago, and saw 14" by 36" X-ray films (known as full spine). Their quality was poor; similar to those then being produced by chiropractors. Taken using a bucky with an 8:1 ratio, which means the lead grid lines were wide apart; coupled with a tube to bucky focal distance of 40", producing a widely divergent X-ray beam; the images were badly distorted, and that distortion was magnified. Young traveled to Chicago and had General Electric assemble 14" × 36" buckys with the same fine line grids used in smaller buckys such as 14" × 17". He named them "Nomax" buckys because they had no maximum, or infinite, focal distance. Able to take X-rays at a distance of 80" or more, his system was significantly better and was purchased by several children's hospitals for performing scoliosis studies.

Another problem with full spine x-rays was the disparity in densities between the cervical, thoracic, and lumbar areas, requiring different exposures. Young's first solution was to paste three different speeds of intensifying screens into the bucky. This improved the films but

patients were receiving a lot more radiation exposure than they should. By this time collimators were being attached to the front of X-ray tubes to control the beam's and size and shape. Young's next move was to build a set of lead shutters to fasten to the collimator's face in such a way that the lumbar area of the spine received full exposure, the thoracic half exposure, and the cervical one-quarter. This reduced total radiation to the patient but the shutter mechanism was complex, difficult to engineer and expensive. Young persevered and eventually developed "Young's Alloy Filter System." It comprised small, metal alloy sheets of various thicknesses that were cost-effective, easily modifiable and could be quickly attached to the collimator by two Velcro strips.

Young had made large improvements in full spine X-ray technology, yet his films still held certain disadvantages over smaller views. First, the 14" × 36" film covered a much larger area and some distortion and magnification remained. Second, to be effective, his methods of compensating for variations of density required a skilled technician, who was frequently not present. Young admitted that, for the most part, his full spine films, particularly the lateral views, were diagnostically poor. On the other hand, although smaller films were clearer, sharper and superior in revealing pathological conditions, they didn't provide an accurate picture of the overall spinal configuration. Dissatisfied, Young began to investigate changing the method by which the X-ray beam itself, was delivered to the film. His final solution was to initiate the prototype of what he termed a "Pana Scanner" X-ray machine. This system could take different-sized X-rays, from 8" × 10" to 14" × 36" and was semi-automatic. The technician simply picked the size of film he wanted to produce and pressed a button. Since the X-ray beam was enclosed in a protective tunnel, surrounding tissues were protected from radiation. With full spine radiology, the patient stood on a turntable and was stabilized by straps to ensure no change in body or foot position. For the anterior/posterior (A/P) view, the device started at the base of the skull and took a series of exposures as it moved down the spine, frame by frame, to the pelvis. Next the patient was rotated 90° on the turntable, and the process repeated for the lateral view, duplicating the exposures taken in the A/P position. Individually, these frames were diagnostically equal to spot X-rays and collectively, gave more comprehensive information about overall spinal distortion. Measurements of

individual vertebrae, taken from these A/P and Lateral films, could be combined via computer technology to produce three-dimensional print-outs.

Microscopic Bone Alignment

Shortly after opening his office in 1950, Dr. Young became aware of the pervasive antipathy of other health care disciplines and the public, toward chiropractic in general and aggressive spinal manipulation in particular. "Statistics revealed that only 10% of the public used the services of a chiropractor, whereas 90% of the population could benefit from the chiropractic profession." After he was introduced to a large audience in Florida as a "bone cruncher" he determined "that chiropractic needs to develop a more gentle form of adjustment."⁵

In the 1950s and 60s Young was busy designing, manufacturing, selling and installing X-ray units in chiropractic offices and hospitals in Canada, the United States and Mexico. Working in hospitals gave him "access to their multimillion dollar equipment" and introduced Young to image intensifiers which became for him, the most important device in the study of chiropractic technique. In this regard, Young had help from Jack D. Ellis, DC, Brampton, Ontario, who let him use his private video-fluoroscopy system for research purposes. Dr. Ellis explained that the image intensifier attached to the fluoroscope, allows the milliamps (MA) for spinal motion studies, to be greatly reduced from 200 MA to as low as 1 MA. Intensification tubes also convert the X-ray beam to an electronic signal which can be recorded on videotape, CD, DVD or computer. [Phone call, Brown to Ellis, Aug. 5, 2008]

Image intensification permitted Young to see vertebrae in three dimensions and in motion, on a nine inch screen. Anatomists have determined the play between spinal joints to be two to three millimeters. Young found the amount of change in bone position following a Micro adjustment to be almost imperceptible. Although never able to record this change using X-rays or image intensifiers, on one occasion he had access to an instrument designed to measure the amount of space between a connecting rod in an automobile engine and its bearing and used it to determine the clearance between the bones of his shoulder. Other than side clearance, it was only one-thousandth of an inch. Looking at the movement of vertebrae as they were adjusted conventionally, he observed them re-

bounding from the force applied. Rather than being transmitted into the intended spinal articulations, much of the energy was deflected up and down the spinal column.

Young knew that leverage is capable of generating great force with little effort. He experimented taking a contact against the spinous process of a vertebra, using either the pisiform or the eminence of the second digit, as a fulcrum. Flexing the wrist caused the pisiform to act as a rotary cam; producing a gentle prying action to lever the vertebra into place. The pisiform is augmented by the forearm which provides a 60:1 mechanical advantage and the spinous process, another 5:1 advantage.

Young first used his levering system to develop specific techniques for adjusting the spine and pelvis. Important steps to remember are: locking the wrist in a neutral position against the spinous process; restraining the spine on the opposite side with the other hand; then flexing the wrist to apply controlled pressure against the spinous process and complete the procedure. Mild force can be directed three-dimensionally, in sagittal, coronal and transverse planes. Because the impulse is light and the velocity low, variable vectors can be employed in a controlled environment to nudge bones into precise positions. This eliminates "follow-through" which can have negative repercussions by carrying the procedure too far.

Young stresses the importance of understanding the construction of the spine as it relates to the differing sizes, shapes and angles of vertebrae, their spinous processes and inter-vertebral articulations. A/P and Lateral X-rays are needed to exclude contra-indicated pathologies and get an in-depth understanding of misalignments; spinal palpation should be conducted with the eyes closed to increase tactile sensation and "get a feel" for what needs to be done.

Young also originated specific techniques for manipulating the cartilages of the throat, the ribs, acetabulae, pubic symphysis and coccyx. Other areas covered were the occiput, sutures of the skull, sinuses, nasal bones, ears, temporomandibular joints, shoulders, scapulae, clavicles, elbows, wrists, hands, knees, ankles and feet.

One of Young's most unique claims is that microscopic bone alignment can assist with the reconstruction of bones, where there are no joints. He reminds us that orthodontists have been using braces of various sorts to realign teeth since the 1880's. Whether they employ rubber bands, springs, or moulds, they all abide by the same

principal: the use of mild force at timed intervals to move teeth. Young refers to Wolff's Law, which states that bone in a healthy person or animal will adapt to the loads placed upon it. Mechanobiology is an emerging discipline which might add credence to Young's assertion. It joins the older science of mechanics with the newer specialties of molecular biology and genetics. At the center of mechanobiology is the cellular process of mechanotransduction, or the way cells sense and respond to mechanical forces.

Teaching

In the 1960s CMCC began purchasing X-ray equipment from Dr. Young and from 1969 through 1972 he taught X-ray Physics, chaired the X-ray Committee and was director of X-ray Research. Young was in the X-ray business and his students benefited from examining actual parts, rather than looking at pictures in a textbook. For example, he taught the creation of an X-ray beam by bringing stationary and rotating anode tubes to class with pieces of the outer casings cut away, so they could see the anode rotate and watch the tungsten filament redden as MA was applied. He also brought in a miniature dental X-ray machine and introduced the class to stationary, reciprocating and (his own) Nomax buckys.

After one of his lectures, a student approached Young regarding a spinal problem that had not responded to traditional therapy. Young administered a Micro adjustment and the student obtained almost immediate relief. Classmates Peter MacKay and Dennis Colenello were intrigued by this new technique and persuaded Young to give them a series of informal workshops. By the time they graduated in 1979 Drs. MacKay and Colenello were skillful advocates of Micro, traveling with Young as associate lecturers throughout North America and using it extensively in their private practices.

Young held Micro seminars at CMCC, the Parker College of Chiropractic, the New York Chiropractic Association and the New York Chiropractic College, where he was listed as a faculty member for 10 years. Barbara James, DC, had been involved with Young for three years by the time she graduated from CMCC in 1988. Dr. James was impressed with Young's "profound" understanding of the human body, his precise analysis and the results he got for his patients. "I realized that I wanted to spend more time with Bob. When he asked me to join him in practice

and help him teach his programs, I agreed to stay in Toronto for two years before moving back to British Columbia." [Email, James to Brown, Sept. 3, 2008]

Articles on Microscopic Bone Alignment have appeared in chiropractic journals such as *The American Chiropractor*, *Today's Chiropractor* and *Chiropractic Economics*, where Homewood published six articles.^{6,7,8,9,10,11} Dr. Homewood's papers focus on Micro manipulation of the spine and the skills necessary to properly analyze and deliver appropriate force in a specific way, to a particular area. He provides detailed information regarding anatomical differences throughout the spine that must be considered and delves into the complexities of the nervous system and how its various divisions influence, and are influenced by, structural distortion and its correction. Homewood declares the underlying principles of Micro manipulation to be "leverage and direction."

Young began documenting his Micro lectures in electronic format in 1980 and by 1988 had succeeded in producing a version on four videotapes.¹² Young is assisted on these tapes by Drs. Colenello and MacKay. It took him 10 years, but in 1990 he completed a greatly expanded series, recorded on 22 DVDs. Young is the main actor with cameo performances by Donald W. Lavis, DC and Barbara James, DC. This program, developed as a Specialist Certification Program, has never been released.

Inventions

According to James, at one time Young owned 52 patents, ranging in diversity from improvements in modes of travel, to health care diagnosis and treatment. One of his creations was what he called an "Armcycle." This was a bicycle whose rear wheel was powered by the rider's legs working the foot pedals and the front wheel by the arms pumping the handlebars, in a similar manner. Another contrivance was Young's version of the "airboat," which is still used in the Florida Everglades. Young took a 500 hp airplane engine and attached it to a rowboat. Frederick N. Barnes, DC, worked for Young for a couple of years, after graduating from CMCC in 1954. Dr. Barnes vividly remembers that "One day, Bob and I were roaring up a shallow, weed-choked section of the Nottawasaga River, when suddenly we ran out of gas and had to slog for miles on foot, in search of help." [Interview, Oct. 1, 2008] Young also built one of the first hybrid automo-

biles. He took the back half of a rear-wheel drive Toyota Cressida, which he powered by batteries; welded it to the front half of a front-wheel drive Volkswagen Jetta with a Diesel engine; and attached a drive shaft, housing a generator from a B52 Bomber. During highway driving the car ran on Diesel fuel as the batteries were recharged. When the brakes were applied, the Diesel engine turned off and the batteries took over, bringing the car to a stop and simultaneously conserving a lot of energy

In addition to his contributions to the field of X-ray, Young developed cardiographs, electroencephalographs and a wide range of electronic medical equipment for hospital use. For decades Young has been convinced that chiropractic must move from the "horse and buggy" era into the modern scientific world of instrumentation. To this end he generated a number of devices to facilitate the analysis, delivery and documentation of Microscopic Bone Alignment.

Young envisions the well-equipped chiropractic office of the future as featuring a "Robotized Computer Operating Theatre ... This device carries the chiropractor around the operating theater while a computer automatically and robotically controls all movements of the doctor's chair, the operating table and X-ray monitors. This allows doctors to remain seated, as they are carried effortlessly around the room."¹³ Young's "alignment" table was similar to a conventional "adjusting" table except that it descended to the floor, providing accessibility for disabled or elderly patients. As well, supported by a central recessed base, rather than legs, it was easier for the practitioner to move around.

In 1954 Young constructed his first "Chiroscanner." Inspired by BJ Palmer's Electroencephaloneuromyography,¹⁴ it was based on newer technologies borrowed from electroencephalography and surface electromyology. Impulses from hundreds of electrodes strategically attached to the patient's body were fed into a computer to be analyzed and recorded. He also utilized computer technology to generate instruments for detecting subluxations, measuring spinal range of motion, muscle testing, postural studies and three dimensional X-ray analysis.

Chiropractors and patients often feel that crepitus signals an effective adjustment. Since movement of vertebrae in Micro adjusting is miniscule, joint noise is absent or slight. Some individuals questioned Micro's validity on this basis. Young answered their queries by devising a

"bone noise analyzer." Consisting of a sensitive vibration microphone, coupled with a Sanborn oscilloscope, it demonstrated that in numerous instances, Micro manipulation produces noise which is inaudible to the human ear.

Discussion

Dissatisfaction seems to have been at the heart of Young's "search for a better way." His father accused him of finding fault with most of the mechanical devices he encountered but admitted that "Bob usually figures out a way to improve them." His discontent made Young a practical inventor, more interested in solving problems than in delving into the theories and reasoning behind them. Unable to purchase quality X-ray equipment, Young began building his own machines and went on to develop a new system for taking, analyzing, and recording the findings from full spine films. Young's Pana Scanner X-ray machine and Robotized Computer Operating Theatre, never got much beyond the prototype stage because both were complex and too expensive for most practitioners. In 1990, he showed how effective his Operating Theatre could be when a colleague, who was a brain surgeon in Montréal, lost both feet in a motor vehicle accident. Young resuscitated his friend's career by constructing a room with a motorized, computer-controlled chair; enabling him to perform all his delicate tasks while seated and reducing the time it took to perform them by one-third.

Sadly, I could not find any concrete evidence of his accomplishments, other than videos of Young in his clinic, demonstrating his inventions. I also have photos of three tractor-trailers which he kept in the lot behind his clinic and have talked to several individuals who remember seeing them loaded with diagnostic and therapeutic devices which Young designed and built. He had planned to take these trailers to various locations such as the Canadian National Exhibition, in Toronto, to inform the public about the therapeutic and scientific competency of chiropractic. Unfortunately, before this occurred, Etobicoke's zoning department ruled that the back lot where Young stored them was residential, not commercial and he was forced to get rid of the trailers and their contents.

Unhappy with traditional methods of adjusting, Young spent 30 years creating Microscopic Bone Alignment; an effective and less invasive form of spinal correction.

One question Young has not answered is how to get

the chiropractic profession interested in Micro manipulation. James provides three possible reasons. "1. Bob was unable to communicate clearly that this is a new technique paradigm which involves using the pisiform as a moving fulcrum that creates changes in the body from the lever action ... When I presented at the CORE (California Chiropractic Association Conference on Research and Education) program in San Diego in 1996, there was no interest shown in this new paradigm of adjusting. Many researchers simply state that all techniques work, and they have no interest in promoting one over any other. 2. I believe Micro has been discounted because there was no organized and standardized approach to presenting it and most students did not feel they had enough training to start using the technique with confidence. Bob took almost 10 years to develop his training videos and was not able to build up momentum for people to start learning it. 3. Very few professionals will commit to learning something that is not accepted as the standard practice, and our profession is no different in this regard. I have had more enthusiasm from American DCs when I demonstrated and presented at Parker seminars than we saw in Canadian DCs. And I definitely see greater interest from other professionals who have no existing paradigm to contend with." [Email, James to Brown, Sept. 15, 2008]

Summary

Microscopic Bone Alignment is at the heart of Dr. Young's accomplishments. His experimentation with image intensification revealed the possibilities of Micro manipulation; his refinements to X-ray technology helped pinpoint areas of spinal distortion requiring attention; and computerized equipment such as the Robotized Operating Theatre, facilitated and recorded the delivery of this technique. There is a parallel between Young's system of Micro adjusting and the Avro Arrow jet airplane under construction at Malton, Ontario, in the 1950's. Both were left in limbo because they were ahead of their time, were not widely publicized, and their significance was not grasped. Although Young and his associates delivered numerous seminars throughout North America and in colleges such as CMCC and the NYCC, Micro was never incorporated into the curriculum of any educational institution. Had this been the case, thousands rather than hundreds of chiropractors would have been being exposed to Micro, and there would presently be a number of compe-

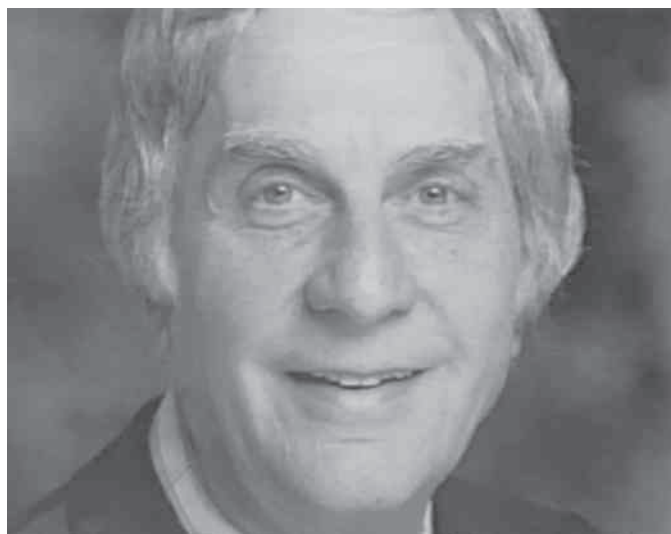


Figure 4 Dr. Young, taken from p. 1 of his book, "What's Wrong with Chiropractors?" Unpublished, Undated.

tent instructors in this field, rather than only one, or perhaps two. Right now, Micro faces the distinct possibility of becoming extinct.

In the 1980's Dr. Homewood declared, "From the fertile mind of Dr. Robert Goddard Young, comes the microscopic bone alignment technique, a form of light force adjustment with emphasis on the exact direction required for correction. One personal experience at the hands of Dr. Young was an eye-opener and encouraged my desire for a greater knowledge of this skillful method." Homewood's testimonial says a lot about the value of Micro for he was an avid scholar of every aspect of chiropractic education and a skilled practitioner. At CMCC (1951-55), I was fortunate to attend Homewood's technique classes. "Here he emphasized attention to detail and drilled his pupils to develop a controlled, dynamic adustive thrust, to make it specific yet safe for the patient, while protecting the practitioner from injury. He reiterated that the purpose of adjustive technique was to normalize neural function while the intent of diagnosis was to influence the type of treatment administered. As always, he was guided by the dictums of DD Palmer. 'It is unsafe and unwise to teach adjusting, unless it is taught intelligently.'"^{15,16} Obviously, Homewood found Microscopic Bone Alignment both "safe" and "intelligent."

Dr. James remembers that, “From the moment I began learning his technique, I knew that his understanding of the body was profound ... In thinking about the impact Bob has made on my life as a chiropractor it becomes really difficult, since I have practiced Micro for 20 years now, and have never used high velocity traditional adjustments. It has certainly been the overall factor in my success as a chiropractor, and has led me to really let the body teach me what to do, since I have complete confidence in what I can adjust and how that will be received by patients. Many times I see patients who will not go for traditional treatments and this is truly the undiscovered value of what Bob invented. He has provided an approach to healing the body which is very well received and appreciated by patients. Every day I am asked why more chiropractors do not use this technique!” [Email James to Brown, Sept. 5, 2008]

On November 9, 2007, I was surprised to find Dr. Young on the front page of the Toronto Star newspaper.¹⁷ The headline, “Ottawa to grab scooter from veteran 86,” describes his plight at being told by Veterans Affairs Canada, that he was being stripped of his electric scooter because he was a “dangerous driver.” Although severely disabled, Young remains a fighter and called the Star, to tell his side of the story. Excerpts from a letter he wrote to the Minister of Veterans Affairs help explain his consternation.

Young begins his letter to the Hon. Gregory Thompson, by describing the injuries he acquired in the RCAF that left him with a permanent heart condition, impaired hearing, disturbed balance and spinal injuries which have rendered him “badly crippled, extremely weak in both the arms and the legs and unable to walk.” He continues, describing the damage inflicted on his home by DVA contractors, in their failed attempt to make his home wheelchair accessible, and the personal cost when forced to hire his own people to do the job properly.

Young outlines the problems he encountered with the DVA scooter, calibrated to run at 22 mph in the house, and the fiasco of his “power mobility assessment.” When he asked for a retest, Young was told to consult a psychiatrist at his own expense. The following paragraph helps to explain why all artifacts from Young’s inventions have vanished.

“I was a practicing chiropractor on Dundas Street at Burnhamthorpe Road, in Toronto, for 53 years. I owned

my office and a workshop at the back where my company, International X-ray Inc., designed and manufactured machines for doctors and hospitals, here and in the United States. I also had three tractor trailers filled with valuable research equipment, an apartment building on Bloor Street, as well as a house and two subdivisions I was developing at Wasaga Beach, on Georgian Bay. Over the years, business reverses, three robberies, bank fraud, and the increasing cost of trying to maintain a semblance of normality, despite severe physical limitations, have left me financially vulnerable. Although I receive the maximum benefits from DVA it isn’t enough to keep me from dipping into my meager savings.

“Once proudly self-sufficient, I am fortunate to be in the hands of competent, compassionate care-givers, but forced by the DVA’s decision to repossess my electric scooter, to use a manual wheelchair which I can only operate by scuffling my feet in such a manner as to painfully propel myself around the house.” [Letter, Young to Thompson, March 20, 2008]

This disturbing story has a mildly happy ending. Although the DVA did nothing to redress its absurd ruling, dozens of letters poured into the Star in support of this valiant Canadian soldier. One “Good Samaritan” donated a new scooter, which Young describes as “cleverly designed, reliable, easy to operate, constructed of steel, and a pleasure to drive.”

Dr. Young is reasonably independent and comfortable in the home formerly owned by his parents, at 34 Clissold Road. Still busy writing books and contemplating more inventions, he remains optimistic that a saviour will appear to “spread the good word about Microscopic Bone Alignment.”

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Baxter's The Foot and Ankle in Sport: 2nd edition, 2008
David A. Porter MD, PhD and Lew C. Schon, MD
Mosby Elsevier 1600 John F. Kennedy Blvd. Ste 1800
Philadelphia, PA 19103-2899
Hardcover, 636 pages,
ISBN: 978-0-323-02358-0
Hardcover, illustrated, 636 pages \$230 Canadian

The foot and ankle complex is a multifaceted, complicated yet imperative facet in the chiropractic evaluation and is habitually included in addressing the body from a kinetic chain perspective. In the second edition of Baxter's *The Foot and Ankle in Sport*, Dr's Porter and Schon provide a comprehensive, anatomical and condition specific reference guide. With surgeons representing over eighty percent of the contributing author's, emphasis is placed upon surgical management. This text is directed to the sports medicine doctor and orthopaedic surgeon, with limited utility to the conservative practitioner.

The book is divided into five sections. Section one, athletic evaluation, is a compilation of twenty clinical pearls. Section two, sport syndromes, provides ten condition specific chapters on neuropathic, musculoskeletal, vascular, and dermatological disorders. Section three, anatomic disorders in sports, encompasses nine chapters on varied diagnoses. Section four, a five chapter section on unique problems in sport and dance, embraces international perspectives tying together numerous cultures, also incorporating unique disorders of the pediatric and female athlete. Section five is a four chapter section on the shoe, orthoses, rehabilitation, and epidemiology of foot and ankle injuries.

Though excellent for differential diagnoses, this text is deficient in the role of the conservative practitioner, often included only as a prelude of failed care to surgery. A short chapter, *Principles of rehabilitation for the foot and ankle*, is a general approach to post-injury status risking cookbook management. This chapter was not in the first edition, providing recognition of rehabilitative and conservative co-management, albeit minor. Emphasizing dancers throughout reflects the background of the authors, however is narrow. Consistency in chapter presentation was lacking. An asset for the conservative sports based practitioner is the return to play and post surgical rehabilitation guidelines. The illustrations, and imaging are exemplary with frequent tables allowing reference

summary, rehashing important themes. Chapter twenty six (the shoe in sports) is of excellent clinical usage.

This book is not of great value for the chiropractic sports practitioner unless a narrow focus in improving differential diagnosis skills or understanding contemporary surgical procedures for the foot and ankle exists. In my opinion, it will not add to the conservative treatment regimen for an individual with a basic knowledge of foot and ankle pathology.

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Textbook of musculoskeletal medicine
Edited by Michael Hutson and Richard Ellis. 550 pages,
Oxford University Press 2006, ISBN 019 263050 4

This is a comprehensive, much needed textbook. As evidence-based therapeutics now clearly provides the framework of our practices, we are constantly searching for better, clearer, and fully supported "evidence" to incorporate into our therapeutic protocols.

This book is a superb integration of the body of knowledge from orthopaedics, rheumatology, pain control, physical medicine and rehabilitation, osteopathic medicine, psychology, physiotherapy, regrettably leaving out the now broad evidence-based chiropractic therapeutics. This is not necessarily a shortcoming of the book, just another fact-of-life, where the interdisciplinary iron curtain still surrounds chiropractic sciences. Where the strength of this book lies is drawing out the similarities and the effectiveness of dissimilar methods of evaluation and treatment methods of each discipline. Sometimes we just have to admit that the treatment advocated is only a conceptual framework and have to be weary of excessive enthusiasms for the belief system without supporting evidence.

The book is cleverly divided into four (4) conceptual Parts: Part 1 is Introduction, while Part 2 deals with Morphology; Dysfunction and Pain; Part 3 then contains Regional Disorders and finally Part 4 Management Strategies.

This text then is a comprehensive account, as the editors established in the preface, "of both structural and functional disorders of the spine, and of the extremities." The theoretical framework of the book is the differentia-

tion of “early pathomorphological changes (which) reflect adaptive process to biomechanical stresses” and is manifested in “reversible dysfunction states” and “advanced structural pathology (which are) consequences of the failure of adaptation of the soft tissues to postural and dynamic stresses.”

The chapter titled *Fundamentals* incorporate concepts such as the Biosocial Model, Distinctiveness of Musculoskeletal Medicine, Models of Neuromusculoskeletal Medicine, Pragmatism and Complexity, The Value of Evidence-based Medicine and its Applicability to Manual/Musculoskeletal Medicine, Reproducibility and Validity of Diagnostic Procedures and RCTs in Manual/Musculoskeletal Medicine. This chapter then sets the tone and framework of what will follow in the next 47 chapters.

Within the context of Physical Examination authored by Drs. Richard Ellis and Cyrus Cooper, both from the University Hospital of Southampton, UK, they refer to two systems used in musculoskeletal examination; selective tissue tension, originally developed by Cyriax, always used in chiropractic premanipulative manoeuvres, and functional examination. In selective tissue tension, as the authors describe “the examiner puts strain sequentially on the possible structures at fault: when the person’s pain is reproduced, the structure under test is identified as the likely cause.” In addition to identifying specific tissues at fault, the authors encourage “examining the whole person” with their specific sensitivities, over-reactivity and abnormal levels of anxiety associated with their condition. A neat pictorial review captures a clinical musculoskeletal examination incorporating Focus of Examination, a picture depicting the actual test procedure, a short description of the procedure, including patient instructions and typical findings and interpretation. This is a very comprehensive “table,” over 35 pages, a most valuable quick compendium. These could formulate a “standardized” musculoskeletal examination.

In summary, this superb textbook is a must-read for anyone interested in diagnosis and management of musculoskeletal pain.

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Conservative Management of Sports Injuries
2nd Edition

Thomas E. Hyde, Marianne S. Gengenbach

2007 Jones & Bartlett Publishers

Sudbury, Massachusetts

1173 pp.

ISBN-13: 978-0-7637-3252-3

ISBN-10: 0-7637-3252-4

The second edition of *Conservative Management of Sports Injuries* provides the sports clinician with an expansive reference for diagnosing, treating and preventing sports injuries in one complete volume. A multidisciplinary team approach to the care of the athlete is strongly encouraged throughout the text.

The extensive list of contributors represents a diverse, international group of specialized chiropractors along with medical doctors and physical therapists with a definitive area of expertise.

The book contains 25 chapters divided into 4 sections: A Conservative Approach to Sports-Related Injuries; Site- & System-Specific Sports Injuries; Age, Gender & Sport Considerations; and Special Issues in Sports Medicine. The first section includes chapters on medicolegal issues in sports medicine and physiological principles of exercise, with a clear focus on rehabilitation and soft tissue techniques specific for athletic injuries. The second section encompasses a very thorough regional approach to understanding anatomy, diagnosis and treatment for specific sports injuries. It is inclusive of a chapter on head trauma, which is particularly relevant for emergency sideline care for the sports physician. The third section gives a pragmatic method to incorporating the special considerations of the female athlete, the pediatric, adolescent and senior athlete, as well as the extreme athlete. An outline of the most prevalent injuries in various extreme sports is integrated well into this edition. The fourth section assimilates sports nutrition and the use of performance-enhancing drugs in sport, and includes a comprehensive chapter on imaging incorporating multiple, well-referenced images. It effectually outlines a logical flow to the requisitioning of studies for each type of injury.

The prevention of catastrophic injuries in sports, particularly in the head and cervical spine, as well as the ongoing emergency care information provided throughout this text, renders it excellent as a global volume for any

sports clinician. The addendum pertaining to athletic shoes also attunes to the preventative tone of this text.

There is a notable amount of redundancy in the site-specific section for the anatomy and pathology of the injury that could be revised to condense the text more, however, overall this is an efficaciously illustrated and well referenced text essential for all sports medicine practitioners.

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Functional Soft Tissue Assessment and Treatment

By Manual Methods

3rd Edition

Warren I. Hammer

2007 Jones & Bartlett Publishers

Sudbury, Massachusetts

775 pp.

ISBN-13: 978-0-7637-3310-0

ISBN-10: 0-7637-3310-5

The latest edition of Warren Hammer's text provides a comprehensive and integrative approach to assessing and treating soft tissue disorders. It was written as a practical reference for health professionals involved in using manual methods of diagnosis and treatment.

The author's narrative style and obvious enthusiasm for his subject is effective at keeping the reader engaged. The contribution of 24 authors representing physiotherapy, massage therapy, physical therapy, osteopathy, chiropractic and medicine enhances the credibility of this compendious text.

The book contains 24 chapters, including 13 new chapters, divided into 3 sections: Introduction to Soft Tissue Examination; Extremities and Lumbar Spine; and Manual Treatment Methods. The first section includes a chapter on the effects of mechanical loading on soft connective tissues, which effectively incorporates apposite neurobiology and physics into our understanding of these disorders at a cellular level. The second section clearly outlines neuromusculoskeletal conditions by region, highlighting etiology, signs and symptoms, functional tests, differential diagnoses and treatment, as well as functional anatomy and pertinent biomechanics.

Throughout, this text is effectually illustrated with well referenced photographs, drawings and diagrams, including easy-to-use regional functional diagnosis charts in the appendix. In the third section the diverse selection of contributors chosen based on areas of expertise renders this text excellent in providing the relevant preliminary information regarding various manual treatment methods.

Overall, this is a well organized, well referenced text effectively reviewing functional anatomy and biomechanics while providing a pragmatic approach to assessing and treating neuromusculoskeletal conditions using up-to-date soft tissue techniques.

Despite a minor concern with editing that doesn't seem to affect readability, I highly recommend this thorough, well written text for both the student and clinical practitioner of any health care profession that utilizes manual treatment techniques.

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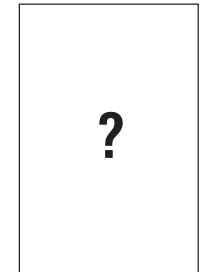
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Dr. John Srbely DC, PhD
CCRF Professorship in Spine Mechanics and
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