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Commentary

The role of force-sensing devices in spinal manipulative therapy research, education, and clinical practice

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Spinal manipulative therapy (SMT) is commonly used by chiropractors, and much attention has been given to teaching students how to master it. Currently, over 20 chiropractic educational institutions use some type of force-sensing device (FSD) to teach students how to modulate their SMT force-time characteristics. Modulating SMT forces is believed to improve SMT's effectiveness, increase comfort during SMT, and reduce adverse events, contributing to improved clinical outcomes. In this commentary, we highlight

Le rôle des appareils de mesure de force dans la recherche sur la thérapie par manipulation vertébrale, son enseignement et sa mise en œuvre en pratique clinique

La thérapie par manipulation vertébrale est très utilisée par les chiropraticiens et on accorde une attention particulière à l'enseignement offert aux étudiants sur la façon de maîtriser cette thérapie. Actuellement, plus de 20 établissements d'enseignement de la chiropratique utilisent un type d'appareil de mesure de force (AMF)

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Conflicts of Interest:
The Canadian Memorial Chiropractic College (CMCC) commercializes the Force Sensing Table Technology (FSTT®) system, which was mentioned in this commentary. None of the authors received any compensation related to the sale of FSTT® units, and CMCC, as an institution, did not have any influence in designing or writing this commentary. The authors declare no other conflicts of interest. No funding was received in preparation of this manuscript.

the transition we are currently living in and discuss the strengths, uncertainties and opportunities of using FSDs to modulate SMT force-time characteristics within research, education, and clinical practice. Given that additional high-quality research is needed to determine if the ability to modulate SMT force-time characteristics indeed influences clinical effectiveness, increases patient comfort, and reduces adverse events, a collaborative effort is needed to address these critical research gaps. Specifically, having similar FSDs across educational institutions allows the collection of multicenter data, sharing research findings across different settings, and provides a unique opportunity for advancing educational and clinical research.

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KEY WORDS: chiropractic, force modulation, force-sensing devices, manual therapy, motor skills, spinal manipulation

pour enseigner aux étudiants la manière de moduler leurs caractéristiques forcetemps dans le cadre de la thérapie par manipulation vertébrale. La modulation des forces dans le cadre de la thérapie par manipulation vertébrale est censée améliorer l'efficacité de cette thérapie, améliorer le confort pendant cette phase et réduire les effets secondaires, contribuant ainsi à l'obtention de meilleurs résultats cliniques. Dans ce commentaire, l'accent est mis sur la transition que l'on vit actuellement et on discute des forces, des incertitudes et des possibilités d'utiliser les AMF en ce qui a trait à la modulation des caractéristiques forcetemps dans le cadre de la thérapie par manipulation vertébrale dans la recherche, l'éducation et la pratique clinique. Étant donné qu'une recherche complémentaire de meilleure qualité est nécessaire pour déterminer si la capacité à moduler les caractéristiques forcetemps dans le cadre de la thérapie par manipulation vertébrale a effectivement une incidence sur l'efficacité clinique, augmente le confort des patients et réduit les effets secondaires, un effort de collaboration est nécessaire pour combler ces lacunes en matière de recherche critique. En particulier, avoir des AMF semblables dans les établissements d'enseignement favorise la collecte de données multicentriques, la communication des résultats de recherche dans différents contextes et offre une occasion unique de faire progresser la recherche éducative et clinique.

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MOTS CLÉS : chiropratique, modulation de la force, dispositifs de mesure de force, thérapie manuelle, habiletés motrices, manipulation vertébrale

Background

Manual therapy and force-time characteristics

Manual therapy is a conservative intervention commonly used by healthcare professionals, including chiropractors, physiotherapists, and osteopaths, among others.[1,2] It encompasses several techniques (such as joint manipulation and mobilization) that apply mechanical forces with unique characteristics to the patient's body.[3,4] These characteristics include force magnitude (i.e., how much force is applied), speed (i.e., how fast the force is applied), and loading rate (i.e., the ratio of force application over the time it is applied). These force characteristics are often dynamic and vary over time and with the chosen technique. Therefore, they are often measured and interpreted in relation to the specific time frame of their application, with each manual therapy technique having its unique set of force-time characteristics.[5–8] Specifically, joint manipulation usually includes the application of a preload

force immediately followed by a single high-velocity, low-amplitude impulse force. Joint mobilization applies a rhythmic cyclic, low-velocity, variable-amplitude series of forces. Spinal manipulative therapy (SMT) is a type of joint manipulation extensively used to treat spinal pain.[9,10] However, SMT is a challenging and complex motor skill that likely requires extensive training to fully comprehend and master it. Therefore, several teaching and learning strategies have been investigated and implemented in SMT training, including visual feedback.[11–14]

Force Sensing Devices

Force-sensing devices (FSDs) were originally implemented in chiropractic education as a training tool to quantify the forces applied during manual therapy, including SMT, and provide students with immediate visual feedback regarding their force-time characteristics.[13–15] An example of a commonly used FSD is the Force Sensing Table Technology (FSTT®, Toronto, Ontario, Canada), which is composed of a treatment table with an embedded force plate that measures the forces in all three axes of motion at the interface between the subject receiving the SMT and the table, at a rate of up to 2000 Hz.[16] The chiropractic profession has used and popularized SMT throughout the last century,[1] and it is now often related to the use of SMT. Specifically, SMT is applied in nearly all chiropractic consultations[2,17,18] and taught at every chiropractic educational institution[19,20]. Thus, it is natural for these institutions to attempt to optimize teaching strategies regarding students' SMT skills. Consequently, several chiropractic educational institutions worldwide have integrated FSDs into their curriculum in various fashions intending to facilitate and support the development of SMT motor skills.

The goal of incorporating FSDs into education is to provide objective feedback to learners so they can replicate the force-time characteristics of experienced field practitioners. Specifically for SMT, educational institutions use FSDs to teach students how to modulate the SMT force-time characteristics and to adapt it to suit each unique patient.[21,22] Practical experiences and observations from the educators in our team indicate that combining the objective feedback from FSDs with individualized guidance on motor skills strategies may facilitate trainees to better modulate their SMT force-time characteristics and reduce variability in SMT performance when compared to observation alone. From a theoretical standpoint, modulating SMT force-time characteristics is believed to optimize clinical outcomes by 1) improving SMT effectiveness, 2) increasing patient comfort, and 3) minimizing potential adverse events.[22–24] In this commentary, the term "adverse events" is used as a broad term that encompass the wide range of adverse events following SMT described in the literature.[25,26]

The purpose of this commentary

As more chiropractic students are being trained using FSDs, it is essential for users to be aware of strengths, uncertainties, and opportunities regarding modulation of SMT force-time characteristics and the role of FSDs in investigating how SMT force-time characteristics may influence clinical outcomes. The discussion is focused on SMT clinical effectiveness, patient comfort, and adverse events when modulating force-time characteristics within the context of research, education, and clinical practice. This commentary was framed based on discussions during the FSTT® workshop at the Chiropractic Australia's Research Foundation (CARF) Researchers' Day 2023, and includes expert opinions from workshop participants, key stakeholders (researchers and educators) from institutions that have utilized FSDs in the last decade and a student representative with vast experience with FSTT®.

Do SMT force-time characteristics matter? The rationale for using FSDs

The clinical effectiveness of SMT is believed to be associated with neuromechanical responses observed following SMT applications. Notably, associations between SMT force-time characteristics (e.g., preload force, peak impulse force, impulse duration, location, technique) and neuromechanical responses (e.g., spinal tissue loading, muscle spindle activity, muscle activation) have been shown consistently.[27–36] While it remains unknown how the underlying mechanisms of SMT influence clinical outcomes, the use of FSDs could potentially facilitate the modulation of SMT force-time characteristics, which, in turn, may contribute to improving clinical effectiveness.
Patient comfort during SMT has been identified as a critical component when teaching SMT.[23,37] From the perspectives of the authors, who all have been the recipients of SMTs from students and practitioners, there appear to be differences in comfort depending on the SMT force-time

characteristics. Additionally, comfort has been associated with improvements in pain and global perceived change.[38] Thus, comfort may influence clinical outcomes and the ability to modulate SMT force-time characteristics may improve patient comfort.

From a safety perspective, SMT is perceived to have added risks of injury due to the application of forces that are perceived to have higher magnitudes and speeds than other types of manual therapies.[39–41] Therefore, applying SMT with lower forces has been recommended to specific populations (e.g., older adults and children[24,42]) as well as to prevent specific adverse events (e.g., costal and vertebral fractures[43,44]). Although no studies have quantified the SMT force-time characteristics required to create tissue injuries, the ability to modulate SMT force-time characteristics in a clinical setting may contribute to preventing adverse events and improving its safety.

What do we know about SMT force-time characteristics? Strengths and uncertainties in using FSDs

Force sensing devices provide students with visual feedback on their SMT force-time characteristics. Feedback can facilitate the development of specific motor skills and optimize motor learning and performance.[45] Current SMT educational approaches focus on training students to consistently modulate their SMT force-time characteristics to deliver SMT with a wide spectrum of forces and speed. The combination of FSDs' visual feedback with tailored instructions can facilitate the development of individual motor skill strategies, allowing each student to modulate SMT force-time characteristics most suited for their individual attributes as well as the patients (e.g., sex, height, weight, strength). Although field chiropractors present a large variability in the characteristics of SMT forces used in clinical practice,[46] previous studies showed that both, students and practitioners reduced the variability of their SMT forces immediately after a training session using FSDs[12,47]. Additionally, a previous pre-post study suggests that students can retain their ability to modulate SMT forces after a 12-week detraining period.[48]

Currently, we are living in a transition period moving from "is force modulation possible?" towards "is force modulation important?". Similar to every research area, the limited capacity and resources "force" researchers to approach one question at a time. In the case of FSDs, investigations to date have focused on determining if force modulation was even possible. With several studies demonstrating that force modulation is indeed possible,[11–15,37,47,48,66,68,72] the focus can now shift towards investigating the clinical relevance of force modulation. Whether this was the best approach or not is beyond the scope of this commentary. Nevertheless, had the focus to date been the importance and clinical relevance of force modulation first, maybe instead of asking "why are we teaching force modulation, if we do not know if it makes a difference clinically?", we would be asking "why are we looking into the clinical effects of force modulation if we do not even know if it is possible to control and modulate forces? People might just apply whatever they feel is needed". Regardless of that, it is unquestionable that the time has come, and future efforts must now focus on investigating the importance and relevance of force modulation on clinical outcomes.

A great example of something similar has recently been demonstrated. Specifically, recent advances related to the non-specific effects of physical treatments for low back pain,[49] including SMT, suggest that the specific site or region of SMT application has limited impact on clinical outcomes[50,51]. Force sensing devices may provide educators with an opportunity to shift their focus towards a more modern and nuanced understanding of SMT,[52] which involves the potential relationship between force-time parameters and clinical outcomes, including clinical effectiveness, patient comfort and safety.

Clinical effectiveness of SMT

The distinct physiological responses elicited by different SMT force-time characteristics suggest that a dose-response relationship between SMT force-time characteristics and clinical outcomes may exist.[27–36] However, it remains unknown if 1) such relationship actually exists,[53] 2) the specific SMT force-time characteristics that should be targeted and 3) the specific provider or patient characteristics that dictates the choice of such characteristics.

Force sensing devices can be easily implemented in clinical settings by embedding it in a regular treatment table, thereby allowing the measurement of SMT force-time characteristics in a clinical setting without significantly disrupting the patient encounter.[54] Such implementation would allow for correlations to be drawn between SMT force-time characteristics and clinical outcomes

(including adverse event). If clinical outcomes are associated with specific SMT force-time characteristics, future research, education, and practice can focus on the specific characteristics that influence clinical outcomes, potentially enhancing the clinical effectiveness of SMT. Specifically, further investigations on the best strategies for developing the motor skills needed to apply such characteristics could be conducted, as well as how to tailor them to specific patient attributes. On the other hand, if SMT force-time characteristics are not associated with clinical outcomes or adverse events, future research, education, and practice can shift their focus away from specific force-time characteristics for clinical effectiveness to a broader focus on other aspects of SMT or perhaps use educational credits on other aspects of clinical practice (e.g., patient education and self-management strategies).[55]

There are, however, some important limitations to currently available FSDs[56] that should be considered. For example, previous studies have shown that forces measured by FSDs embedded in treatment tables are different than the ones applied by the provider[57–60] and, as such, cannot be used as a proxy to the forces being applied to the patient. However, currently available FSDs to measure forces directly applied to patients (such as flexible pressure mats and finger sensors) are limited in terms of maximum force capability, sampling rate, measurement error, number and type of sensors, uniaxial force measurement, and design, significantly limiting its application and implementation in clinical SMT investigations.[56] Additionally, costs of FSDs and their respective software can vary significantly, as well as costs related to training personnel on how to use FSDs and interpret the data, especially in the research context. Most investigations have used FSDs integrated into treatment tables focused on prone thoracic SMT.[38,54,58,60–62] While this was an important start, fewer people suffer from thoracic spinal pain compared to cervical and lumbar spinal pain.[63] The force-time characteristics of side-posture lumbar and supine cervical SMT are not simple to quantify as they involve coupled-motions and the impulse vector is not directed perpendicular to the table. While FSDs at the clinician-patient interface would provide a more appropriate quantification of applied forces during SMT to these regions, not only the devices' limitations mentioned above, but also the combination with rotational movements, would still make the interpretation and application of cervical and lumbar SMT force measurement in a clinical setting challenging. Therefore, force-time characteristics of cervical and lumbar techniques remain uncertain as they cannot be accurately quantified in a clinical setting with current FSDs with the required rigour for research.

Comfort of SMT

Currently, the limited available evidence does not support the idea that SMT force-time characteristics are related to comfort.[37] Specifically, perceived SMT impulse duration, but not objectively measured SMT impulse duration, was observed to be associated with the comfort experienced by students following SMT.[37] However, findings obtained from students familiar with SMT applied with limited force-time characteristics variability limits the generalizability of these results to people not trained in SMT and suffering from pain. Despite that, comfort has been associated with improvements in pain and global perceived change.[38] Therefore, it remains unknown if using modulated SMT force-time characteristics tailored to specific patient characteristics may influence patient comfort.[38]

Adverse events of SMT

Adverse events have been suggested to be associated with SMT force-time characteristics, particularly with the total peak impulse force and, potentially, the loading rate.[39–41,60] Although previous investigations suggest that SMT force magnitudes are below the magnitudes described in the literature to cause tissue damage,[60,64,65] the potential relationship between SMT force-time characteristics extending beyond just peak forces and injuries remains unknown.

Based on the rationale that SMT force magnitudes may be associated with adverse events, some teaching institutions focus on training students to modulate their SMT force-time characteristics so that lower forces are applied first and subsequently gradually increased. This training is greatly facilitated by FSDs' visual feedback and students and practitioners are indeed able to better modulate their SMT force-time characteristics immediately after a training session using FSDs.[12,47] However, it remains unknown if such an approach is maintained in clinical practice and if it, indeed, prevents the occurrence of adverse events. Additionally, it also remains unclear if feedback specifically from FSDs are necessary or if traditional verbal feedback are just as effective in developing force modulation skills. Importantly, adverse events are broad in nature and

can affect not only physical aspects (e.g., tissue damage), but also psychological and social aspects of the patient (e.g., mental health and participation). Therefore, SMT force-time characteristics may not be the only factor contributing to adverse events.

Where to next? Opportunities in using FSDs

Research and clinical practice

Specific FSDs have been reported to have excellent within-patient reliability in measuring SMT force-time characteristics at the patient-table interface.[16,21] Several FSDs have been used in numerous studies focusing on motor skills development, student training in force modulation using manikins,[11,13,66–68] and characterizing SMT's forces, loading, and dynamic behavior with the human body[5,7,57,60,62,69]. These have significantly advanced our knowledge of SMT kinetics to date. Combined with integrating into a standard treatment table, this allows FSDs to easily replicate real-life scenarios, supporting the generalizability of investigations using it.

Since many chiropractic educational institutions worldwide have FSDs, there is an opportunity to foster international research collaborations. Recently, a consortium using the FSTT® was developed to bring together institutions interested in jointly conducting collaborative research investigating all aspects of SMT force-time characteristics and their modulation. Specifically, the FSTT® consortium has to date held two formal in-person meetings with representatives from 13 institutions (with additional institutions attending virtually). At these meetings, pedagogical approaches to delivery of SMT and best-practice approaches to training in force-modulation were debated, along with challenges/opportunities to integrating FSD technology into both lab- and clinically-based research. The FSTT® consortium is currently finalizing its inaugural collaborative research project and has fostered many additional international educational and research collaborations using a variety of FSDs, including FSTT®, load cells, finger pressure sensors and pressure mats. While not aspiring to fill all the gaps, the consortium has the potential to advance this field by standardizing methodologies across studies ensuring greater external validity. Through standardization and resource pooling across institutions, the consortium is well positioned to investigate the value of FSDs in this field, whilst supporting institutions with smaller research capacities, enabling them to benefit from the expertise and support of more established and experienced researchers. Such multisite, international collaborations foster high quality research and educational opportunities, paving the way for more consistent and impactful advancements in SMT research and education.

Additionally, the quantification and reporting of SMT force-time characteristics used in previous clinical trials is nearly nonexistent, as most studies quantifying the SMT force-time characteristics have been conducted on asymptomatic participants or manikins.[5,37,57,67] Consequently, the characteristics of the SMT forces being applied in clinical settings, to real patients, remains under-investigated.[38,54] A recent observational study found no associations between specific SMT force-time characteristics (measured at the patient-table interface) and pain, disability, and global perceived change.[38] While this challenges the potential dose-response relationship between SMT force-time characteristics and clinical outcomes, there is a significant paucity of evidence related to this topic.[53] Although FSDs are currently being used in clinical investigations within real-world clinical settings, a joined international multisite collaborative approach would have a greater impact and generalizability. It is important to note, however, that the overall effects of SMT have been observed to be small compared to no treatment or sham SMT,[70,71] leaving little variance for SMT force-time characteristics to potentially explain. Still, there is also the possibility that the effects are small, with wide confidence intervals, and present substantial heterogeneity exactly because neither the SMT force-time characteristics, its customization to specific patient characteristics or the ability to modulate it were taken into account within clinical trials.

Education and clinical practice

The goal of chiropractic education is ultimately focused on clinical practice and its curriculum allows students to develop skills to treat patients with spinal pain. For SMT, this includes applying a wide range of force-time characteristics, mimicking the forces reported in the literature and those applied by experienced practitioners.[5,7] The use of FSDs not only assists students and clinicians to better modulate SMT force-time characteristics,[12,13,47] but also provides the opportunity for quality assurance in standardizing skill development (by providing visual quantitative feedback) and establishing minimal competencies required for entering clinical practice. However,

while better modulation of SMT force-time characteristics has been anecdotally observed in teaching institutions using FSDs, additional high-quality, rigorous investigations are crucial to demonstrate that 1) trainees can indeed better modulate their SMT forces-time characteristics in comparison to those who do not use FSDs, and 2) if such modulation skills are transferable to clinical practice. Importantly, similar to any other intervention, evidence on its benefits is fundamental prior to further incorporating FSDs into more formal standards, such as professional regulations or accreditation requirements.

In educational settings, FSDs have mainly been used for training modulation of SMT force-time characteristics of the thoracic spine.[13,48,61,66,72] Using FSDs is a good pedagogical approach for students to understand the kinetic components of SMT and receive visual feedback when learning to modulate their forces so they can modify their motor strategies accordingly. Therefore, there is the opportunity for more complex SMT techniques (e.g., side-posture lumbar SMT) to also be accurately quantified through FSDs. Additionally, the use of FSDs can be expanded as they can provide force-time feedback on any manual therapy technique that involves the application of forces, such as muscle energy technique and mobilization with movement. Finally, using FSDs may support complementary learning strategies, such as students' self-assessment and peer-mentoring by trained and experienced student mentors, particularly when time, resources, and faculty availability is limited.[73]

Considering the current uncertainties surrounding the clinical value of modulating SMT force-time characteristics and the lack of high-quality evidence on the impact of using FSDs in SMT training, we strongly recommend educators who use FSDs in education to keep their mind open to the possibility of adapting their teaching focus and approach as higher-quality evidence becomes available. We plead educators to play an active role in contributing to make such evidence become available. Specifically, while several previous studies[11–15,37,47,48,66,68,72] have been instrumental in providing the current foundational knowledge, further advancement is needed and high-quality trials are imperative. An international collaborative effort, such as the FSTT® consortium, presents a unique opportunity to make significant contributions in this area. By involving multiple institutions in collaborative initiatives, funding options are also broadened, including external and internal funding – from institutional and research grants to governmental educational organizations and beyond. It is fundamental that educational institutions who use FSDs in their curricula to conduct rigorous and systematic investigations on its impact and report their findings regardless of if they are supportive of FSDs use or not. The researchers in this commentary make themselves available to help and support such endeavour (MF, ASD, FCKD, IP, CAM, CN).

Next steps

It is time to shift the focus of SMT forces-time characteristics investigations. More high-quality research is urgently needed regarding whether the ability to modulate SMT force-time characteristics actually influences clinical effectiveness, increases patient comfort, and reduces adverse events. These would inform whether educational settings should continue to focus on modulating SMT force-time characteristics using FSDs. Thus, several questions remain:

- What are the SMT force-time characteristics currently used in the real-world clinical practice with real patients?
- Does the modulation of force-time characteristics enhance the clinical effectiveness?
- Does the modulation of force-time characteristics tailored to the patient attributes increase comfort or patient satisfaction with care?
- What are the patient attributes that dictate what SMT force-time characteristics should be used?
- Does using lower SMT forces prevent adverse events?
- How can cervical and lumbar SMT force-time characteristics be appropriately quantified and interpreted?

Conclusion

We have discussed the strengths of modulating SMT force-time characteristics using FSDs. The ability to modulate SMT force-time characteristics could potentially improve clinical outcomes by improving SMT effectiveness and comfort, and reducing adverse events. However, additional high-quality research is needed to confirm or refute this. While FSDs are being rapidly included in SMT curricula in chiropractic education, the uncertainties discussed should not be ignored. So far, research has yet to keep up with the educational implementation of FSDs.

We have identified several opportunities for future clinical and educational research using FSDs to increase the knowledge that will help advance the field and elucidate its impact.

List of abbreviations

SMT = Spinal manipulative therapy
FSD = Force sensing device
FSTT® = Force Sensing Table Technology

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Commentary

Chiropractic care and skin health: a partnership for early melanoma detection

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Chiropractic care and skin health: a partnership for early melanoma detection

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KEY WORDS: chiropractic, early detection, interdisciplinary collaboration, melanoma, skin cancer

Soins chiropratiques et santé de la peau: un partenariat pour la détection précoce du mélanome

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MOTS CLÉS : chiropratique, détection précoce, collaboration interdisciplinaire, mélanome, cancer de la peau

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Melanoma, a malignant form of skin cancer, contributed about 325,000 new cases and 57,000 deaths worldwide in 2020, with fair-skinned populations having the greatest incidence rates due to UV radiation exposure being a key risk factor.[1] While it accounts for only around 1% of all skin cancers, melanoma accounts for more than 75% of skin cancer-related deaths, with early detection offering a five-year survival rate of more than 99%.[2]

Chiropractors, as healthcare providers who have frequent physical contact with patients, are particularly positioned to help with the early detection of melanoma.[3] Their hands-on approach to patient care allows them to examine and evaluate severe skin conditions during routine examinations, perhaps discovering problematic lesions that might otherwise go undetected.[3] Canadians are often without family physicians, which further emphasizes the need for screening from other primary contact providers.[4] Additionally, due to increasing telehealth visits and limitations on evaluation of skin lesions,[5] this role is vital because early detection of melanoma results in a much better prognosis than later stages of the disease.[3]

Chiropractors frequently inspect and manipulate body parts usually hidden by clothing, such as the back, shoulders, and lower extremities.[6] Routine gowning of patients at initial and follow-up visits is critical for a comprehensive skin inspection, especially in areas frequently covered by clothing, such as the back and lower extremities. This method increases the possibility of discovering worrisome lesions early, while preserving professional standards and respecting patient boundaries through clear communication and consent protocols. These areas are typically neglected during self-examinations and may not be routinely checked by other healthcare providers, making chiropractors ideal allies in melanoma screening.[6] Furthermore, chiropractors frequently develop long-term connections with their patients, allowing them to track changes in skin appearance over time, which is critical for detecting emerging lesions.[6-9]

Despite their ability to help with early melanoma identification, many chiropractors may lack professional training in dermatological assessments.[3] Implementing targeted instructional programs on skin cancer identification could dramatically improve their ability to detect problematic lesions. Such training should focus on the ABCDE criteria (Asymmetry, Border irregularity, Colour variegation, Diameter >6mm, and Evolution) for melanoma detection and guidance on adequate documentation and referral processes.[6-9] Collaboration between chiropractors and dermatologists should help increase melanoma detection rates.[6] By creating clear referral procedures, chiropractors may ensure that patients with suspicious lesions receive a quick assessment by dermatological specialists.[7] In Canada, chiropractors are not permitted to refer patients directly to dermatologists. Instead, patients must first visit their primary care physician, who can examine the problem and provide a referral for dermatological examination if necessary.[4] This interdisciplinary approach helps with early diagnosis and encourages holistic patient care.[7]

Chiropractors can also educate patients on skin cancer prevention and the importance of regular self-examinations.[6] Chiropractors can assist in raising awareness and fostering proactive practices among their patients by incorporating brief discussions about sun protection and skin health into their patient visits.[6-9]

It is critical to highlight that while chiropractors can be valuable partners in melanoma identification, their involvement should be viewed as an addition to, not a substitute for, routine dermatological check-ups.[8] Patients, particularly those at increased risk of skin cancer, should be encouraged to schedule regular skin exams with dermatologists.[8,9] Implementing a structured plan for skin examination within chiropractic offices may improve the efficacy of this approach.[3] A strategy of this nature could involve a brief visual check of exposed skin during initial patient visits and frequent reassessments, with recommendations and referrals to dermatology on an as-needed basis.[3,6-9]

Given their unique position in patient care, chiropractors have the potential to play an essential role in the early diagnosis of melanoma.[6-9] Chiropractic professionals can help improve melanoma outcomes by utilizing their frequent patient interactions and enhancing their understanding of skin cancer recognition.[3] Future research should focus on developing tailored educational programs and fostering inter-professional collaboration to establish effective screening criteria for chiropractors, enhancing their role in this vital aspect of patient care.

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A descriptive review of common dermatological diseases encountered by manual therapy providers

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Manual therapy providers such as chiropractors and physical therapists may encounter various dermatologic diseases during visits with their patients, and it is important for these providers to have astute knowledge of both benign and malignant lesions. This collaborative guide reviews many of these lesions and includes descriptions, identifying features, and clinical significance such as when to refer to a specialist. Through early detection, identification, and proper referral, manual therapy providers can play a valuable role in minimizing the effects of sinister lesions. Preventative measures and risk factors for these skin lesions are also discussed. Providing primary prevention recommendations to patients can allow manual therapy

Un examen descriptif des maladies dermatologiques courantes rencontrées par les fournisseurs de thérapie manuelle.

Les fournisseurs de thérapie manuelle comme les chiropraticiens et les physiothérapeutes peuvent rencontrer diverses maladies dermatologiques au cours des rencontres avec leurs patients et il est important que ces fournisseurs aient une meilleure connaissance des lésions bénignes et malignes. Ce guide collaboratif passe en revue bon nombre de ces lésions et comprend des descriptions, des caractéristiques identifiables et l'importance clinique, comme le moment de recommander le patient à un spécialiste. Au moyen de la détection précoce, à l'identification et à un aiguillage approprié, les fournisseurs de thérapie manuelle peuvent jouer un rôle précieux dans la réduction au minimum des effets des lésions inquiétantes. On discute également des mesures préventives et des facteurs de risque pour ces lésions cutanées. Le fait de fournir des recommandations de prévention primaire aux patients peut permettre aux fournisseurs de thérapie manuelle de

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providers to play a vital role in public health awareness of skin disease.

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KEY WORDS: chiropractic, dermatological disease, dermatology, manual therapy provider, skin lesion

jouer un rôle essentiel dans la sensibilisation du public aux maladies de la peau.

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MOTS CLÉS : chiropratique, maladie dermatologique, dermatologie, fournisseur de thérapie manuelle, lésion cutanée

Introduction

The integumentary system, or skin, serves as the body's first line of defense against the external environment, protecting against pathogens and other harmful agents. Consequently, skin cells are exposed to a wide range of stressors, including ultraviolet (UV) light-induced radiation, pollution, and chemical irritants, all of which can cause localized cellular damage. To counteract this constant injury, skin cells undergo rapid proliferation to replace damaged or dead cells. However, cumulative exposure to environmental stressors can lead to genetic mutations, increasing the risk of benign and malignant skin growths.[1] Without early intervention, malignant skin growths can metastasize, often resulting in a poor prognosis with a five-year survival rate of less than 10%.[2] Early diagnosis significantly improves outcomes, and an interdisciplinary approach to evaluating suspicious skin lesions can be particularly beneficial.

Healthcare professionals, including chiropractors and physical therapists, are uniquely positioned to identify concerning skin lesions during consultations or interventional therapies. These practitioners often observe areas of the skin that patients may have difficulty examining themselves, such as the scalp or back. This article outlines common benign and malignant skin lesions, highlights when referrals are necessary and summarize preventive measures conservative care providers can offer to improve public health.

Overview of skin/general knowledge

The skin consists of three distinct layers each with its own physiological function. The layers include the subcutaneous layer (hypodermis) - the innermost layer, the dermis - the middle layer, and the epidermis -- the outermost layer.[3,4] The hypodermis, or subcutaneous layer, plays a limited role in lesion formation but is crucial for energy storage and anchoring the dermis to underlying bone and muscle. Above it lies the dermis, which houses vital structures such as blood vessels, sensory neurons, sweat glands, and connective tissue.[5] Superficial to the dermis is the epidermis, the skin's primary barrier to the external environment. The epidermis is a dynamic structure mediating signals between internal and external environments. Histologically, the epidermis comprises five distinct layers, each serving a specific function: the stratum basale, stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum. For simplicity, the epidermis is often categorized into two main layers: the outer cornified layer of dead skin cells and the inner layer of proliferating epithelial cells.[4,6] This proliferative matrix contains key cellular components, including melanocytes and keratinocytes, which are essential for skin protection. Melanocyte activity, stimulated by sunlight, produces melanin to shield against UV-induced DNA damage, while keratinocytes generate keratin to form a protective barrier and aid in wound healing.[7] Dysregulation of these cells can lead to various lesions, which are classified as either benign (non-cancerous) or malignant (cancerous).

Common benign lesions

Benign skin lesions often occur secondary to trauma (including prolonged UV exposure), aging, or genetic mutations.[8] While lesions of unknown origin can cause patient distress, accurate differentiation between benign and dys-

plastic growths by healthcare professionals is crucial in determining the need for intervention. The following are some common benign skin lesions and their contributing factors.

Cherry angioma

Cherry angiomas are benign lesions of vascular origin. While disease etiology is debated, the prevailing theory is lesion development as a result of age-related angiogenesis, and gene dysregulation (blood vessel formation).[9] Genetic analysis following lesion removal has identified dysregulation of three key genes—*GNAQ, GNA14*, and *GNA11*—suggesting these may be driver mutations.[10] The lesions predominantly develop in older individuals and are evenly distributed across race, sex, and ethnicity. They most commonly manifest on the trunk and upper extremities, though less frequently, they may appear on the hands, feet, or face.[11]

Given the association with aging, the development of new angiomas tends to increase over time. Lesions are characterized as macules, a flat lesion less than one cm in diameter (Figure 1A) or papules, an elevated lesion less than one cm in diameter (Figure 1B). Despite variations in appearance, cherry angiomas are benign and pose no health risks, and healthcare professionals should not be alarmed by their presence.

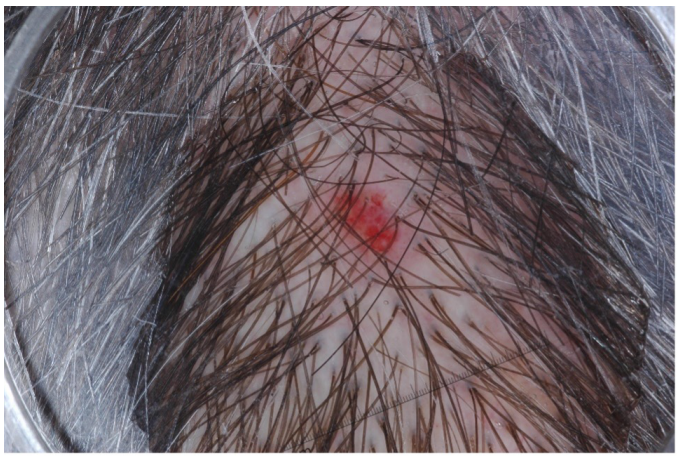

Figure 1A.
Cherry angioma macule on a patient's scalp. International Skin Imaging Collaboration: "ISIC_0013046" is licensed under CC-0; accessed September 23, 2024.

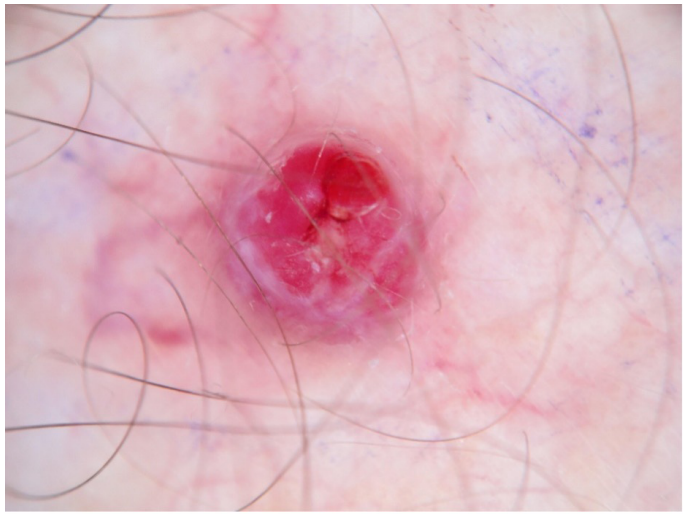

Figure 1B.
Papular cherry angioma with surrounding erythema. International Skin Imaging Collaboration: "ISIC_0022607" is licensed under CC-0; accessed September 23, 2024.

Keratosis

Skin keratoses, like cherry angiomas, also have a higher prevalence with age. Unlike angiomas, the term keratosis is a broad term, referring to a thick localized overgrowth of the skin. Keratoses can be further categorized as seborrheic or actinic, which have different manifestations, causes, and prognoses.

Seborrheic keratosis

Seborrheic keratosis (SK) is extremely common, affecting over 83 million Americans.[12] Disease etiology is contributing factors including genetics, age, and sun exposure.[13] Lesions are more common among individuals with lighter skin tones, and occurs at higher rates in men.[12]

Recognizing SK is sometimes difficult without prior knowledge, due to its highly variable presentation. Formation results from cell cycle dysregulation in keratinocytes, leading to immature epidermal cell proliferation. While SK lesions typically range from 0.5 to 1.5 cm in diameter, they can be significantly much smaller or larger.[13] Lesions are round to oval with well-defined borders and vary in color from light to dark brown. Most SKs present as raised papules or plaques (Figures 2A, 2B), though they may occasionally appear as flat, macular lesions.[12,13]

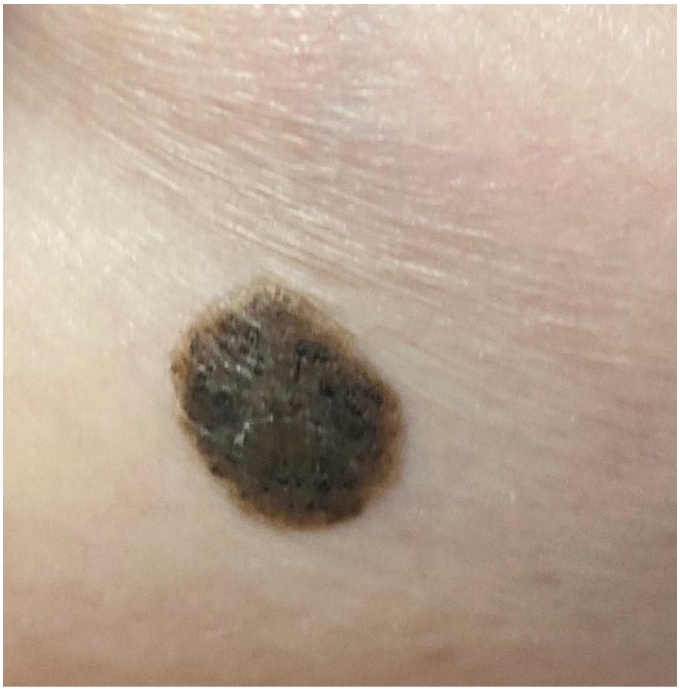

Figure 2A.
Hyperpigmented seborrheic keratosis. International Skin Imaging Collaboration: "ISIC_7546980" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

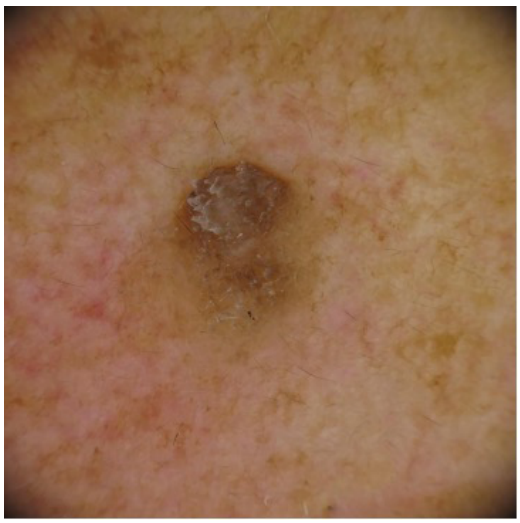

Figure 2B.
Tan solitary seborrheic keratosis. International Skin Imaging Collaboration: "ISIC_0067608" by Hospital Clinic de Barcelona is licensed under CC-BY-NC; accessed September 23, 2024.

Individuals may have anywhere from a single SK or several hundred. These benign lesions pose no health risk, and removal is generally pursued for cosmetic reasons rather than medical necessity. Therapists conducting physical exams may encounter suspected SKs and can perform a tactile assessment using gloves to confirm their presence. SKs are often characterized by a thick, gritty, or waxy texture, which complements their distinct visual appearance.[14] While no treatment is typically required for SKs, lesions that present with pain, color changes, or bleeding warrant referral to a dermatologist for further evaluation.

Actinic keratosis

Actinic keratoses (AK) are premalignant skin lesions that warrant timely dermatologic referral. They arise due to chronic UV exposure, which causes pyrimidine dimer formation and subsequent DNA damage within keratinocytes.[15,16] This leads to cumulative cell defects and dysregulated division. Left untreated, some AKs progress to malignant tumors, most often squamous cell carcinoma. Risk factors for AK development include advanced age, fair skin, and occupations with significant sun exposure. Individuals with lighter skin tones are particularly vulnerable, as lower melanin levels reduce the body's natural protection against UV radiation.[15,17] Clinically, AKs present as poorly defined lesions with a rough, sandpaper-like texture and scaling.[16] Unlike seborrheic keratoses, which have well-defined borders, AKs present with erythema, irritation, and irregular borders, commonly appearing on sun-exposed areas such as the scalp, face, neck, and forearms (Figure 3A). Lesions are often tender to palpation and typically non-pigmented, though pigmented variants can occur (Figure 3B).[16,18]

Due to their subtle presentation, AKs often go unnoticed by patients, who may attribute them to other causes. In therapy settings, the macroscopic presentation of AKs may be subtle, making visual diagnosis challenging. Palpation of the lesions, using appropriate personal protective equipment, can enhance suspicion, as their irregular borders and characteristic rough texture can aid in recognition.[16,19] Providers should maintain a high index of suspicion and refer patients with AKs, particularly if lesions present with pruritus, bleeding, pain, or persistent irritation, as timely intervention and early management can reduce the risk of malignant progression.[16]

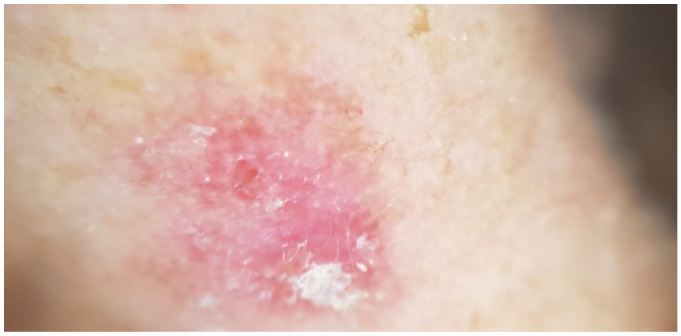

Figure 3A.
Actinic keratosis with central crusting and underlying erythema. International Skin Imaging Collaboration: "ISIC_9314666" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

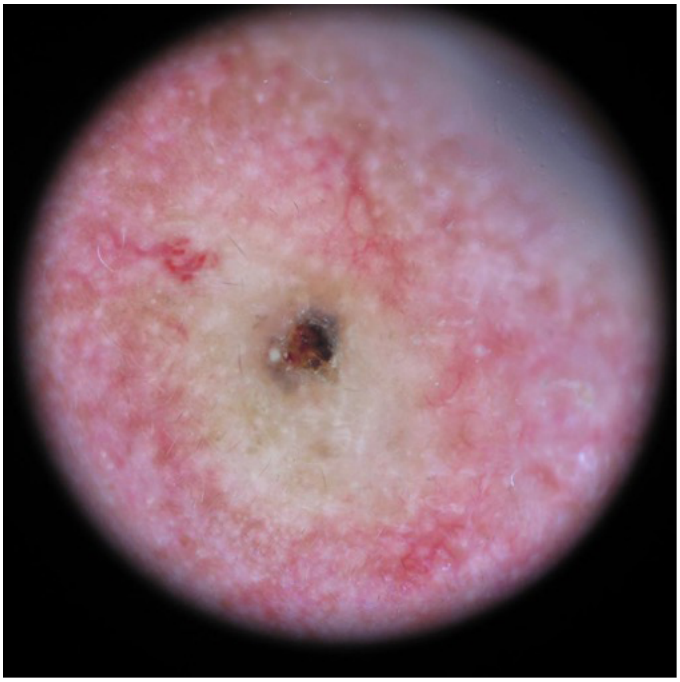

Figure 3B.
Actinic keratosis with central pigmentation. International Skin Imaging Collaboration: "ISIC_0067799" by Hospital Clinic de Barcelona is licensed under CC-BY-NC; accessed September 23, 2024.

Dermatofibroma

Dermatofibroma is a relatively common cutaneous lesion that is categorized as a benign neoplasm. The leading theory behind dermatofibroma development is that it represents a reaction to localized trauma, with lesions most commonly appearing on the extremities. Other theories suggest genetic influences with the lesions resulting from a loss of function mutation.[20] At-risk groups include young adults with studies showing over 80% of lesions occur in individuals between the ages of 20-49.[21] Lesion formation occurs independently of ethnicity or skin color, but appears to have a higher prevalence in females than males.[21]

Dermatofibromas differ from AKs and SKs as the cells proliferate in the dermis and/or subcutaneous tissue. Proliferation of cells deep to the epidermis causes dermatofibromas to have high levels of collagen following fibroblast activation.[22] This collagen can feel firm and reminiscent of scar tissue, often protruding out of the skin. In some cases, dermatofibromas can form nodules exceeding 1 cm in diameter.[23] Dermatofibromas are often limited in number, so suspected lesions will often be solitary, presenting as a hard, raised, skin lesion with a brown, pink, or tan color (Figures 4A, 4B).

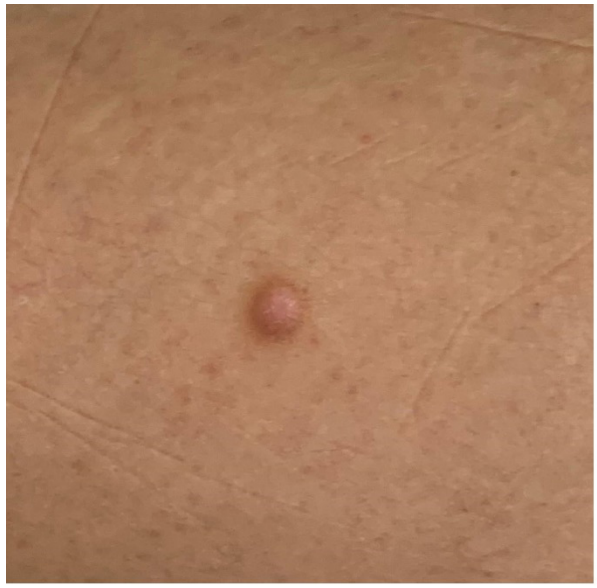

Figure 4A.
Well-circumscribed dermatofibroma of the lower extremity. International Skin Imaging Collaboration: "ISIC_4825485" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

Although most lesions are benign, rare cases of malignant transformation in dermatofibromas have been reported,[24] meaning referral to a dermatologist may be judicious. In

the chiropractic or physical therapy setting, if a lesion is noticed during examination and treatment, a dimple sign test can confirm its presence with up to 90% accuracy.[25] To perform simply squeeze the lesion on both sides and if depression occurs, this is indicative of a dermatofibroma (Figures 4C, 4D).

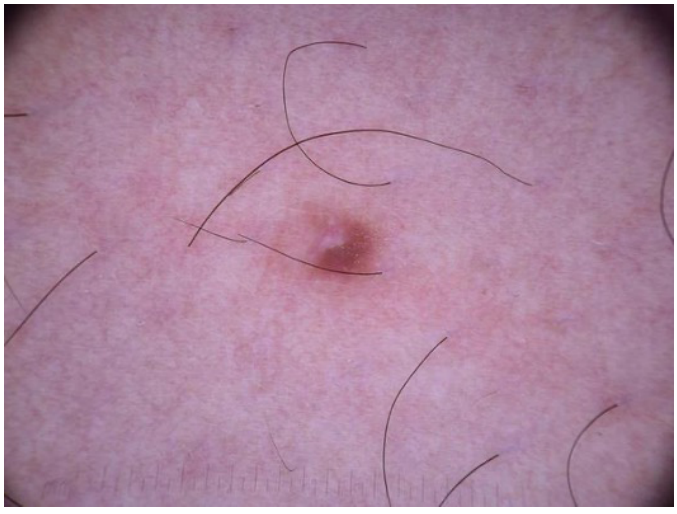

Figure 4B.
Dermatofibroma on the torso. International Skin Imaging Collaboration: "ISIC_0028735" by ViDIR Group, Department of Dermatology, Medical University of Vienna is licensed under CC-BY-NC; accessed September 23, 2024.

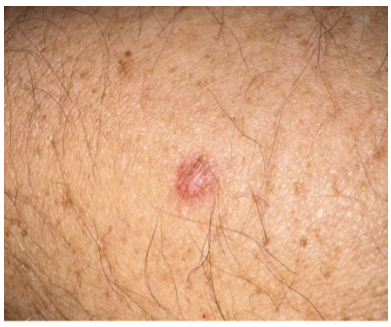

Figure 4C
Dermatofibroma before "squeeze test." Anonymous. Dermatofibroma before "squeeze test." January 9, 2025. Author's personal collection.

Melanocytic nevi

Melanocytic nevi are common, and often referred to as moles. Nevi are benign lesions, however, may evolve into melanoma. Nevi may be acquired or congenital. Congenital nevi are usually benign and they may be present in the subcutaneous tissue.[26] Acquired nevi can be described histologically by the depth of the cells with junctional nevi developing at the dermal-epidermal junction, and intradermal nevi confined to the dermis.[27] While nevi often occur without the development of melanoma, at-risk behaviors including blistering sunburn can increase presence of melanocytic nevi, and future risk of dysplasia.

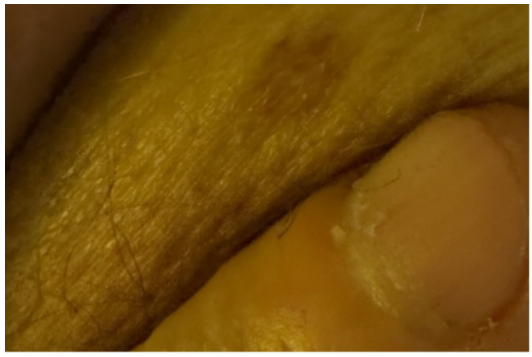

Figure 4D.
Dermatofibroma during "squeeze test" showing dimpling. Anonymous. Dermatofibroma during "squeeze test." January 9, 2025. Author's personal collection.

Melanocytic nevi, or pigmented nevi, can range in color from light brown to dark brown, black, or even flesh-toned. They are found across all skin tones; however, their abundance and risk of malignancy are higher in individuals with lighter skin tones (Figures 5A, 5B).[28] Nevi found on clinical exam with asymmetry, irregular borders, large size (greater than 6 mm in diameter), multiple colors, increasing size over time, pain, pruritus, or bleeding warrant urgent dermatology referral. The so-called ABCDE criteria are helpful to screen for melanoma: Asymmetry, irregular borders, a change in color, a diameter greater than 6 mm, or the patient indicates the lesion is evolving.

Malignant skin lesions

Malignant lesions are often characterized by their ability to locally invade adjacent cells and metastasize to other parts of the body. This may be characterized by rapid growth and skin ulceration. Timely intervention is important with malignant skin lesions as survival rates drastically decline after metastasis.

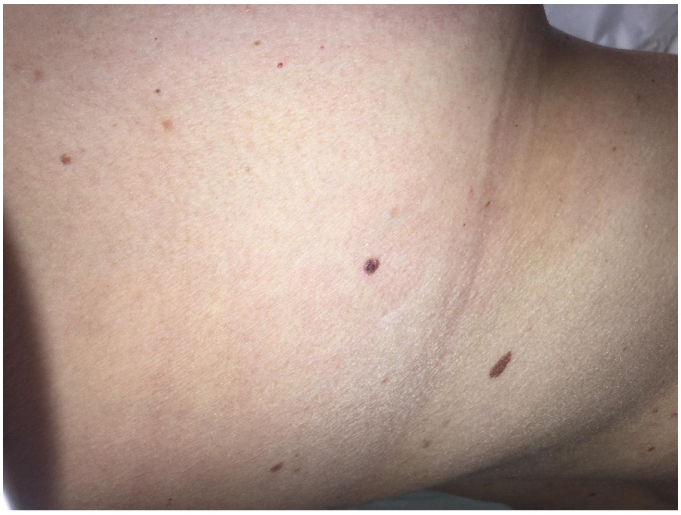

Figure 5A.
Multiple light and dark brown pigmented nevi on the torso. International Skin Imaging Collaboration: "ISIC_5257439" by Memorial Sloan Kettering Cancer Center is licensed under CC-BY; accessed January 28, 2025.

Figure 5B.
Melanocytic nevi b: flesh colored nevi on upper extremity. International Skin Imaging Collaboration: "ISIC_0022016" is licensed under CC-0; accessed January 30, 2025.

Melanoma

Melanoma is directly correlated to sun exposure.[29] While other metastatic lesions are linked to cumulative sun damage, melanoma is correlated to sunburn severity as one blistering sunburn can double a person's likelihood of developing melanoma later in life.[30] Pathogenesis involves UV-induced DNA damage and acquired mutations of the CDK, NRAS, and BRAF genes. Accumulation of mutations overwhelms the cell causing inability to remove UV-induced pyrimidine dimers.[30,31] Clinically, melanomas may be classified as superficial spreading melanoma, nodular melanoma, lentigo malanga melanoma, and acral lentiginous melanoma.[29-31]

Superficial spreading melanoma

Superficial spreading melanomas (SSM) account for the majority of all melanoma diagnoses. Lesions often occur in sun-exposed areas including the face, neck, back, and extremities.[32] SSM lesions often display varied pigmentation, asymmetric borders, and loss of demarcation from surrounding tissues appearing as a "blotchy" red, white, or blue lesion (Figures 6A, 6B).[33] Lesions can be flat patches or raised plaques. They characteristically undergo an initial radial growth phase, and then with time invade surrounding tissue and produce a series of hyper or hypopigmented distally spreading lines (vertical growth phase) (Figure 6C). SSM diagnosis is often delayed when melanomas present in difficult-to-visualize areas (commonly on the legs of females and backs of males).[34] Prognosis can be improved with early detection and referral for biopsy.

Nodular melanoma

Nodular melanoma (NM) like superficial spreading melanoma, presents most commonly in lighter skin tones with no predilection for race or ethnicity. Unlike SSM, nodular melanoma exhibits a weaker correlation to sun exposure and a higher metastasis rate. This subtype is defined by an early vertical growth phase, with metastasis risk escalating as the lesion penetrates deeper into the dermis.[35] NM is less likely to develop from pre-existing nevi, with patients frequently reporting the appearance of a new lesion.[36] NM may exhibit growth patterns that deviate from the traditional ABCDE warning signs, potentially delaying diagnosis and treatment.[37] Compared to SSM, NM typically has a worse prognosis due to its more rapid proliferation.[37] Nodular melanoma should be considered in rapidly growing pigmented lesions (Figures 7A, 7B). Any bleeding, erythema, pruritus, or pain may also indicate the need for immediate skin biopsy.

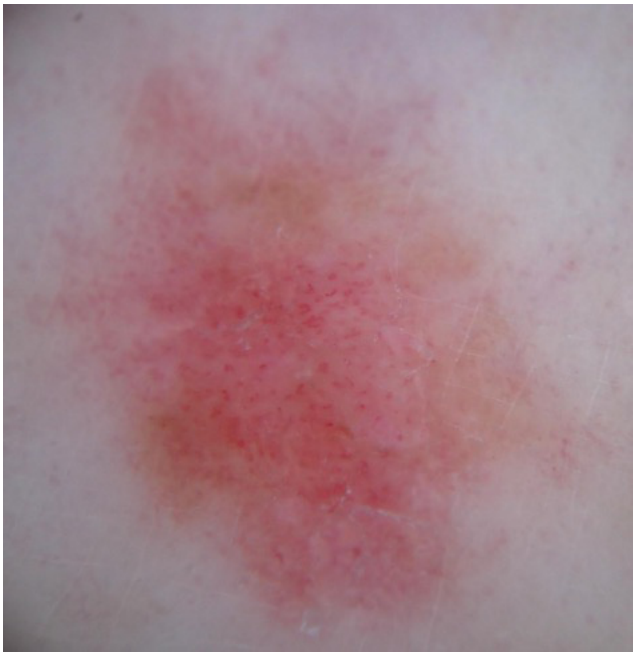

Figure 6A.
Superficial spreading melanoma with red pigmentation. International Skin Imaging Collaboration: "ISIC_0022180" is licensed under CC-0; accessed September 23, 2024.

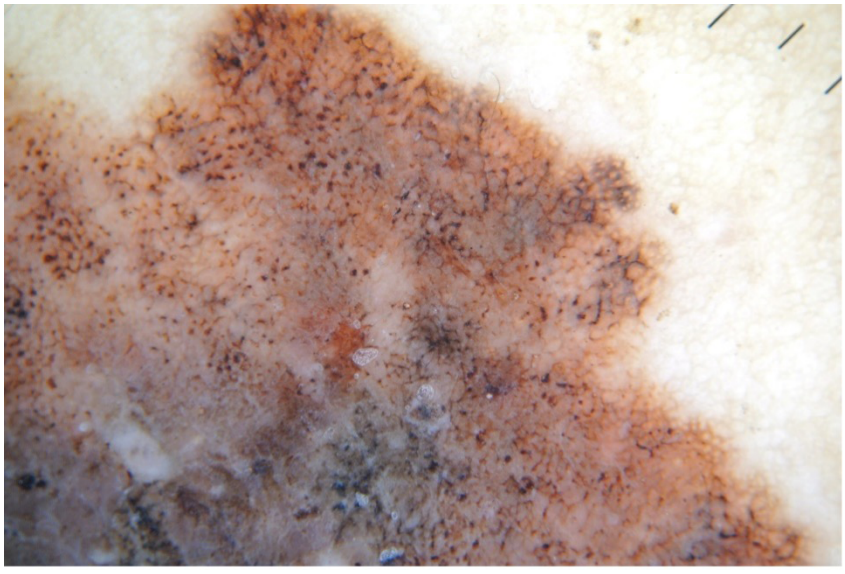

Figure 6B.
An alternating white and blue hue on a superficial spreading melanoma. International Skin Imaging Collaboration: "ISIC_0023270" is licensed under CC-0; accessed September 23, 2024.

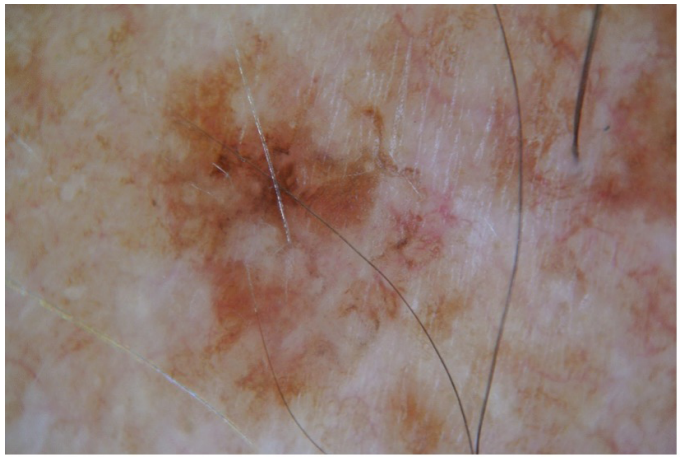

Figure 6C.
Superficial spreading melanoma demonstrating hypo and hyperpigmentation. International Skin Imaging Collaboration: "ISIC_0023376" is licensed under CC-0; accessed September 23, 2024.

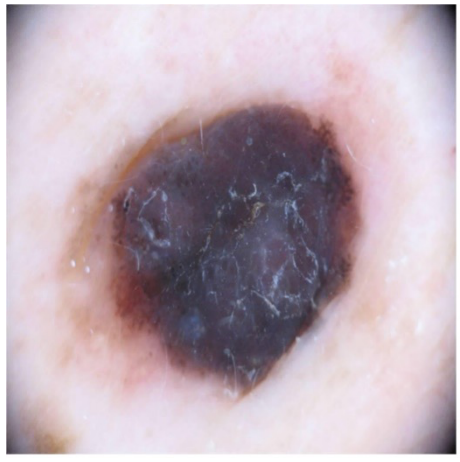

Figure 7A.
Violaceous nodular melanoma. International Skin Imaging Collaboration: "ISIC_0046450" is licensed under CC-BY; accessed September 23, 2024.

Lentigo maligna melanoma

Development of Lentigo Maligna Melanoma (LMM) is characterized by dysplastic infiltration of the epidermal basement membrane arising from preexisting lentigines—commonly referred to as age spots. Lenti-

gines are benign, hyperpigmented lesions that develop due to chronic sun exposure over time (Figure 8A). Formation of LMM is linked to melanocytic dysregulation and is more strongly associated with cumulative sun exposure rather than the intensity of individual exposures.[38,39] Clinical diagnosis can be challenging as LMM frequently appears on the face and its slow, stagnant growth can mimic the appearance of a freckle. Diagnosis should be considered in fair-skinned individuals, with the appearance of a "Hutchinson's freckle;" a light brown superimposed freckle that ranges from a macule (a flat lesion less than 1 cm in diameter) to patch appearance (a flat lesion greater than 1 cm in diameter) (Figure 8B).[40] If a patient presents with these findings, questions about lesion origin, presence, and any signs of evolution may help to differentiate between a benign nevus and a malignant neoplasm.

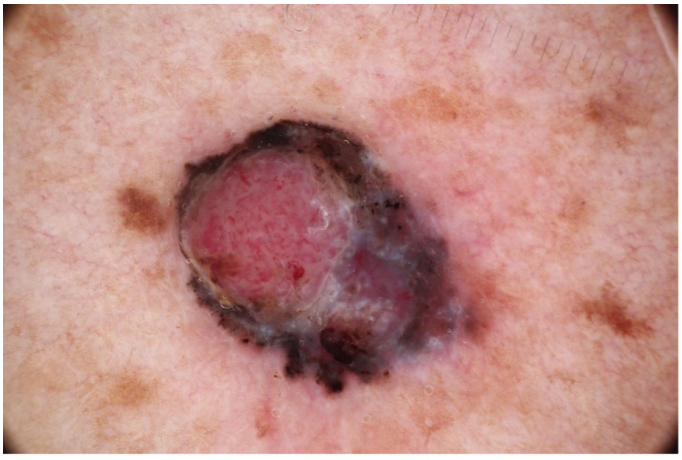

Figure 7B.
Nodular melanoma. International Skin Imaging Collaboration: "ISIC_0046671" is licensed under CC-BY; accessed September 23, 2024.

Acral lentiginous melanoma

Cutaneous manifestations of acral lentiginous melanoma (ALM) are isolated to soles, hands, digits, nailbeds, and other hairless regions of skin.[41-42] ALM shows a marked propensity for darker skin tones, with approximately 78% of cases occurring in individuals of African descent.[42-43] However, it can also present in lighter skin tones. The prognosis for ALM is often poorer, likely due to its tendency to develop in atypical or hard-to-visualize locations. Lesions are associated with trauma and may appear as dark smooth papules presenting against a gray or black macular background of uneven pigmentation (Figures 9A, 9B). ALM should be suspected in pigmented lesions on the palms and soles that meet ABCDE criteria.

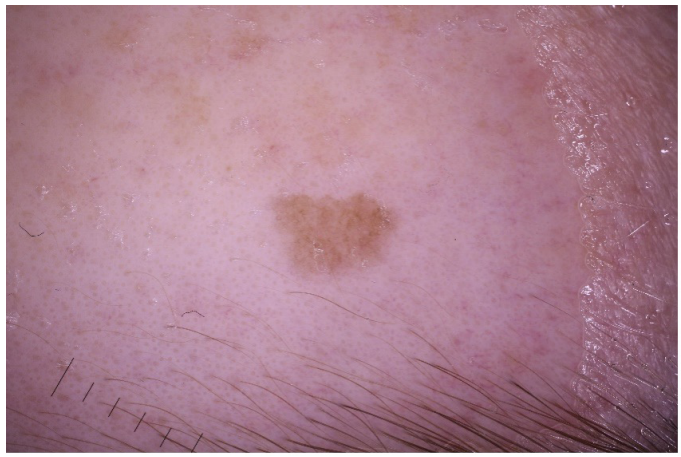

Figure 8A.
Solar lentigo/age spot benign lesion on face. International Skin Imaging Collaboration: "ISIC_9152603" by Memorial Sloan Kettering Cancer Center is licensed under CC-BY; accessed January 28, 2025.

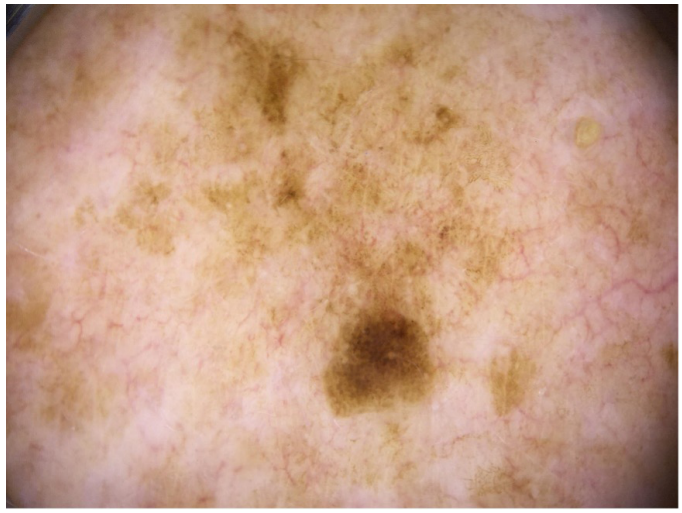

Figure 8B.
Lentigo malinga melanoma. International Skin Imaging Collaboration: "ISIC_5367118" by Memorial Sloan Kettering Cancer Center is licensed under CC-BY; accessed September 23, 2024.

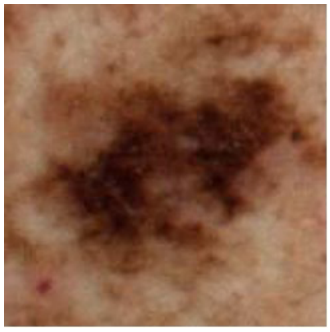

Figure 9A.
Acral lentigo melanoma. International Skin Imaging Collaboration: "ISIC_3951022" by Dermatology Department of Hospital Clinic de Barcelona is licensed under CC-BY-NC; accessed September 23, 2024.

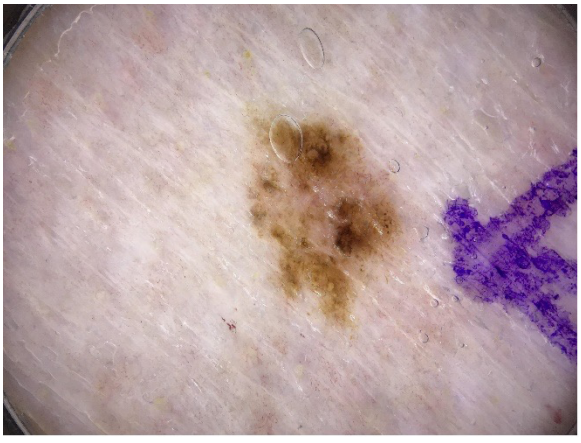

Figure 9B.
Acral lentigo melanoma under dermatoscope. International Skin Imaging Collaboration: "ISIC_8436194" by Memorial Sloan Kettering Cancer Center is licensed under CC-BY; accessed September 23, 2024.

Squamous cell carcinoma

Squamous cell carcinoma (SCC) may occur from pre-cancerous cells known as actinic keratosis and may also arise de novo. Pathogenesis is related to the accumulation of UV-induced DNA damage. SCC shares a similar disease burden with actinic keratoses, occurring more frequently in males, with risk increasing with age and in individuals with Fitzpatrick skin types I–III, characterized by lighter skin that burns easily and tans poorly.[44] Progression from an AK to an SCC is gradual, with an annual risk increase of approximately 0.5% following initial onset.[45]

Lesions appear on areas of high sun exposure including the face, back, neck, and extremities. They are often rough, thick keratotic plaques that may be skin-colored or exhibit localized erythema.[44] Over time, these lesions can evolve from small papules to larger plaques. SCC in situ typically presents as well-demarcated lesions with subtle erythema (Figure 10A).[46] Invasive SCC tends to have increasing erythema, discoloration, ulceration, and skin induration (Figures 10B, 10C). Invasive SCC has the potential for metastasis and referral for excision for SCC is prudent.

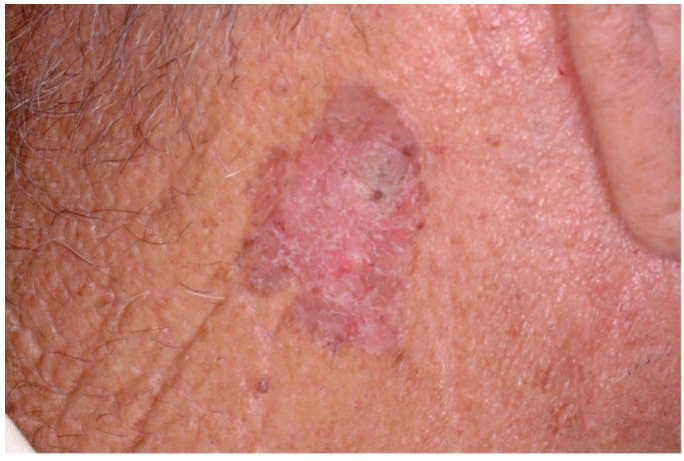

Figure 10A.
Squamous cell carcinoma in situ. International Skin Imaging Collaboration: "ISIC_0024231" is licensed under CC-0; accessed September 23, 2024.

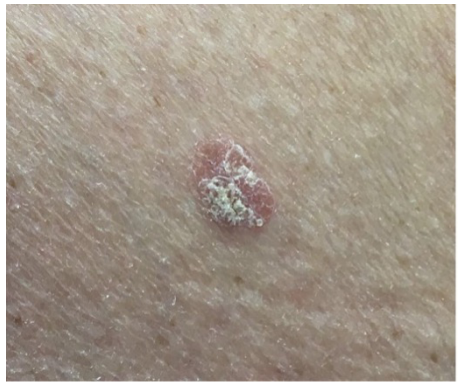

Figure 10B.
Crusting of a squamous cell carcinoma. International Skin Imaging Collaboration: "ISIC_3804099" by Hospital Italiano de Buenos Aires is licensed under CC-By; accessed September 23, 2024.

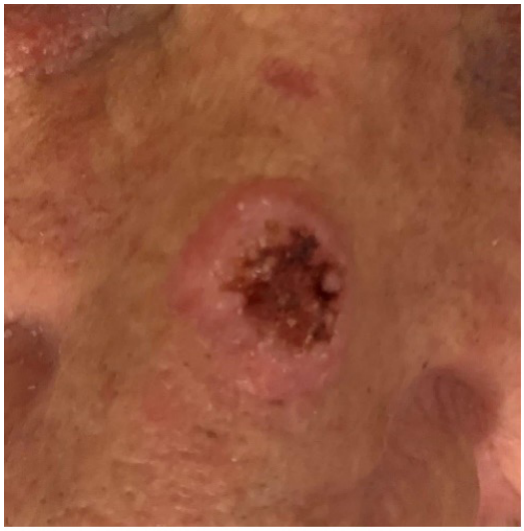

Figure 10C.
Squamous cell carcinoma with ulceration. Internation Skin Imaging Collaboration: "ISIC_0580759" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

Basal cell carcinoma

Basal cell carcinoma (BCC) differs from SCC as the formation of BCC is very rarely linked to AK formation. Cutaneous presentation most commonly is independent of other skin manifestations. The diseases are similar in carcinogenic triggers, with BCC arising primarily from cumulative UV exposure, leading to damage in epidermal keratinocytes. Exact pathogenesis of BCC is the result of DNA-induced loss of function mutation to the PTCH1 gene.[47,48] Constitutive activation of the hedgehog pathway, the pathway which PTCH regulates, occurs shortly after initial mutation-inducing cell dysplasia.

Risk factors for developing basal cell carcinomas include age, sex, and history of UV exposure. BCC favors males over the age of 50. Patients with lighter skin tones are more predisposed to BCC due to lower melanin levels, increasing susceptibility to UV-induced damage.[49] Careful examination of sun-exposed areas is necessary with lesions most commonly occurring on the hands, legs, back, and face.[48,50] Most commonly, BCC appears as flesh-toned to pink, with a shiny or pearly hue, and may present as plaques, nodules, or papules (Figures 11A, 11B, 11C). Additional features include telangiectasias and localized skin induration (Figure 11D).

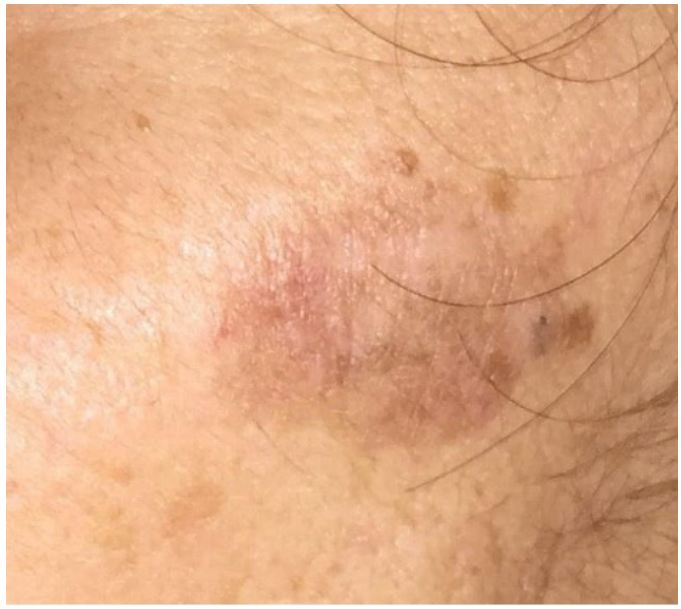

Figure 11A.
Superficial basal cell carcinoma. International Skin Imaging Collaboration: "ISIC_5401158" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

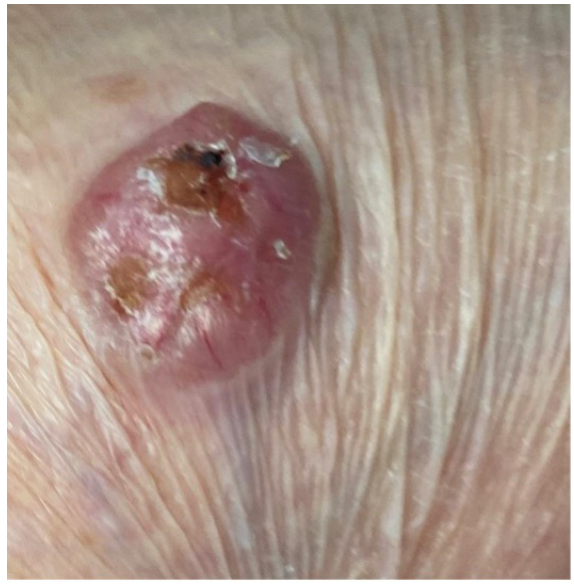

Figure 11B.
Nodular basal cell carcinoma. International Skin Imaging Collaboration: "ISIC_8044078" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

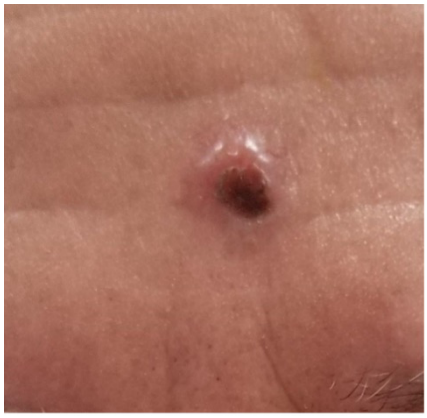

Figure 11C.
Basal cell carcinoma appearing as a papule. International Skin Imaging Collaboration: "ISIC_9107240" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

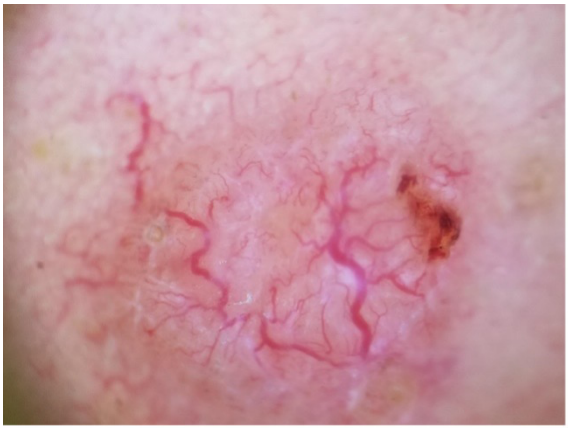

Figure 11D.
Basal cell carcinoma showing telangiectasia on dermatoscope. International Skin Imaging Collaboration: "ISIC_2113665" by Hospital Italiano de Buenos Aires is licensed under CC-BY; accessed September 23, 2024.

BCC is a disease of clinical importance with most recent studies indicating over 200 cases develop per 100,000 individuals.[50] The risk of metastasis is rare, with the high estimates indicating only a 0.55% chance of occurrence.[50] Suspected BCC should be biopsied and excised if positive. Removal of BCC is often curative but should not be delayed, as likelihood of metastasis, local invasion, and adverse outcomes increase with time.[50]

Recommended preventative measures

In addition to recognizing and identifying skin lesions and making prompt appropriate referrals, manual therapy providers have an opportunity to promote the health of the population. They can do this through counseling on good preventive practices in hopes of decreasing risk factors for acquiring preventable dermatological disease. In the United States, 95% of melanoma cases can be attributed to preventable risk factors, most notably ultraviolet radiation exposure.[55] Healthcare providers can help modify these risks through patient education of topical and physical protection against UV radiation. Effective topical protection includes use of sunscreen with SPF of 30 or higher with reapplication every two hours. Physical protection includes use of sun-protective clothing, hats with a full, wide brim, long sleeves and pants, full coverage sunglasses, and finding shade whenever possible while outside, especially between the hours of 11:00 am and 3:00 pm.[56]

Summary

Skin lesions are undoubtedly complex with presentation, and progression is often case-dependent. Disease onset and outcomes are further worsened by initial delay of diagnosis. Manual therapy providers such as physical therapists, chiropractors, and massage therapists are frequently in physical and visual contact with patients' skin. These regions could include areas not frequently visualized by patients such as posterior of neck, ears, soles of feet, or back. Instilling universal knowledge of the characteristics for normal and abnormal lesions such as color, borders, and texture can enable a multi-disciplinary approach to skin cancer screening and prevention methods. Future implementation of this interdisciplinary approach to include chiropractors and physical therapists should lead to timely referrals for diagnosis, more effective treatment outcomes, and increased prevention measures.

Abbreviations

AK – Actinic Keratosis
ALM – Acral Lentiginous Melanoma
BCC – Basal Cell Carcinoma
cm – Centimeter
LMM – Lentigo Maligna Melanoma
mm – Millimeter
NM – Nodular Melanoma

PPE – Personal Protective Equipment
SCC – Squamous Cell Carcinoma
SK – Seborrheic Keratosis
SPF – Sun Protective Factor
SSM – Superficial Spreading Melanoma
UV – Ultraviolet

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Spinal manipulation for fibromyalgia: a narrative review

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Objective: *The purpose of this review was to summarize the available literature on the use of spinal manipulative therapy for the management of fibromyalgia.*

Methods: *A narrative review of the literature was performed through February 29, 2024, using keywords and Boolean operators, such as "manipulation AND fibromyalgia." Databases searched include MEDLINE, ICL, PEDro, the Cochrane Library, Google Scholar, as well as clinical trials registries. Online literature mapping was also used to identify relevant studies. All publications involving spinal manipulation for fibromyalgia management were included, excluding editorials, commentaries, conference proceedings, and trade magazine articles.*

Manipulation vertébrale dans le cadre de la fibromyalgie: un examen narratif

Objectifs: *Le but de cet examen consistait à résumer la littérature disponible sur l'utilisation de la thérapie par manipulation vertébrale dans le cadre de la gestion de la fibromyalgie.*

Méthodes: *On a réalisé un examen narratif de la littérature jusqu'au 29 février 2024, au moyen de motsclés et d'opérateurs booléens, comme « manipulation ET fibromyalgie ». Les bases de données consultées comprennent MEDLINE, ICL, PEDro, la Bibliothèque Cochrane, Google Scholar, ainsi que les registres d'essais cliniques. On a également utilisé la cartographie de la littérature en ligne pour cerner des études pertinentes. Toutes les publications concernant la manipulation vertébrale dans le cadre de la gestion de la fibromyalgie ont été incluses, à l'exception des éditoriaux, des commentaires, des actes de conférence et des articles de magazines spécialisés.*

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Disclaimer - The information presented in this publication does not necessarily represent or reflect the positions, strategies, or opinions of the U.S. Government or the Department of Veterans Affairs.
Ethics Statement - Ethical approval was not required for this narrative review as it involved the synthesis of existing data from previously conducted studies. Therefore, there was no involvement with research participants at any stage of this project.

Results: *A total of 38 publications met the inclusion criteria. These results consisted of nine case reports, three case series, four pilot studies, four randomized controlled trials, 14 systematic reviews, and four clinical practice guidelines with publication dates ranging from 1997 to 2023.*

Conclusion: *Higher-quality controlled studies are limited and report mixed results for treating fibromyalgia with spinal manipulation, while lower-quality studies are more likely to report benefit following treatment. Systematic reviews report a lack of established efficacy or inconclusive evidence, while clinical practice guidelines vary widely from strong recommendations against its use to suggesting that it be considered as a component of multi-modal treatment.*

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KEY WORDS: fibromyalgia; chronic pain; manipulation, spinal; manipulation, chiropractic; narrative review

Résultats: *Au total 38 publications ont répondu aux critères d'inclusion. Ces résultats consistaient en neuf rapports de cas, trois séries de cas, quatre études pilotes, quatre essais contrôlés randomisés, 14 examens systématiques et quatre lignes directrices cliniques, ayant des dates de publication allant de 1997 à 2023.*

Conclusion: *Les études contrôlées de meilleure qualité sont limitées et présentent des résultats mitigés pour le traitement de la fibromyalgie par manipulation vertébrale, tandis que les études de moindre qualité sont plus susceptibles de signaler un bénéfice après le traitement. Les examens systématiques présentent une absence d'efficacité établie ou des données probantes non concluantes, tandis que les lignes directrices de pratique clinique varient considérablement, allant de recommandations robustes par rapport à son utilisation à la suggestion qu'elle soit considérée comme étant un élément d'un traitement multimodal.*

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MOTS CLÉS : fibromyalgie, douleur chronique, manipulation, vertébrale, manipulation, chiropratique, examen narratif

Introduction

Fibromyalgia is a complex condition characterized by chronic widespread pain that is now considered a disorder of altered pain processing.[1,2] Fibromyalgia also involves a variety of other features, such as fatigue, memory problems, and sleep disturbance, which can negatively impact an individual's daily activities and quality of life.[1,3,4] The prevalence of fibromyalgia is estimated to be between 5-8% of the adult population and it is more common among females.[5–7] The development of fibromyalgia is multifactorial and associated with a variety of risk factors, such as anxiety, depression, physical or emotional traumas, or poorer overall health.[8]

In 1990 the American College of Rheumatology (ACR) developed the first widely accepted diagnostic criteria for fibromyalgia.[9] The ACR's initial criteria were limited to musculoskeletal features and focused on the number of tender points in various body regions. The diagnostic criteria have since changed and were updated in 2011 and 2016;[10,11] these updated criteria moved away from numbering tender points and included features related to chronic fatigue, disturbed sleep, and cognitive dysfunction (i.e. "fibro fog"). The ACR's 2016 criteria are the current diagnostic standard for fibromyalgia and are outlined in Table 1. The 2016 criteria also highlight how "a diagnosis of fibromyalgia does not exclude the presence of other clinically important illnesses,"[11] emphasizing how fibromyalgia may occur in the presence of other comorbidities. Additionally, since the diagnosis of fibromyalgia does not involve objective findings on standard radiography or laboratory testing, this condition poses a diagnostic challenge that is believed to contribute to fibromyalgia being underdiagnosed, misdiagnosed, or diagnosed following a substantial delay.[12–14]

Table 1.
Current Diagnostic Criteria for Fibromyalgia[11]

1. Generalized pain in at least 4 of 5 body regions
2. Symptoms present at a similar level for at least 3 months.
3. A.) Widespread Pain Index score ≥ 7 and a Symptom Severity Scale score ≥ 5 or B) Widespread Pain Index score 4-6 and a Symptom Severity Scale score ≥ 9

The complex nature of fibromyalgia, coupled with evolving diagnostic criteria, has complicated the diagnosis and subsequent management of this condition.[12,13] Various factors have been reported to complicate the treatment of fibromyalgia, including difficulties regarding patient education as well as limited knowledge regarding evidence-based treatment options.[13,15,16] Numerous agencies have emphasized the foundational importance of multimodal non-pharmacologic interventions for fibromyalgia management, such as patient education, regular physical activity, and a focus on self-care strategies.[17–19] These recommendations also advocate for the integration of psychological treatments when patients exhibit maladaptive pain beliefs (i.e. fear-avoidance) or have comorbid mood disorders. Simultaneously, they recommend limiting pharmacologic interventions to those with severe pain or sleep disturbances. While non-pharmacologic management strategies form the foundation of fibromyalgia treatment, specific treatment guidance remains limited, particularly concerning the appropriate use of manual therapies for this condition.[20–23]

The use of complementary and integrative health (CIH) treatments are more common among individuals with musculoskeletal pain and CIH utilization is common and reported to be increased among patients with fibromyalgia.[22,24] The use of "chiropractic treatments" are reported by approximately 40% of individuals with fibromyalgia.[22,25,26] Reasoning for patients seeking such treatment for fibromyalgia management may include limited response to other treatments, availability of care, limited side effects, patients' preference, and promotion of non-pharmacological treatments by treatment guidelines.[17,27–29] While chiropractic is a healthcare profession that is not limited to the delivery of spinal manipulation, this treatment does play a central role in the profession's identity and is by far the most common service provided during clinical encounters.[30,31] Despite the frequent use of chiropractic by individuals with fibromyalgia, uncertainty exists regarding the effectiveness of spinal manipulation for fibromyalgia management. Therefore, the objective of this narrative review was to identify and summarize the available literature regarding the use of spinal manipulative therapy for the treatment of fibromyalgia.

Methods

A literature search was performed up to the date of February 29, 2024, using Boolean operators and relevant search terms, such as "manip* AND fibromyalgia," "spinal manip* AND "fibromyalgia," "chiropr* AND fibromyalgia;" our database search strategy is outlined in Appendix 1. Our search involved the following databases: National Library of Medicine (MEDLINE via PubMed), Index to Chiropractic Literature (ICL), Physiotherapy Evidence Database (PEDro), Cochrane Library, ClinicalTrials.gov, International Clinical Trials Registry Platform, and Google Scholar from the time of their inception to the search date. We searched the grey literature and manually searched the reference lists of included studies to identify relevant publications that may not have been captured by our search strategy. We also used literature network mapping websites to identify relevant studies via network diagrams; the two sites used for literature mapping were Connected Papers and Research Rabbit.

Full-text versions of the articles were obtained online or via inter-library loans, with the assistance of two technical librarians, employed at a chiropractic college, and the relevant data was extracted by both authors of this study. Data extraction included the year of publication, title, authors, study design, interventions provided, number of study participants, demographic characteristics, as well as the study's results or conclusions.

Inclusion criteria

We included peer-reviewed publications involving spinal manipulation for the management of fibromyalgia. We accepted publications using any form of thrust-based spinal manipulation technique (i.e. high-velocity, low-amplitude; HVLA),[32]passive manual therapeutic maneuver during which a synovial joint is beyond the normal physiological range of movement (in the direction of the restriction applied to any spinal or pelvic region that was deliv-

ered by any qualified healthcare professional. We included publications describing the use of spinal manipulation as an isolated treatment or as a component of multimodal therapy, whereas spinal manipulation was delivered along with other forms of treatment. We also included results published in any language, as long as an English version could be obtained.

Exclusion criteria

We excluded studies that did not involve spinal manipulation for fibromyalgia management. Therefore, studies involving various forms of manual therapy (e.g., massage, myofascial release, craniosacral therapy) or rehabilitation activities (e.g., exercise, strength training) were excluded, if not performed in combination with spinal manipulation. Publications reporting on outcomes unrelated to standard fibromyalgia features (e.g., psychological sense of coherence) were excluded. We also excluded results in the form of editorials, commentaries, conference proceedings, articles published in trade magazines, or clinical trial registrations (Appendix 2).

Results

A total of 38 publications met our inclusion criteria. Results consisted of publications between the years of 1997 and 2023 and involved a total of nine case reports, three case series, four pilot studies, four randomized controlled trials, 14 systematic reviews, and four clinical practice guidelines.

Case reports

A total of nine case reports were published from 2011-2022 (Table 2).[33–41] Each of these nine case reports described the management of females with fibromyalgia, ranging in age from 31-64. Five of these case reports (56%) describe SMT provided in combination with additional forms of treatment (e.g., traction, massage, ergonomic advice),[34,38–41] while the other four (44%) provided SMT in isolation and each of these four reports limited SMT to the cervical spine.[33,35–37] How treatment plans were reported across all nine case studies was highly variable and not always completely reported, which made it difficult to report aggregate data regarding treatment frequency and total visit numbers, but a conservative average of the available studies is approximately 50 total visits over an average duration of 32 weeks. Notably, not all case reports provided SMT at every visit; the same four case reports that limited SMT to the cervical spine described multiple visits where patients were evaluated, but SMT was determined to be unnecessary. These nine case reports universally described highly favourable outcomes for patients with fibromyalgia, reporting improvements in pain and/or physical function. Six of these nine cases (67%) described improved physical function (e.g. walking, running, swimming, or daily activities),[33–35,37,40,41] while three of the nine cases (33%) objectively measured physical functioning via the SF-36 and Rand-36 questionnaires[36,38,39].

Case series

A total of three case series were published from 2000-2001 (Table 3).[42–44] These three case series describe the management of 40 total individuals with fibromyalgia with ages ranging from 11-76. The majority of the patients described in these case series were female (88%, 35/40) with only one case series including males.[42] Two of these case series provided SMT in combination with additional treatments,[43,44] while one provided SMT as an isolated treatment.[42] These case series described a total number of visits that ranged from 18-48 over a treatment duration of four weeks to seven months. Each of these three case series described highly favourable outcomes for most patients with fibromyalgia, primarily reporting improved pain, improved function (e.g. resuming daily activities), and reduced fatigue.

Pilot studies

A total of four pilot studies were published from 1997-2018 (Table 4).[45–48] These four pilot studies involved a total of 101 study participants with fibromyalgia. Demographics related to age and sex were not consistently reported across these four studies, preventing our ability to report aggregate data, but the majority of study participants were middle-aged females.

The first pilot study was published in 1997 and was a crossover, randomized controlled trial (RCT), whereas the control group became a second treatment group after a four-week wait period.[45] This study involved 21 total participants between the ages of 25-70 and provided SMT in combination with stretching, massage, and patient education at a frequency of three to five treatments per week for a four-week duration. This pilot reported general improvements in pain and spinal ranges of motion, while

Table 2.
Summary of case reports

Authors	Year	Patient	Intervention	Treatment Visits	Outcomes
Alibhoy N.[33]	2011	45-year-old female	SMT limited to the cervical spine	A total of 79 visits over a 17-month duration (no frequency reported). SMT was provided on 47 of the 79 visits (60% of all visits).	Resolution of back pain, headaches, sciatica, and knee pain as well as improved tolerance for walking, standing, swimming, and daily functioning (Positive Results)
Briggs L.[34]	2011	36-year-old female	SMT, instrument-assisted spinal manipulation, spinal traction, trigger point compression, ice, heat, and high-voltage electrical stimulation	Initial treatment involved 36 visits over a 12-week duration with treatment frequencies of 2-5 visits per week. After this initial series, a long-term treatment plan was provided for the next 14 years with frequencies of up to 3 treatments per week, which "decreased as the patient felt better" (no total treatment number reported).	Improved pain from a 10/10 to a 2/10, improved gait, and normalization cervical and lumbar ranges of motion at the end of the first 12-week treatment. After 14 years of treatment, her pain was improved to a 1/10 and her migraine frequency was reduced (Positive Results)
Bennett C, *et al*.[35]	2012	64-year-old female	SMT limited to the cervical spine	A total of 35 visits over a 3-month duration with a visit frequency of 3 times per week for the first month followed by 2 times per week for the next 2 months. SMT was provided at 4 of the 35 visits (11% of all visits).	Improved neck and mid-back pain, improved tolerance for standing and walking, as well as improved strength energy levels that were describes as "80% relief of symptoms" (Positive Results)
Soriano W, *et al*.[36]	2014	31-year-old female	SMT limited to the cervical spine	Approximately 40 total visits over an 8-month duration. Visit frequency was twice per week for the first month followed by once per week for the next 7 months (no details provided after this period). SMT was provided 5 times over a duration of 1.5 years with ongoing visits since this time.	Improved back pain, radicular pain, knee pain, foot pain, and headaches described as "an 80% relief." She returned to her running activities and various quality-of-life measures were also improved, via SF-36 questionnaires (Positive Results)
Tedder N, *et al*.[37]	2015	32-year-old female	SMT limited to the cervical spine	A total of 41 visits over a 6-month duration. SMT was provided on 8 of the 41 visits (20% of all visits), but no treatment frequency was reported.	Complete resolution of fibromyalgia symptoms and improved physical activity/ exercise (Positive Results)
Fedorchuk C, *et al*.[38]	2017	40-year-old female	SMT limited to the cervical spine, traction, and postural exercises	A total of 44 treatments over a 5-month duration (no treatment frequency reported).	Improved pain, headaches, fatigue, and increased physical functioning via SF-36 questionnaire (Positive Results)
Chance M.[39]	2018	61-year-old female	SMT limited to the cervical spine, cranial manipulation, and nutritional supplements	A total of 21 treatments over a 6-month duration with a frequency of 3 times per week for the first week, once per week for the next 6 weeks, followed by twice per month for the next 4 months.	Improved pain, fatigue, sleep, quality of life, general health, and physical functioning via Rand-36 questionnaire (Positive Results)
Dunton TA, *et al*.[40]	2020	48-year-old female	SMT or instrument-assisted spinal manipulation	Approximately 52 total visits over a 6-month duration. Visit frequency was 3 times per week for 12 weeks, twice per week for the next 8 weeks, followed by once per week for 8 weeks with ongoing weekly visits since this time.	Improved fibromyalgia symptoms, improved neck ranges of motion, and improved quality of life with an overall description of "over 75% relief in symptoms" (Positive Results)
Chu EC, *et al*.[41]	2022	44-year-old female	SMT, massage, cervical traction, ultrasound, ergonomic advice, and home exercises	Approximately 107 total treatments over a 26-month duration. Initial treatment frequency of 3 times per week for 3 months, then twice per week for the next 6 months, and finally once per month for the next 17 months.	Improved pain from a 6/10 to a 2/10 rating, improved sleep quality, improved mood, and her fatigue was "mostly resolved" (Positive Results)

Legend: SMT; spinal manipulative therapy

Table 3.
Summary of case series

Authors	Year	Patients	Intervention	Treatment Visits	Outcome
Amalu WC.[42]	2000	23 total patients, consisting of 18 females and 5 males. Ages ranged from 11-76 (mean age of 35)	SMT limited to the cervical spine	A mean treatment total 31 visits (range of 20-48 treatments). The mean treatment duration was 3.5 months (range of 3-7 months). Treatment was initiated at a frequency of 3 times per week for 4-8 weeks, followed by extended follow-ups.	Improvement reported for 92-100% of all fibromyalgia and chronic fatigue symptoms along with returning to normal activities, maintained for at least 1.5 years (Positive Results)
Hains G, *et al*.[43]	2000	15 total patients. All 15 were females (mean age of 51)	SMT combined with ischemic compression	All patients received a total of 30 treatments at a frequency of 2 or 3 per week over a duration of 10-15 weeks.	Nine of the 15 patients (60%) were classified as "respondents" with reports of improved pain, sleep, and fatigue levels (Positive Results)
Wise P, *et al*.[44]	2001	2 total cases were reported, consisting of a 40-year-old female and a 58-year-old female	SMT combined with paraspinal massage, lifestyle advice, and ergonomic advice	A total of 18 visits over a 10-week duration with a visit frequency of 3 times per week for the first 2 weeks, 2 times per week for 4 weeks, followed by once per week for the last 4 weeks.	Favourable results were described for pain and fatigue. The authors recommended "optimal improvement" after 12 treatments over a 5-week duration, while minimal benefit occurred beyond this period (Positive Results)

Legend: SMT; spinal manipulative therapy

recommending an adequately powered follow-up RCT of 81 study participants.

The second pilot study was published in 2002 and involved a total of 24 participants between the ages of 30-65, all of which were female.[46] This study involved three treatment groups as well as a control group; all treatment groups received standard medical care while group 1 received SMT, group 2 received SMT along with education on self-trigger point therapy, and group 3 received moist heat treatments. Each group received one treatment per week over a duration of 23-weeks. This pilot reported the most favourable improvements in pain and function (e.g. daily activities) for those in the two groups involving SMT, but failed to report power calculations for a follow-up RCT.

The third pilot study was published in 2009 and involved 27 total participants, all of which were females between the ages of 21-59.[47] All participants were involved in a resistance training program, while 44% (12/27) were assigned to the treatment group. Treatment consisted of SMT and soft-tissue ischemic compression at a frequency of twice per week for a duration of 16 weeks. The remaining 66% (15/27) of all study participants functioned as the control group. This study failed to show any difference between the treatment and the control groups regarding fibromyalgia pain or function. Uniquely, this study was not labeled as a pilot study and no power calculations were reported. This study's small sample size and lack of sample size calculations lead the authors of this narrative review to classify this study as a pilot.

The fourth pilot study was published in 2018 and involved a total of 29 participants, most of which were female (93%, 27/29) with a mean age of 51.[48] This study involved two treatment groups along with a control group and provided treatment once per week for a six-week duration. This pilot reported more favourable improvement in pain and global impression of health when SMT was combined with gabapentin medication, while recommending an adequately powered follow-up RCT involving between 63 and 126 study participants.

Randomized controlled trials

A total of four randomized controlled trials (RCTs) were published from 2014-2023 (Table 5).[49–52] These four RCTs involved 370 total study participants and 69% (255/370) of all participants were females.

The first RCT was published in 2014 and involved a total of 89 participants, 54% (48/89) of which were female, with a mean age of 54.[49] This study involved a treatment group that received thoracic SMT, soft-tissue treatment, and lumbosacral mobilizations at a frequency of once per week for five weeks, while the control group

Table 4.
Summary of pilot studies

Authors	Year	Participants	Intervention	Treatment Visits	Control	Conclusion
Blunt KL, *et al*.[45]	1997	21 study participants. Sex: no breakdown reported Age: range 25-70 (mean of 49)	SMT, massage, stretching, and education on fibromyalgia, sleep, body mechanics	3-5 treatments per week for a 4-week duration (range of 11-15 total treatments)	Wait list for 4-weeks, which when crossed over to receive the same treatment as group 1	A follow-up RCT with 81 participants was calculated for adequate power. This study describes improved pain and range of motion of the cervical and lumbar regions for those receiving treatment (Positive Results)
Gamber RG[46]	2002	24 study participants. Sex: all females Age: range of 30-65 (no mean reported)	Group 1: SMT and standard medical care Group 2: SMT, education on trigger point therapy, and standard medical care Group 3: Moist heat and standard medical care	1 treatment per week for a 23-week duration (23 total treatments) Groups using SMT were allowed to also add myofascial release, stretching, and craniosacral therapy at the treating clinician's discretion	Standard medical care (any medications currently taking)	No calculations for an adequately powered follow-up study were reported. This study described improved pain and function when SMT is combined with standard medical care, compared to standard medical care alone. (Positive Results)
Panton LB, *et al*.[47]	2009	27 study participants (all female, mean age of 48)	SMT, ischemic compression to the neck and back, and resistance training	2 treatments per week for 16-week duration (32 total treatments)	Resistance training alone	No calculations for an adequately powered follow-up study were reported. Adding chiropractic to resistance training had no impact on pain perception or fibromyalgia impact. (Negative Results)
Marske C[48]	2018	29 study participants. Sex: 27 females, 2 males Age: mean of 51 (no range reported)	Group 1: SMT alone Group 2: SMT and gabapentin	1 treatment per week for a 6-week duration (6 total treatments)	Medication only (gabapentin)	A follow-up RCT with 63-126 participants was calculated for adequate power. Improvements in pain and overall health favors SMT groups with the greatest improvement with SMT combined with gabapentin (Positive Results)

Legend: SMT; spinal manipulative therapy, RCT; randomized controlled trial

received no treatment. This study reported improved pain and sleep as well as reduced fibromyalgia impact, favoring the treatment group.

The second RCT was published in 2015 and involved 120 participants, 57% (68/120) of which were male, with an age range of 45-65.[50] This study involved two groups. Both groups received patient education, exercise, and cognitive behavioral therapy (CBT), but the treatment group also received 20 cervical spine treatments consisting of SMT, mobilizations, massage, and traction over a 12-week duration. No differences were observed between groups at the 12-week follow-up, but improvements in fibromyalgia impact were observed at the one-year period, favoring the treatment group.

The third RCT was published in 2021 and involved 101 participants, 94% (95/101) of which were female, with a mean age of 51.[51] This study involved two groups. The treatment group received full-spine SMT along with spinal mobilization, traction, and stretching at a frequency of once per week for six weeks, while the control group received sham manipulation. No between group differences were reported regarding pain, fatigue, physical function, or quality of life.

The fourth RCT was published in 2023 and involved

60 participants, all of which were female, with a mean age of 42.[52] This study involved two treatment groups and one control group. All three groups received standard medication management, but the first treatment group also received full-spine SMT, while the second treatment group received sham SMT. Both treatment groups (SMT or sham SMT) were treated twice per week for a three-week duration. The primary outcome for this study was pain rating and between-group comparisons, which showed no difference between any of the groups at one-month follow-up, but the SMT group showed improvement over the sham SMT group and the control group at three-month follow-up period.

Systematic reviews

A total of 14 systematic reviews were published from 2002-2017 (Table 6).[53–60] These systematic reviews cited a variety of literature sources, including other systematic reviews, pilot studies, case series, a study protocol, multiple conference proceedings, surveys, an editorial, and a trade magazine article. Additionally, trials describing the treatment of fibromyalgia with massage or craniosacral therapy were occasionally cited as and categorized as evidence for "chiropractic" treatment. Pilot studies were the most common citation type cited by these 14 systematic reviews and, uniquely, none of the four RTCs captured by this narrative review (Table 5) were directly cited by any of the systematic reviews.

The conclusions resulting from these systematic reviews were widely variable. Two of the systematic reviews (2/14, 14%) reported positive results and suggested "limited evidence supports spinal manipulation"[57] or that "studies suggest that there is some evidence that chiropractic manipulation may benefit persons with FM" (i.e. fibromyalgia)[59]. Five of the systematic reviews (5/14, 36%)[53,54,60–62] reported inconclusive results and mentioned how the available evidence is generally of low methodological quality and "uninterpretable in terms of therapeutic efficacy,"[54] that there is "inconclusive evidence in an unclear direction,"[60,61] or that "no firm con-

Table 5.
Summary of randomized controlled trials

Authors	Year	Participants	Intervention	Treatment Visits	Control	Results
Castro-Sánchez AM, *et al*.[49]	2014	89 study participants (48 female, 41 male), mean age of 54)	SMT limited to the thoracic spine, soft-tissue release, and lumbosacral mobilizations	1 treatment per week for a 5-week duration (5 total treatments)	No treatment	Manual therapy was effective for improving pain intensity, widespread pressure pain sensitivity, impact of fibromyalgia symptoms, sleep quality, and depressive symptoms (Positive Results)
Moustafa, IM, *et al*.[50]	2015	120 study participants (68 male, 52 female), ages 45-65	SMT limited to the cervical spine, cervical mobilizations, cervical massage, cervical mobilizations, education, exercise, and CBT	3 treatments per week for a 4-week duration, followed by 1 treatment per week for 8 weeks (20 total treatments in 12 weeks)	Education, exercise, and CBT	No differences between groups were observed on the Fibromyalgia Impact Questionnaire at 12-weeks, but significant differences favoring the SMT group at 1-year (Mixed Results)
Coste J, *et al*.[51]	2021	101 study participants (95 female, 6 male), mean age of 51	SMT, spinal mobilizations, traction, and stretching of hips and piriformis regions	1 treatment per week for a 6-week duration (6 total treatments)	Sham treatments mimicking the treatment group, but all were "stopped halfway" with no thrusting	No difference between the sham and the experimental groups for pain, fatigue, functioning, and quality of life (Negative Results)
Ince B, *et al*.[52]	2023	60 study participants (all female), mean age of 42	Group 1: SMT along with medication Group 2: Sham SMT intended to resemble SMT, but "using a smaller force than usual" along with medication	2 treatments per week for 3-week duration (6 total treatments)	Medication alone	No between-group differences were reported at the 1-month follow-up, but the SMT group showed improved in pain ratings 3-month follow-up when compared to the sham SMT and control groups (Mixed Results)

Legend: SMT; spinal manipulative therapy, CBT; cognitive behavioral therapy

clusions were drawn for efficacy" for managing fibromyalgia with SMT[62]. Seven of the systematic reviews (7/14, 50%)[55,56,58,63–66] reported negative results and made statements such as how chiropractic is "not currently recommended,"[55] that "there was no evidence to indicate that chiropractic may be effectively used to treat the symptoms of FM (i.e. fibromyalgia),"[65] that the available studies "fail to demonstrate that spinal manipulation is an effective intervention" for fibromyalgia,[64] that "there is "no overall effect,"[63] or that there is "no reliable positive evidence"[66] favoring spinal manipulation for fibromyalgia management.

Clinical practice guidelines

A total of four clinical practice guidelines were published between 2004 and 2020 (Table 7).[17,29,67,68] These guidelines cited various sources, including systematic reviews, pilot studies, a conference proceeding, a trade magazine article, and a massage therapy trial. The most common citation type was pilot studies, followed by systematic reviews, and none of the RTCs captured by this narrative review were directly cited by any guidelines.

The recommendations reported in these clinical practice guidelines were extremely variable. Two of the guidelines (2/4, 50%) reported positive recommendations,[29,67] while the remaining two guidelines reported negative recommendations.[17,68] Of the two guidelines reporting positive recommendations, they reported "weak evidence for efficacy"[67] or suggested that SMT is generally "recommended" for consideration into a broader multidisciplinary approach to treating fibromyalgia.[29] The two guidelines reporting negative recommendations were more direct and described how chiropractic is "not recommended" and "should not be implemented"[68] due to a lack of established effectiveness as well as concerns about safety, leading to a "strong against" rating.[17]

Discussion

This narrative review summarizes the available literature regarding the use of spinal manipulative therapy (SMT) for fibromyalgia. We identified a total of 38 publications, which largely consist of retrospective observational reports (e.g., case reviews or case series) or summary articles like systematic reviews or clinical practice guidelines. Very few well-designed controlled trials exist on this topic and such studies are foundational to establishing treatment efficacy. Those that do exist are difficult to compare due to variations in study methodologies, such as simultaneously combining SMT with various forms of additional treatment or having considerable differences in treatment frequency and duration.

Quality controlled trials investigating the use of SMT for fibromyalgia management describe highly variable results, ranging from positive,[49] negative,[51] or mixed outcomes depending on follow-up timeframe[50,52]. These variable results are contrasted against the almost uniformly favourable outcomes reported in case reports and case series and may also contribute to the variations seen in the plethora of systematic reviews that have been published on this topic. Systematic reviews also tended to rely heavily on data from pilot studies or other lower quality sources of information (Table 5). It is possible that the low number of high-quality RCTs on this topic, combined with frequent citations to lower levels of evidence among systematic reviews, has resulted in the heterogeneous recommendations reported across current clinical practice guidelines. These variable recommendations are illustrated in Figure 1 and stand to create confusion among clinicians interested in the best available evidence regarding SMT for fibromyalgia management. Figure 1 also highlights the need for more quality experimental trials on this topic. The authors of this narrative review also encourage future studies that compare standard fibromyalgia care to standard care, combined with SMT, to evaluate whether SMT is an effective form of complementary treatment. Studies comparing standard care to SMT, in isolation, may also be used to evaluate whether SMT is an effective form of alternative treatment for fibromyalgia management. We would also like to encourage reporting data regarding adverse events associated with such treatments and using patient-centred outcome measures reflective of a modern understanding of the features associated with fibromyalgia, such as the Widespread Pain Index (WPI) or Symptom Severity Scale (SSS) outcome measures. Without such studies, our understanding of whether SMT is a safe and effective treatment approach for fibromyalgia will continue to be incomplete.

Females represent most of the individuals involved in the existing literature on SMT for fibromyalgia management. This narrative review shows that about 90% of the patients described in the available case reports and case studies were female (Tables 1 and 2) and the majority

Table 6.
Summary of systematic reviews

Authors	Year	Cited Articles Involving SMT	Conclusion
Sim J, *et al*.[53]	2002	1 citation, which was a pilot study[45]	The evidence is insufficient for meaningful conclusions. (Inconclusive Results)
Ernst E.[54]	2003	1 total citation, which was a pilot study[45]	The available evidence was noted to have methodological weaknesses that make this pilot study uninterpretable in terms of therapeutic efficacy. (Inconclusive Results)
Holdcraft L, *et al*.[55]	2003	4 total publications were cited; including 1 pilot study[45], 2 surveys,* and 1 editorial*	The evidence is insufficient to support therapeutic benefit of chiropractic treatment for fibromyalgia management and this treatment is not currently recommended for treating fibromyalgia. (Negative Results)
Ernst E.[56]	2009	4 total publications were cited, including: 2 pilot studies,[45,47] 1 study protocol,* and 1 trade magazine article*	There is no evidence to suggest that chiropractic is effective for treating fibromyalgia. (Negative Results)
Schneider MJ, *et al*.[57]	2009	9 total publications were cited, including: 2 pilot studies,[45,46] 2 case series,[43,44] 4 conference proceedings,* and 1 trade magazine article*	Limited evidence supports spinal manipulation for fibromyalgia. The article describes emerging literature on a variety of CAM therapies for the conservative management of fibromyalgia, including spinal manipulation, while noting the lack of experimental studies on the topic. (Positive Results)
Baranowsky J, *et al*.[58]	2009	2 total publications were cited and both were pilot studies[45,46]	Chiropractic did not show superiority to the control group and noted the lack of experimental evidence to support the use of chiropractic care for fibromyalgia. (Negative Results)
Porter NS, *et al*.[59]	2010	2 total publications were cited, including: 1 pilot study[45] and one non-manipulation study investigating supplements*	There is some evidence that spinal manipulation may provide benefit for fibromyalgia, but the literature consists of a small number of studies of generally low methodological quality highlight the need for further investigation. (Positive Results)
Bronfort G, *et al*.[60]	2010	6 total publications were cited, including: 3 systematic reviews,[56,57,67] pilot studies,[45–47] 1 conference proceeding,* and 1 trade magazine article*	The evidence regarding the effectiveness of spinal manipulation for the treatment of fibromyalgia is inconclusive and does not provide clear direction. (Inconclusive Results)
Terhorst L, *et al*.[63]	2011	3 total publications were cited and all 3 were pilot studies[45–47]	Manipulative treatments of fibromyalgia showed no overall effect. The authors also emphasized how the literature consists of a small number of studies, each with very small sample sizes. (Negative Results)
Posadzki P, *et al*.[64]	2011	2 total publications were cited and both were systematic reviews[56,57]	The available studies fail to demonstrate that spinal manipulation is an effective intervention for fibromyalgia. (Negative Results)
Terry R, *et al*.[65]	2012	1 systematic review[56] was cited	There is no evidence to indicate that chiropractic may effectively treat fibromyalgia while stating how little evidence supports adopting chiropractic treatments for fibromyalgia treatment. (Negative Results)
Clar C, *et al*.[61]2010	2014	5 total publications were cited, including: 3 systematic reviews[58,59,63], 1 cranio-sacral study,* and 1 study involving only soft-tissue therapy*	There is inconclusive, but potentially favourable, evidence for the use of chiropractic spinal manipulation for fibromyalgia management. (Inconclusive Results)
Lauche R, *et al*.[66]	2015	4 total publications were cited and all 4 were systematic reviews[55–57,63]	There is no reliable or positive evidence for chiropractic interventions for fibromyalgia management. (Negative Results)
Perry R, *et al*.[62]	2017	7 total publications were cited, including: 2 systematic reviews,[56,58] 3 pilot studies,[45–47] 1 conference proceeding,* and 1 trade magazine*	No firm conclusions were drawn regarding the efficacy of spinal manipulation for fibromyalgia management. (Inconclusive Results)

*Not cited due to not meeting inclusion criteria for this narrative review
Legend: CAM; complementary and alternative medical therapies, SMT; spinal manipulative therapy

Table 7.
Summary of guidelines

Authors	Year	Cited Publications	Recommendation
Goldenberg DL, *et al*.[67]	2004	2 total publications were cited; 1 pilot study[45] and 1 massage study*	There is weak evidence for efficacy of spinal manipulation for managing fibromyalgia (Positive Recommendation)
Winkelmann A, *et al*.[68]	2012	4 total publication were cited; 2 pilot studies,[45,47] 1 conference proceeding,* and 1article from a trade magazine*	Chiropractic is not recommended for fibromyalgia and this recommendation had a strong consensus. This article also stated that chiropractic should not be implemented for fibromyalgia management. (Negative Recommendation)
Macfarlane GJ, *et al*.[17]	2017	1 systematic review was cited,[56]	Chiropractic received a *strong against* recommendation due to a lack of established effectiveness as well as safety concerns (Negative Recommendation)
Hawk C, *et al*.[29]	2020	1 systematic review was cited[61]2010	Spinal manipulation is recommended for consideration as part of a multidisciplinary approach to fibromyalgia, which incorporates active, passive, and mind-body interventions. (Positive Recommendation)

*Not cited due to not meeting inclusion criteria for this narrative review

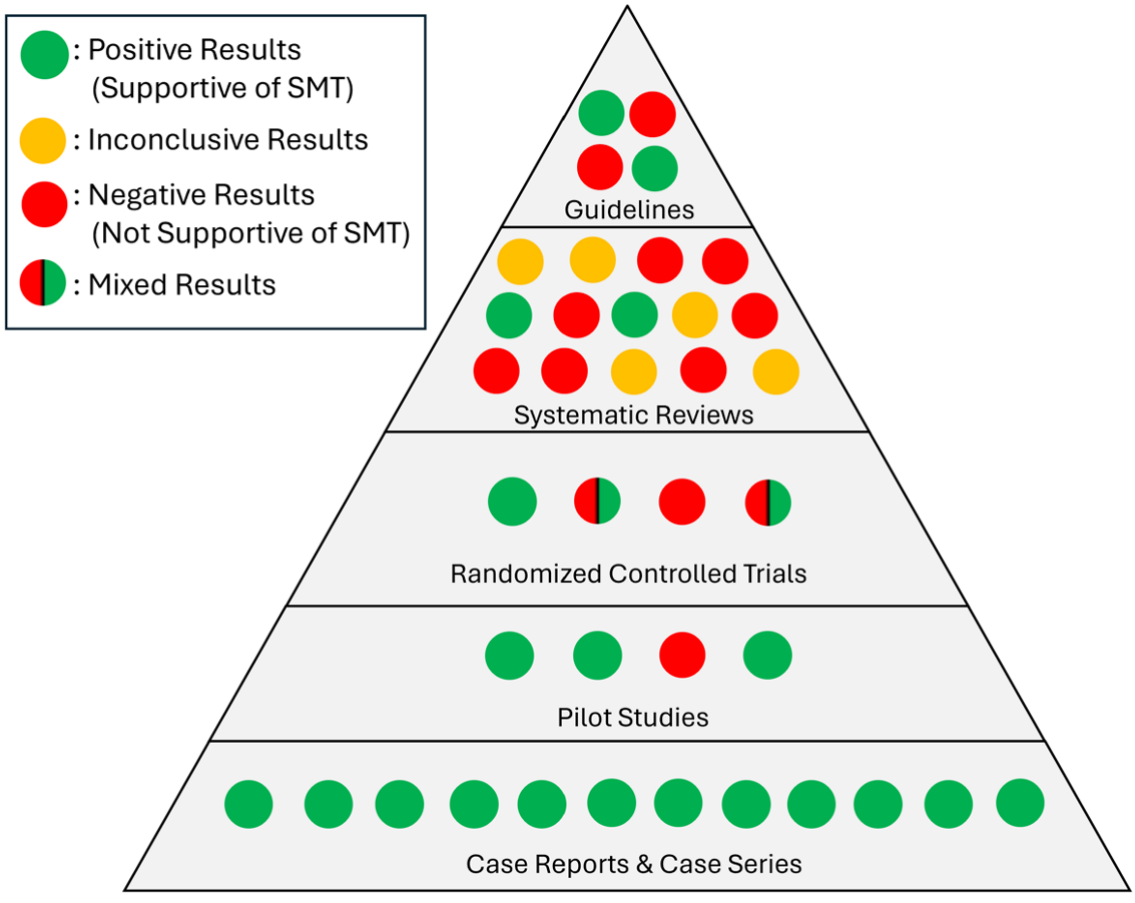

Figure 1.
Hierarchy of evidence regarding spinal manipulation for fibromyalgia

of study participants included in clinical trials were also female (Tables 3 and 4). While fibromyalgia has been described as being more prevalent among females,[69] descriptions of females having lower pressure pain thresholds, higher rates of chronic fatigue, more frequent headaches, and higher rates of irritable bowel syndrome are likely to have biased fibromyalgia diagnoses toward females[49,70]. The authors of this review encourage future research on this topic to deliberately include males and non-binary individuals, in an attempt to further explore this topic.

As mentioned in the Introduction of this narrative review, the diagnostic criteria of fibromyalgia has undergone an evolution since ACR's initial criteria in 1990, which was limited to musculoskeletal complaints, to the most recent 2016 revisions which better reflect the current understanding of fibromyalgia. What was originally believed to be a peripheral soft-tissue condition is now understood to primarily be a disorder of central pain processing. Manual therapies applied to peripheral tissues, such as manipulative techniques, have been shown to have favourable effects on patient's pain experience,[71,72] but much remains to be known about the "black box" of mechanistic reasoning connecting an intervention with clinically relevant outcomes[73]. Manual therapies have been described to impact centrally-mediated neurophysiologic pain processing,[74–76] and training clinicians from this perspective has been proposed,[77] but future research is needed to further explore whether these mechanisms have a clinically meaningful impact among individuals with fibromyalgia. Future research could also investigate whether adding spinal manipulation to evidence-based behavioural health treatments, such as cognitive behavioural therapy for chronic pain (CBT-CP) or mindfulness-based stress reduction (MBSR), impacts treatment outcomes for fibromyalgia management. Investigating patients' motives for seeking chiropractic care for fibromyalgia management and/or their treatment goals from such care may also be valuable research contributions, as these appear to be lacking in the available literature.

Limitations

There are inherent limitations to this review. The nature of narrative reviews is less structured than other study designs, which may limit the reproducibility of our search results. Searching the grey literature and manually searching reference lists may introduce selection bias and it is also possible that our search strategy failed to discover relevant studies. Service fees associated with accessing the Allied and Complementary Medicine Database (AMED) and Cumulative Index for Nursing and Allied Health Literature (CINAHL) databases prevented our ability to include these into the search strategy, but including these databases may have discovered additional results. Lastly, grading publication quality was not a component of this review, so it is not possible to objectively compare the quality of the included results.

Conclusion

The existing body of literature on the efficacy of spinal manipulative therapy (SMT) for fibromyalgia management reveals a scarcity of high-quality controlled studies. Lower-quality reports suggest positive effects, while controlled trials report mixed results. Systematic reviews consistently highlight a lack of established efficacy or inconclusive evidence. Clinical practice guidelines exhibit significant variability, ranging from strong recommendations against the use of SMT to recommendations advocating its consideration as part of a multi-modal treatment approach.

Authors' roles

CBR conceptualized this project and developed the methods. CBR and SRH were both involved with the literature search, analyzing search results, and drafting of this manuscript.

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Appendix 1.
Electronic search strategy

Date	February 29, 2024
Databases	• National Library of Medicine (MEDLINE via PubMed) • Index to Chiropractic Literature (ICL) • Physiotherapy Evidence Database (PEDro) • Cochrane Library • ClinicalTrials.gov • International Clinical Trials Registry Platform (ICTRP) • Google Scholar
Search Terms	• "manip* AND fibromyalgia" • "spinal manip* AND "fibromyalgia" • "chiropr* AND fibromyalgia" • "osteop* manip* AND fibromyalgia" • "physical therap* AND fibromyalgia" • "physiotherapy* AND fibromyalgia" • "occupational therap* AND fibromyalgia"

Appendix 2.
List of referenced studies excluded from this review

Conference proceedings:

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Unable to verify existence of citation:

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Publications reporting on outcomes unrelated to standard fibromyalgia features:

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Characteristics of GLA:D® Canada Hip and Knee Osteoarthritis patients at the Canadian Memorial Chiropractic College: a retrospective analysis of registry-based cohort data

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The Canadian Memorial Chiropractic College (CMCC) began delivering the GLA:D® Canada program for knee and hip osteoarthritis (OA) in 2018. Little is known about the program participants or their outcomes. This study aimed to describe participant characteristics and outcomes (via a secondary dataset analysis) of CMCC patients in the GLA:D® Canada registry from inception to June 30, 2023. Results revealed improvements in mean scores for knee-related pain, function, quality of life, and hip-related pain. Health related quality of life and self-efficacy in managing symptoms were similar for participants with knee and hip OA. Demographic and outcome data were similar between CMCC and other GLA:D® programs in Canada and internationally. The data from this analysis may provide further investigative

Patients atteints de gonarthrose au Canadian Memorial Chiropractic College: une analyse rétrospective des données de cohortes basées sur un registre

Le Canadian Memorial Chiropractic College (CMCC) a commencé à offrir le programme GLA:D Canada pour la gonarthrose et la coxarthrose en 2018. On sait peu de choses sur les participants au programme ou leurs résultats. Cette étude visait à décrire les caractéristiques des participants et les résultats (au moyen d'une analyse de l'ensemble de données secondaire) des patients du CMCC dans le registre du programme GLA:D Canada pour la période allant de sa création jusqu'au 30 juin 2023. Les résultats ont révélé des améliorations des scores moyens pour la douleur au genou, la fonction, la qualité de vie et la douleur à la hanche. La qualité de vie liée à la santé et l'autoefficacité dans la gestion des symptômes étaient similaires pour les participants atteints de gonarthrose et de coxarthrose. Les données démographiques et les résultats étaient similaires entre le CMCC et d'autres programmes GLA:D au Canada

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opportunities to better understand the experience of GLA:D® patients, clinical and educational faculty and students at CMCC, and should be conducted to optimize the program for an academic chiropractic setting.

(JCCA. 2025;69(1):49-61)

KEY WORDS: osteoarthritis, patient education, exercise therapy, chiropractic, health education, implementation, program evaluation

et à l'étranger. Les données de cette analyse pourraient offrir d'autres possibilités d'enquête afin de mieux comprendre l'expérience des patients du programme GLA:D, du personnel clinique et éducatif ainsi que des étudiants au CMCC, et cette enquête devrait être effectuée pour améliorer le programme de mise en œuvre d'un cadre de chiropratique en milieu scolaire.

(JCCA. 2025;69(1):49-61)

MOTS CLÉS : arthrose, éducation des patients, thérapie par l'exercice, chiropratique, éducation à la santé, mise en œuvre, évaluation du programme

Introduction

Knee and hip osteoarthritis (OA) affects over 500 million people worldwide and poses a high economic burden on both society and individuals.[1,2] In Canada, over four million people live with OA.[3] Current international guidelines recommend patient education and exercise therapy as first-line treatments for OA;[4,5,6,7,8,9] however, these treatments remain underutilized across the world including Canada.[10,11,12] Two Canadian studies found that 40% of knee OA patients had not received the recommended non-surgical treatments prior to seeing an orthopedic surgeon,[13] and only 19% used these treatments after being recommended by the surgeon[14]. Considering education and exercise programs have the potential to reduce the need for costly total joint replacement surgeries,[15,16] there is an unmet need for quality patient education and exercise therapy for Canadians living with knee and hip OA.

The Good Life with osteoarthritis in Denmark (GLA:D®) program is an evidence-based education and exercise treatment program for people with knee and hip OA that was designed to address this unmet need. It is a group-based education and exercise intervention for individuals with symptoms of knee and hip OA, consisting of two education and twelve exercise sessions supervised by a GLA:D®-certified clinician. The program aims to help clinicians implement clinical guidelines and deliver high-value care consisting of three standardized parts to ensure program quality, including a national patient data registry.[1] GLA:D® is a high-value treatment option for people with knee and hip OA[2] and is now implemented in ten countries. Over 100,000 participants have taken part in the program since its inception. In 2016, Canada became the first country to implement GLA:D® outside of Denmark (the only difference being a translation of education and course materials to English), and by 2022 registered over 15,000 participants.[17] Over half of the GLA:D® Canada participants report a clinically meaningful improvement in pain levels and 83% report being satisfied or very satisfied at program completion.[18]

Recognizing the value of the GLA:D® Canada program for patients with knee and hip OA, and the potential educational benefit for chiropractic interns, the Canadian Memorial Chiropractic College (CMCC) began offering the GLA:D® Canada program in 2018, along with inclusion of patients as part of the national GLA:D® Canada data registry for evaluation.

The available data presents an opportunity to assess the potential impact of delivery of group-based education and exercise therapy programs in a chiropractic academic setting (CMCC) and more generally, musculoskeletal rehabilitation delivered by chiropractors. Additionally, this data provides the opportunity to compare such findings to larger-scale studies in clinical settings within Canada and internationally.[19] The purpose of this study was to describe participant characteristics and key treatment and experience outcomes of participants with knee and hip OA participating in the GLA:D® Canada program at CMCC.

Methods

Design

This study was a secondary analysis of registry data of all patients in the GLA:D® Canada registry who participated in the program at CMCC from program inception (2018) until June 30, 2023. This report conforms to the STROBE statement for reporting observational studies.[20] Ethics approval for the GLA:D® Canada registry was granted by the UHN Research Ethics Board (REB# 16-5676) and ethical approval for this study was granted by the CMCC Research Ethics Board (REB# 2305X02).

GLA:D® Canada program at CMCC

CMCC piloted the delivery of the GLA:D® Canada program with one certified clinician at its main teaching clinic site. Additional clinicians were sent for training due to program success and educational value. In 2019, CMCC began accepting patient referrals via public funding through the Toronto Local Heath Integration Network which has further enhanced patient accessibility to this program. A CMCC clinic administrator is on the GLA:D Canada Leadership Team and Clinical Quality committee. Currently there are 12 GLA:D® Canada certified clinicians on faculty who deliver the program at three CMCC teaching clinic sites.

Participants

Eligibility criteria used by all international GLA:D® programs for OA[1,21] include: age 18+; knee or hip joint problems as a result of OA that are sufficient in intensity to seek care in the health care system; fluency in English; consent to participate; and no other diagnoses for the hip or knee pain or more severe symptoms from another diagnosis (e.g., fibromyalgia or rheumatoid arthritis). There are no strict diagnostic criteria for knee or hip OA required (i.e., imaging is not required) for participation in the GLA:D® Canada program. Participation in the GLA:D® Canada program at CMCC follows the same eligibility criteria.[22]

Patients with knee or hip OA enrolling in the GLA:D® Canada program at CMCC are eligible to provide data to the GLA:D® Canada registry. Only those participants who consent to providing data are included in the GLA:D® Canada registry. However, consent to provide data to the registry is not required for participation in the program.

Pre-treatment characteristics

As noted in previous research regarding GLA:D® Canada participant profiles, the pre-program survey information and outcomes are standardized for all GLA:D® Canada participants regardless of clinic location.[20] Pre-treatment characteristics and post-treatment outcomes were selected based on scientific or theoretical rationale for their impact on OA research studies.[23]

Key baseline characteristics extracted from the registry data of participants attending GLA:D® at CMCC include: age (years); sex (male, female); BMI (kg/m2); marital status (married, living with partner, single, divorced/separated, widow); education level attained; current employment status; number of comorbidities (0, 1, 2, 3+); duration of symptoms (years); physical activity level (days/week); bilateral joint symptoms (yes, no); comorbid hip/knee symptoms (yes, no); low back pain (yes, no); previous joint injury (yes, no); previous joint surgery (yes, no); desire for surgery on their affected joint (yes, no); fear physical activity will damage joints (yes, no), and pain medication use (yes, no).

Patient-reported health status measures was also extracted from the GLA:D® registry. Knee or hip pain intensity was assessed using the Numeric Rating Scale (NRS), scored from 0 (no pain) to 10 (worst pain imaginable).[24] Knee- or hip-related pain, function, and quality of life (QOL) were assessed using the Knee injury and Osteoarthritis Outcome Score 12-item short form (KOOS-12)[25] or Hip disability and Osteoarthritis Outcome Score 12-item short form (HOOS-12)[26] subscales, respectively. All KOOS-12 and HOOS-12 subscales are scored from 0 (worst) to 100 (best). Overall health status was assessed using the EuroQol 5 Dimension 5 Level Visual Analog Scale (EQ-5D-5L VAS), scored from 0 (worst health imaginable) to 100 (best health imaginable).[27] The Arthritis Self-Efficacy Scale 8-item version (ASES-8) was used to assess perceived self-efficacy of arthritis management, scored from 1 (low self-efficacy) to 10 (high self-efficacy).[28,29]

Participants also performed two objective physical function tests: the 30-second chair stand test (repetitions) and 40-metre walk test (collected in seconds and converted to metres/second). These two objective physical function tests are recommended for use by the Osteoarthritis Research Society International[30] and were conducted by the GLA:D® Canada clinician at CMCC.

In 2019, additional measures were added to the GLA:D® Canada registry to better assess patient and healthcare system impact including: payment source (private, public) for program participation; previous OA diagnosis by a health professional (yes, no, unsure); and currently waitlisted for surgery (yes, no). In 2022, two questions related to previous imaging of the index joint were added to the registry: 1) previous radiograph of knee/hip (yes, no); and 2) if yes, radiograph showed OA (yes, no).

Post-treatment outcomes

During the final exercise session, patients repeated the 30-second chair stand and 40-metre walk tests (under supervision of the GLA:D® Canada clinician at CMCC) and these results were inputted in the three-month follow-up survey (they are not collected at 12 months). Other pre-program measures collected in the three- and 12-month surveys include: pain NRS; HOOS-12 or KOOS-12 pain, function, and QOL; and EQ-5D-5L VAS scores.

Participants are also asked a set of additional questions related to the patient's attendance and experience during the program. They are asked how many education sessions they attended (0, 1, 2) and are also asked how many exercise sessions were attended (0-12, recorded as less than 10, 10 or more). At the three-month follow-up (only), participants are asked to report their overall level of satisfaction with the GLA:D® program (1-not at all satisfied to 5-very satisfied). At both three- and 12-month follow-up, participants are asked to rate their level of benefit from the program (1-not at all beneficial to 5-very beneficial), and how often they use what they have learned in GLA:D® (never, every month, every week, every day, several times per day, don't know).

Data analysis

The number of participants enrolled by year in the GLA:D® Canada registry from program inception (2018) until June 30, 2023, was calculated. Participants with completed pre-program data during this period were included in pre-program characteristic analysis, and those with completed three- and 12-month data were included in the post-program outcome analysis (i.e., complete case analysis). Participants who did not complete the pre-program data were recorded but not included in the analysis (Figure 1). Pre-program characteristics of knee and hip participants were described separately. Proportions were reported for dichotomous and categorical pre-treatment data. For normally distributed pre-treatment data, the mean and standard deviation (SD) were calculated.

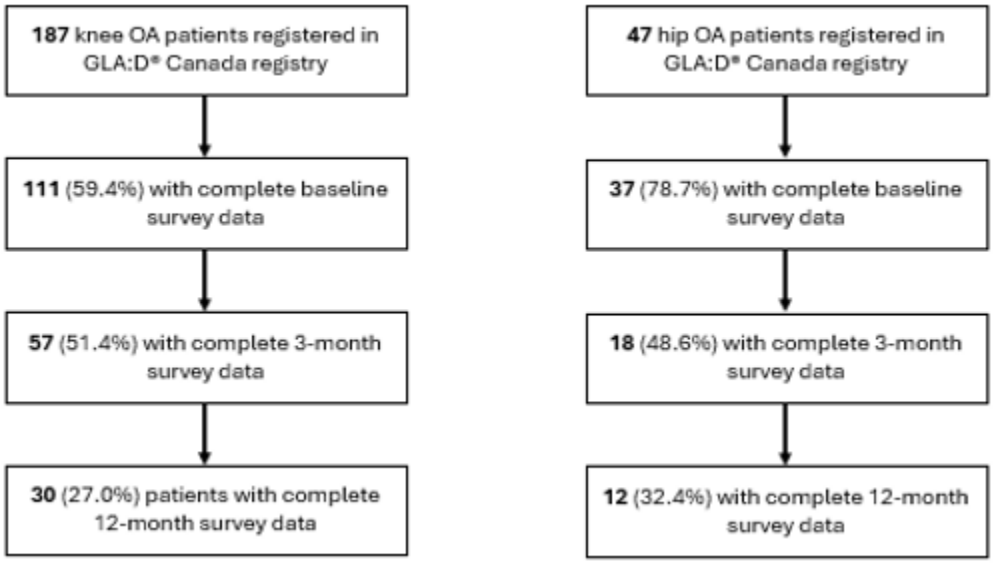

Figure 1.
Data completion for GLA:D® Canada participants at CMCC clinics from inception in 2018 to June 30, 2023.

The median and inter-quartile range were reported for non-normally distributed continuous data. Post-treatment outcomes were calculated using the mean change and 95% confidence interval (95% CI) from baseline to three- and 12-months. Responder percentages were also reported using a minimal clinically important change threshold of 30%, as recommended for musculoskeletal disorders, including OA.[31,32] All data analyses were conducted in R version 4.2.1 (R foundation for statistical computing, Vienna, Austria).

Results

A total of 234 (187 knee, 47 hip) participants registered in the GLA:D® Canada registry. After considerable growth in the first two years of the program, registration dropped in 2020 and 2021 due to the COVID-19 pandemic and temporary clinic closures of all CMCC clinics, despite availability of program delivery virtually (Figure 2). In 2022 and up to June 30, 2023, enrollment numbers surpassed pre-pandemic levels. Of the 234 participants enrolled, 111 knee (59%) and 37 hip (79%) participants provided pre-treatment data.

Pre-treatment characteristics

The profile of GLA:D® Canada participants at CMCC is presented in Table 1. Participants were predominantly female, with an average age of 65 years and classified as overweight. On average, participants have had knee or hip problems for more than five years prior to GLA:D® and more than one in three have multiple symptomatic knee and hip joints. About one in five knee participants and one in two hip participants reported a desire to have joint surgery before starting the program, while roughly one in five knee participants and one in 10 hip participants have had a previous joint surgery. On average, participants were physically active, and roughly one in four report a fear that physical activity will damage their joints. Nearly two out of every three participants reported using pain medication at time of enrolment, with an average pain intensity (pain NRS) rating of five out of 10 for

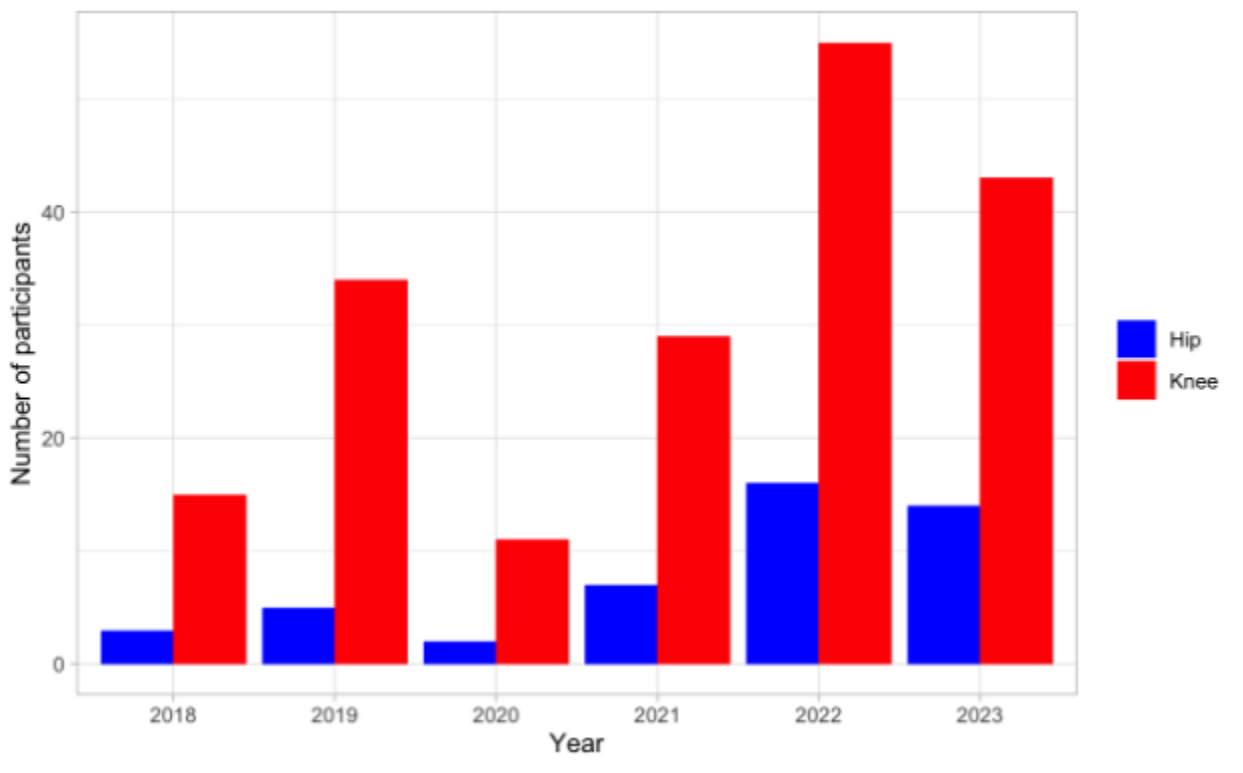

Figure 2.
GLA:D® Canada enrolment at CMCC clinics per year from inception in 2018 to June 30, 2023.

both knee and hip participants. Mean scores for knee- and hip-related pain, function, and quality of life, health related QOL, and self-efficacy in managing their OA were similar for participants with knee and hip OA, as were pre-treatment outcomes for the 30-second chair stand test and the 40-metre walk test.

Table 1.
Pre-treatment characteristics of CMCC knee and hip participants.

	Knee (n=187)	Hip (n=47)
Age (years)	69.5 (8.4)	65.2 (12.1)
Missing (n=)	2	0
Female	77.5%	75.7%
Missing (n=)	0	0
BMI (kg/m^2)	28.6 (6.3)	27.5 (5.9)
Missing (n=)	3	2
Marital status:		
Married	61.8%	75.7%
Living with partner	3.6%	5.4%
Single	11.8%	10.8%
Divorced/separated	10.0%	2.7%
Widow	12.7%	5.4%
Missing (n=)	1	0
Education level:		
Elementary school	0%	0%
High school	16.2%	16.7%
Trade or community college	24.3%	13.9%
University	59.5%	69.4%
Missing (n=)	0	1
Employment status:		
Working full-time	21.3%	22.9%
Working part-time	5.6%	11.9%
Disability leave	1.9%	8.6%
Unemployed	2.8%	0%
Retired	62%	48.6%
Other	6.5%	8.6%
Missing (n=)	3	2
Number of comorbidities:		
0	41.4%	37.8%
1	16.2%	29.7%
2	18.0%	13.5%
3+	24.3%	18.9%
Missing (n=)	0	0

Symptom duration (years)* Missing (n=)	6.8 (7.4) 7	4.6 (6.9) 0
Bilateral joint symptoms Missing (n=)	64.5% 1	27.0% 0
Back pain Missing (n=)	31.5% 0	48.6% 0
Previous joint injury Missing (n=)	31.8% 1	8.1% 0
Previous joint surgery Missing (n=)	22.0% 2	13.5% 0
Desire for surgery Missing (n=)	20.9% 1	44.4% 1
Physical activity level (days/week) Missing (n=)	4.5 (2.5) 0	4.0 (1.9) 0
Fear physical activity will damage joints Missing (n=)	29.0% 4	27.0% 0
EQ-5D-5L VAS Missing (n=)	68.1 (20.3) 1	65.1 (19.0) 1
ASES-8 Missing (n=)	6.5 (1.9) 0	5.6 (1.9) 0
Anxiety or depression symptoms Missing (n=)	20.7% 0	22.2% 1
Pain medication use Missing (n=)	57.7% 0	67.6% 0
Pain NRS Missing (n=)	5.1 (2.4) 0	5.8 (2.3) 0
K/HOOS-12 pain subscale Missing (n=)	52.9 (17.0) 0	48.7 (19.0) 0
K/HOOS-12 function subscale Missing (n=)	56.6 (21.8) 0	55.8 (21.6) 0
K/HOOS-12 quality of life subscale Missing (n=)	39.1 (19.4) 0	42.2 (19.8) 0
40-metre walk test (m/s) Missing (n=)	1.2 (0.5) 71	1.2 (0.4) 20
30-second chair stand test (repetitions) Missing (n=)	11.4 (5.1) 52	12.3 (4.7) 16

All data is presented as mean (SD) or %, except where * indicates median interquartile range (IQR) reported due to non normal distribution. NRS = Numeric Rating Scale (0 best to 10 worst); EQ-5D-5L VAS = EQ-5D-5L Visual Analog Scale (0 worst to 100 best); ASES-8 = Arthritis Self-Efficacy Scale 8-item version (1 lowest to 10 highest); KOOS-12 = Knee injury and Osteoarthritis Outcome Score 12-item short form (0 worst to 100 best); HOOS-12 = Hip disability and Osteoarthritis Outcome Score 12-item short form (0 worst to 100 best).

Since 2019, additional pre-treatment questions noted that two out of three participants accessed GLA:D® at CMCC via public funding, nine out of 10 participants had a previous diagnosis of OA from a health care professional, and approximately one out of every 20 participants were on a surgical waitlist at time of program enrolment. Approximately nine out of every 10 participants reported a previous radiograph of their joint, and of those reporting the radiographs, more than 80% reported having imaging findings associated with OA.

Post-treatment outcomes

Post-treatment data for GLA:D® CMCC participants is presented in Table 2. Approximately half (51.4% knee, 48.6% hip) of GLA:D® CMCC participants completed the three-month survey. All knee participants and 81.1% of hip participants attended at least one education session, and the majority (86.0% knee, 88.9% hip) attended 10 or more of the 12 exercise sessions. Most knee (87.5%) and hip (82.3%) participants reported being either *somewhat satisfied* or *very satisfied* with the program and rated the program as *beneficial* or *very beneficial* (84.2% knee, 82.3% hip). Additionally, 91.2% of knee and 88.9% of hip participants reported using what they have learned from GLA:D® at least once per week.

At 12-month follow-up, only 29.7% (27.0% knee, 32.4% hip) of participants completed the survey. A much greater percentage of knee (74.2%) versus hip (58.3%)

Table 2.
Post-treatment outcomes of CMCC knee and hip participants.

	Knee (n=111)	Hip (n=37)
Education sessions attended:		
Two	63.5%	66.7%
One	36.5%	33.3%
Zero	0%	0%
Missing (n=)	59	19
Exercise sessions attended:		
10 or more	86.0%	88.9%
Less than 10	14.0%	11.1%
Missing (n=)	54	19
Somewhat or very satisfied with program:		
3 months	87.5%	82.3%
12 months	---	---
Missing (n=)	55	20
Found program beneficial or very beneficial:		
3 months	84.2%	82.3%
Missing (n=)	54	19
12 months	74.2%	58.3%
Missing (n=)	80	25
Used what they have learned at least weekly:		
3 months	91.2%	88.9%
Missing (n=)	54	19
12 months	70.9%	50.0%
Missing (n=)	80	25

participants deemed the GLA:D® program *beneficial* or *very beneficial* and reported using what they have learned from GLA:D® at least once per week (70.9% knee, 50.0% hip).

Post-program patient-reported outcomes for knee participants are presented in Table 3. The proportion of knee OA participants who achieved a clinically significant improvement at three months ranged from 28.1% (KOOS-12 function subscale) to 49.1% (KOOS-12 QOL subscale). At 12-months, the proportions ranged from 35.1% (KOOS-12 pain subscale) to 53.1% (KOOS-12 QOL subscale). The proportion of responders on the

Table 3.
Patient-reported outcomes in knee participants

Outcome	Baseline	3 months			12 months		
	Mean (SD)	Mean (SD)	Mean change from baseline	Responder %	Mean (SD)	Mean change from baseline	Responder %
Pain NRS	5.1 (4.7 to 5.5	3.8 (3.3 to 4.4)	1.3 (0.0 to 4.7)	47.4%	3.9 (3.2 to 4.6)	1.2 (0.4 to 2.2)	46.9%
KOOS-12 pain	52.9 (49.8 to 56.0)	59.7 (55.7 to 63.6)	6.8 (1.4 to 12.1)	35.1%	61.7 (56.8 to 66.6)	8.8 (2.0 to 15.6)	35.1%
KOOS-12 function	56.6 (52.9 to 60.3)	64.8 (60.1 to 69.4)	8.2 (1.9 to 14.4)	28.1%	66.1 (60.4 to 71.8)	9.5 (1.7 to 17.4)	37.5%
KOOS-12 quality of life	39.1 (35.7 to 42.5)	50.7 (46.4 to 55.0)	11.6 (5.8 to 17.5)	49.1%	51.9 (46.5 to 57.2)	12.8 (5.4 to 20.2)	53.1%
40-metre walk test (m/sec)	1.2 (1.1 to 1.3)	1.4 (1.3 to 1.6)	0.2 (0.0 to 0.4)	23.1%	---	---	---
30-second chair stand test (repetitions)	11.4 (9.9 to 12.9)	16.0 (14.2 to 17.8)	4.6 (1.9 to 7.3)	52.2%	---	---	---

NRS = Numeric Rating Scale (0 best to 10 worst); KOOS-12 = Knee injury and Osteoarthritis Outcome Score 12-item short form (0 worst to 100 best). Responders defined as two points for NRS, 0.095 m/s gait speed, two rises for chair stand test and 15 points for KOOS-12 pain, function, and quality of life. Missing/unknown knee responder percentage numbers for each variable at 3-months Pain NRS, KOOS-12 Pain/ Function/QOL n= 54; 40-metre walk test n= 98, 30-second chair test n=88. Missing/unknown knee responder percentage numbers for each variable at 12-months Pain NRS, KOOS-12 Pain/ Function/QOL n= 79.

Table 4.
Patient-reported outcomes in hip participants.

Outcome	Baseline	3 months			12 months		
	Mean (SD)	Mean (SD)	Mean change from baseline	Responder %	Mean (SD)	Mean change from baseline	Responder %
Pain NRS	5.8 (5.1 to 6.6)	4.5 (3.4 to 5.5)	1.4 (0.0 to 2.5)	44.4%	4.9 (3.7 to 6.1)	0.9 (-0.9 to 2.7)	25.0%
HOOS-12 pain	48.7 (42.9 to 54.6)	57.7 (49.8 to 65.5)	9.0 (2.5 to 20.5)	16.7%	51.4 (42.2 to 60.7)	12.7 (10.8 to 16.3)	25.0%
HOOS-12 function	55.8 (49.3 to 62.3)	60.7 (52.1 to 69.3)	4.9 (-7.3 to 17.1)	22.2%	59.5 (49.4 to 69.5)	3.6 (-10.0 to 18.1)	33.3%
HOOS-12 quality of life	42.2 (35.6 to 48.9)	45.6 (36.9 to 54.4)	3.4 (-8.9 to 15.8)	27.8%	41.4 (31.2 to 51.6)	0.8 (-15.4 to 13.7)	33.3%
40-metre walk test (m/sec)	1.2 (1.0 to 1.4)	1.2 (1.0 to 1.4)	0.02 (-0.2 to 0.3)	0%	---	---	---
30-second chair stand test (repetitions)	12.1 (9.6 to 14.5)	14.7 (11.6 to 17.7)	2.6 (-1.6 to 6.8)	37.5%	---	---	---

NRS = Numeric Rating Scale (0 best to 10 worst); HOOS-12 = Hip disability and Osteoarthritis Outcome Score 12-item short form (0 worst to 100 best). Responders defined as two points for NRS, 0.095 m/s gait speed, two rises for chair stands test and 15 points for HOOS-12 pain, function, and quality of life. Missing/unknown hip responder percentage numbers for each variable at 3-months Pain NRS, KOOS-12 Pain/ Function/QOL n= 19; 40-metre walk test n= 32, 30-second chair test n=29. Missing/unknown hip responder percentage numbers for each variable at 12-months Pain NRS, KOOS-12 Pain/ Function/QOL n= 25.

40-metre walk test and 30-second chair stand tests (measured at three-months only) were 23.1% and 52.2%, respectively.

Post-program patient-reported outcomes data for hip participants are presented in Table 4. The proportion of hip OA participants who achieved a clinically significant improvement at three-months ranged from 16.7% (HOOS-12 pain subscale) to 44.4% (pain NRS). At 12-months, the proportions ranged from 25.0% (pain NRS and HOOS-12 pain subscale) to 33.3% (HOOS-12 function and QOL subscales). The proportion of responders on the 40-metre walk test and 30-second chair stand tests (3-months only) were 0% and 37.5%, respectively.

Discussion

This study summarized the largest dataset of patients receiving education and exercise (via the GLA:D® Canada program) at a chiropractic clinic to assess pre-treatment characteristics and post-treatment outcomes. While many pre-program baseline characteristics were similar between the GLA:D® CMCC versus GLA:D® Canada knee and hip OA patients, improvement scores between the two programs (other than three-month knee- and hip-pain NRS) were different but were not considered clinically important. This study highlights the positive impact of delivery of GLA:D® at CMCC and more generally, musculoskeletal rehabilitation delivered by chiropractors. Additionally, this study provides a foundation for future GLA:D® at CMCC research as it relates to patients, clinical and educational faculty, and students.

A previous larger-scale study comparing data for GLA:D® Canada knee and hip OA participants to the GLA:D® Denmark and Australia programs[33] showed similar demographic and baseline characteristics as in our study. Additionally, the demographic and outcome data of patients who participated in the GLA:D® Canada program solely at CMCC compared to those in GLA:D® programs in other clinical settings in Canada (across all provinces, excluding CMCC participants) were similar in many key areas. Across all programs, most participants are female, with CMCC participants having slightly higher baseline NRS knee and hip pain scores and slightly lower baseline mean BMI measurements. CMCC participant baseline testing scores on the 40-metre walk test were slightly lower compared to international GLA:D® participants, and 30-second chair stand test scores were nearly identical. Comparison of the KOOS/HOOS-12 QOL subscale mean baseline scores were also similar between GLA:D® Canada and CMCC participants, but slightly less than those in Denmark or Australia.

However, CMCC participants noted a much higher duration for both knee and hip symptoms (knee: 6.8 years versus 4.0 years; hip: 4.6 years versus 3.0 years) as compared to GLA:D® Canada participants.[22] Additionally, comparison of pre-program characteristic data noted a greater percentage of CMCC hip and knee participants (62.5%) accessed GLA:D® via public funding compared to GLA:D® Canada (57.3%), and 100% of CMCC participants had obtained a previous knee radiograph compared to 92.0% of GLA:D® Canada participants. Previous hip radiograph numbers were closer, with CMCC participants at 88.9% compared to GLA:D® Canada participants at 90.2%. This may be a reflection of CMCC accepting public patient referrals through the Toronto Local Heath Integration Network, where participants may have more advanced disease and less access to private medical care. However, a lower number of CMCC participants reported being on a waitlist for knee (CMCC participants: 4.5% versus GLA:D® Canada participants: at 8.6%) or hip (CMCC participants: 6.5% versus GLA:D® Canada participants: 11.7%) surgery [22] versus GLA:D® Canada participants. Overall, the similar baseline demographic findings to GLA:D® Canada participants suggest that further research using this cohort could help improve implementation and delivery of education and exercise programs delivery, especially within educational institutions and other smaller specialty demographic cohorts.

Post-treatment outcomes

For post-program combined knee and hip scores, comparisons of GLA:D® at CMCC versus GLA:D® Canada participant outcome data[33] at 3-months revealed varied results. Mean change NRS scores were similar for GLA:D® CMCC versus GLA:D® Canada participants (1.3 knee/1.4 hip versus 1.5 combined) despite a higher baseline mean score (5.1 knee/5.8 hip versus 5.1 combined), while 40-metre walk test change mean was slightly lower for GLA:D® at CMCC versus GLA:D® Canada participants (1.4 knee/1.2 hip versus 0.14 combined). Significant differences were noted with mean change in the KOOS-12 QOL (11.6) being higher and HOOS-12 QOL lower (3.4) versus GLA:D® Canada participants (7.8 combined), as

was the disparity in knee and hip mean change for the 30-second chair stand test for GLA:D® at CMCC versus GLA:D® Canada participants (4.6 knee/2.6 hip versus 3.7 combined).

Responder percentages for GLA:D® at CMCC versus GLA:D® Canada participants at 3-months were similar for pain NRS (47% knee/44% hip versus 43% combined). However, significantly higher scores for GLA:D® at CMCC KOOS-12 (49%) and HOOS-12 (45%) QOL versus GLA:D® Canada (28% combined) were noted. Responder percentages for GLA:D® at CMCC versus GLA:D® Canada participants were much lower for the 40-metre walk test (23% knee/0% hip versus 59% combined) and 30-second chair stand test (52% knee/37% hip versus 71% combined).[33]

As with the similar baseline data, the noted outcome data similarities in CMCC participants compared to all GLA:D® Canada participants (despite the difference in number of patients), bodes well for future collaboration studies investigating the implementation and impact outcomes of the GLA:D® Canada program at educational institutions and clinics (of various sizes) alike. Future research could include qualitative studies involving stakeholders, clinicians, and patients to explore their perspectives on how to improve several important aspects (such as program delivery and poor survey response rates at three- and 12-months) of evidence-based education and exercise programs, whether in an educational institution, private clinic, or hospital setting. Additionally, CMCC is the only educational institution in Canada to expose and actively engage their students in delivery of the program. Future research could investigate the impact of evidence-based programs on satisfaction ratings of students involved in GLA:D or investigating student competency in helping patients with knee and hip OA improve their quality of life.

Strengths and limitations

A strength of this study was its use of the GLA:D® hip/knee OA program with standardized methods and outcomes, enabling comparison to similar programs delivered across several countries, using similar national data registries, and to those reported in the Cochrane reviews on exercise for knee and hip OA.[34,35] This study was limited by the relatively low data completion rates at pre- and post-treatment data collection time-points (knee/hip response rate of only 50% at three-months, and 29.7% at 12-months). This may introduce a selection bias, wherein participants who experience a positive outcome from the GLA:D® program are more likely to complete the follow-up outcome measures, thereby overestimating the true effect of the program. Specifically, the lack of data from 12-month follow-up surveys limits the ability to confidently assess long term program outcomes. Future work could address participants perceived/real barriers to completing follow-up surveys. As noted in previous studies, this lack of follow-up is not limited solely to the CMCC participants, but all GLA:D® programs internationally.[22,33] Also, other additional factors that could contribute to improvement outcomes of this (or other) GLA:D® programs have not been considered. Participants in GLA:D® programs nationally or internationally were not excluded from seeking additional treatments/care, participating in additional physical activity, and were free to take medication/supplementation while participating in the program (or any time following the program). Therefore, possible future randomized control trials could be performed to better determine the effect of exercise and education alone compared to other interventions. Additionally, because sensitivity analyses (to examine the impact of missing data) were not performed, this study solely provides a description of patient results following implementation of the GLA:D® Canada program at CMCC and limits the authors' ability of imputing (and evaluating) any missing data. Future studies should include such sensitivity analyses to determine the impact of any missing data on outcome data summary. Furthermore, with the number of GLA:D® at CMCC participants being roughly one percent of the national data, presented similarities and differences between CMCC and all GLA:D® Canada patients should be interpreted with caution. Despite this, future work (which will likely include increased CMCC participant numbers) should include further comparisons to national and international data.

Conclusion

This study provides a detailed summary of patients with knee and hip OA who participated in the GLA:D® Canada program at CMCC. Results revealed improvements in mean scores for knee-related pain, function, and quality of life, and hip-related pain. Health related QOL, and self-efficacy in managing their OA were likewise similar for par-

ticipants with knee and hip OA. Overall, participants in the CMCC program have similar profiles and outcomes compared to those in the national GLA:D® Canada registry. These findings suggest further work should compare outcomes to other international GLA:D® registries. Additionally, future research to better understand the experience of GLA:D® patients, clinical and educational faculty, and students at CMCC should be conducted to optimize the program for an academic chiropractic setting.

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Intern use and perceptions of implementing diagnostic ultrasonography in a chiropractic educational clinic

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Objective: Use of musculoskeletal ultrasonography has been growing in many healthcare fields. Our aim is to evaluate the use and attitudes toward musculoskeletal ultrasound within a chiropractic educational clinic.
Methods: A survey questionnaire was distributed to interns (n=168), who were provided access to musculoskeletal ultrasound services for patients in our clinic. We collected self-reported usage and attitudes toward musculoskeletal ultrasound among interns in our clinic. Descriptive statistics summarized the data.

Results: The response rate was 60.1% (101/168). Overall, 31.7% (n=32) of respondents reported access of musculoskeletal ultrasound services. Ninety-one percent (n=29) reported the experience as beneficial. Identified benefits included: improved anatomic understanding, exclusion or confirmation of diagnoses, increased

Utilisation interne et perceptions de la mise en œuvre de l'échographie diagnostique dans une clinique éducative de chiropratique

Objectifs: L'utilisation de l'échographie musculosquelettique a augmenté dans de nombreux domaines des soins de santé. L'objectif est d'évaluer l'utilisation de l'échographie musculosquelettique au sein d'une clinique éducative de chiropratique ainsi que les attitudes liées à cette pratique.

Méthodes: Un questionnaire d'enquête a été distribué aux stagiaires (n = 168) qui ont eu accès aux services d'échographie musculosquelettique pour les patients de la clinique. On a recueilli des données autodéclarées sur l'utilisation et les attitudes envers l'échographie musculosquelettique parmi les stagiaires de la clinique. Des statistiques descriptives ont résumé les données.

Résultats: Le taux de réponse était de 60,1 % (101 stagiaires sur 168). Dans l'ensemble, 31,7 % (n = 32) des répondants ont déclaré avoir accès aux services d'échographie musculosquelettique. Quatrevingtonze pour cent (n = 29) des répondants ont déclaré que l'expérience était bénéfique. Les avantages indiqués comprenaient ceux qui suivent : une meilleure compréhension de l'anatomie, l'exclusion ou

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confidence, and patient reassurance. Of those that did not report use, 96% (n=66) reported interest in future use. Frequently reported limiting factors included: absence of indications for imaging, and patient ineligibility.

Conclusion: Our findings support musculoskeletal ultrasound implementation in an educational clinic to enhance student learning and confidence.

la confirmation de diagnostics, une confiance accrue et une capacité de rassurer les patients. Parmi ceux qui n'ont pas déclaré l'avoir utilisée, 96 % (n = 66) ont exprimé un intérêt pour une utilisation à l'avenir. Parmi les facteurs limitants fréquemment signalés, on pouvait citer : l'absence d'indications liées à l'imagerie et à l'inéligibilité du patient.

Conclusion: Les résultats soutiennent la mise en œuvre de l'échographie musculosquelettique dans une clinique éducative afin d'améliorer l'apprentissage et la confiance des étudiants.

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KEY WORDS: *ultrasonography, diagnostic imaging, education, graduate, chiropractic*

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MOTS CLÉS : *échographie, imagerie diagnostique, éducation, diplômé, chiropratique*

Introduction

Interest in musculoskeletal ultrasonography (musculoskeletal ultrasound) is growing in many healthcare professions, with its use being evaluated in an increasing variety of settings including rheumatology, pediatrics, orthopedics, physiotherapy, healthcare education, and chiropractic.[1-12] Musculoskeletal ultrasound has numerous advantages compared to other diagnostic imaging modalities including a lack of exposure to ionizing radiation, the ability to perform dynamic examinations, cost-effectiveness, time-efficiency, ease and accessibility to follow up and comparison imaging, and the ability for patients to ask questions regarding imaging findings directly to the performing and interpreting physician.[4,6,8,11,13,14] This combination can also allow the patient to avoid waiting for additional, more expensive, unnecessary imaging which can expedite diagnosis and treatment, and may provide faster relief of patients' concerns.[13] Additionally, as advances in ultrasound technology allow it to become more portable and affordable, its use is expected to become more accessible and universal.[15-17]

Musculoskeletal ultrasound has also been shown to have advantages within education as it provides exposure to common anatomic variants, demonstrates anatomic function and can reinforce the clinical relevance of anatomy and ultrasonography.[2,9,13,18,19] Instruction of anatomy using ultrasonography has recently gained traction within medical education with medical student surveys indicate that an ultrasound demonstration is a useful learning tool for reinforcing anatomy.[9,10,15,19,20] However, studies evaluating impacts on clinical skills demonstrate varied results.[9,18,20] Ivanusic *et al*.[18] used a demonstration of ultrasonography by an expert and student survey responses indicated that this experience reinforced material in a stimulating way and demonstrated clinically relevant anatomy. Other studies have shown that ultrasonography demonstrations can show clinical applications of anatomical knowledge and emphasize the importance of human anatomical variation.[19,21] The Ivanusic *et al*.[18] study specified that "ultrasound is best used to highlight specific anatomical features or concepts and used as an adjunct to other methods of teaching anatomy, rather than as a substitute for these."

One of the most frequently identified drawbacks of musculoskeletal ultrasound is user dependency with the quality and usefulness of the imaging being directly linked to the skill of the sonographer.[22,23] However, it has since been noted that standardization of image acquisition protocol and interpretation, as well as improvements in ultrasound training and technology have minimized the variability of results.[23-27] Additionally, validated semi-quantitative scales have been established for certain findings such as synovitis, which may further improve efficiency in interpretation.[25] Despite these advances, lack

of training remains a considerable obstacle to the implementation of musculoskeletal ultrasound in many clinical settings.[6,23,28] Other identified barriers include the cost of initial purchase and maintenance of the machine as well as the cost and time to complete appropriate training.[6]

The most commonly treated complaints in a chiropractic setting are musculoskeletal conditions. Thus, musculoskeletal ultrasonography is well suited for use in this setting. Some conditions commonly diagnosed with ultrasonography in our clinics include rotator cuff tears, collateral ligament injuries, calcific tendinopathies, bursitis, lateral and medial epicondylitis, Achilles tendinopathy, plantar fasciitis and peripheral neuropathy. Currently, only one study evaluated the current and prospective use of musculoskeletal ultrasound within chiropractic teaching institutions.[4] Another study described changes in accuracy of palpation following instruction with ultrasound.[2] Additionally, musculoskeletal ultrasound has been studied in its ability to support learning of palpation skills within physiotherapy, with mixed results.[22] In medical education, it has been suggested that use of musculoskeletal ultrasound as an extension of the clinical examination can improve immediate diagnosis of joint and soft tissue conditions as well as enhancing interventional skills. This may translate into improved patient outcomes in fewer follow-up visits.[6,9] Similar impacts may be seen within the chiropractic setting.

The aim of this study was to investigate the degree of intern utilization of provided musculoskeletal ultrasound services within a chiropractic educational clinic, as well as to explore the perceptions of the clinic interns regarding observation of musculoskeletal ultrasound exams and the influences of this on patient care. To the best of our knowledge this is the first survey of its type within chiropractic education.

Methods

We surveyed a convenience sample of student interns within a chiropractic college in the United States. The study was determined to be exempt by the university's institutional review board (#A-00200).

Access to diagnostic ultrasonography was initially added to the educational clinic of this chiropractic institution in May of 2019. At the time of survey distribution ultrasonography was available only to internal patients of the clinic; including fellow students, faculty, staff, and their families. The remaining patients, who are not directly affiliated with the institution, are considered external patients. During their clinical experience, student interns complete eight to 12 months of training within the institution's educational clinic: examining, diagnosing, and treating patients in an outpatient setting under the supervision of supervising faculty clinicians. The majority of students spend the final four months of training in university accredited, community-based internships under the supervision of practicing chiropractors. The authors invited all student interns enrolled in their first trimester of clinical internship to participate in this survey. The authors collected data during the Fall 2019 (n=70 interns) and Winter 2020 (n=98 interns) trimesters (n=168 interns).

Examinations were ordered following approval by supervising clinicians based on clinical exam findings and differential diagnoses. The interns who ordered the exams also attended the sonography appointments with their patients. Exams were performed by the radiology residents under the supervision of a registered musculoskeletal sonographer (RMSK). This allows both patients and interns to engage in discussion with the sonographer and get additional clarification beyond the finalized reports. The residents and sonographer are also educators within the program and intentionally include clinical pearls, review of relevant anatomic structures visualized on the scan, and discussion of differential diagnoses as part of the appointment. Following the ultrasonography appointments, interns completed an imaging narrative report where they correlate the need for imaging with the patient presentation, compare and contrast the benefits and limitations of the imaging modality, discuss the integration of the findings provided by the imaging with the clinical picture and other diagnostic information and describe how this influences the development of the patient's treatment plan.

An initial invitation was sent via email to all students enrolled in their first term as clinic interns. Follow up emails were sent to non-responders after two weeks. Participating interns completed a 10-item questionnaire that provided self-reported data regarding their use of and attitudes toward the inclusion of musculoskeletal ultrasound in their clinical training. The questions consisted of a mixture of yes/no, four-point Likert-type, multiple selection and open response formats. Each question also included an option not to answer. Development of the questionnaire was performed in accordance with survey design best

practices and content domains from the literature. The questionnaire was adapted based on the questions used in a similar survey by Acebes *et al*.[1] The authors pretested the questionnaire with content experts and students who were not involved in the study as investigators or participants. Following pretesting, grammatical revisions were made based on feedback received. The questionnaire was designed and distributed using the REDCap (Research Electronic Data Capture) platform.[29,30] Informed consent was obtained as part of the survey through REDCap. Respondents were not able to progress to the questionnaire without acknowledging the informed consent document and confirming their consent to participate in the survey. Study data were collected and managed using REDCap electronic data capture tools hosted at Parker University. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.[29,30] A descriptive analysis of the survey data was undertaken.

Results

The authors received responses from 101 of 168 subjects surveyed, indicating a response rate of 60.1%. Overall, 31.7% (n=32) of those surveyed reported accessing the available musculoskeletal ultrasound services in the course of caring for patients. Of those who had accessed the musculoskeletal ultrasound services provided by the sonographers, 100% (n=32) reported imaging for 1 or 2 patients. These data are included in Table 1.

Of those who reported accessing the musculoskeletal ultrasound services, nearly all (91%, n=29) reported that they perceived the experience as beneficial. A majority of those (62.5%, n=20) indicated an extremely positive experience, while the rest (n=12) reported a somewhat positive experience. When asked about their likelihood to recommend the musculoskeletal ultrasound services, of those respondents who used musculoskeletal ultrasound in patient care, 78.1% (n=25) reported that they would be extremely likely and 18.8% (n=6) reported they would be somewhat likely to recommend it to other interns and patients. These data are summarized in Table 2.

Respondents indicated multiple perceived clinical benefits following their musculoskeletal ultrasound experience (Table 3) including: 46.9% (n=15) improved

Table 1.
Reported access of and interest in musculoskeletal ultrasonography services.

Access of Musculoskeletal Ultrasonography Services?	Yes (31.7%; n=32)			No (68.3%; n=69)	
# of Exams Attended	1-2 (100%: n=32)	3-4 (0.0%; n=0)	3-4 (0.0%; n=0)	Interest in Future Use?	
				Yes (95.7%; n=66)	No (4.3%; n=3)

Table 2.
Intern attitudes regarding the ultrasonography experience

Domain	Responses			
Beneficial	Yes (91.0%; n=29)	No (3.1%;n=1)	Chose not to answer. (6.3%; n=2)	n/a
Rate experience	Extremely positive (62.5%; n=20)	Somewhat positive (38%; n=12)	Somewhat negative (0.0%; n=0)	Extremely negative (0%; n=0)
Likelihood to Recommend	Extremely likely (78.1%; n=25)	Somewhat likely (18.8%; n=6)	Somewhat unlikely (0.0%; n=0)	Extremely unlikely (3.1%; n=1)

Table 3.
Summary of user and non-user's perceived and expected clinical benefits to musculoskeletal ultrasound experience.

Impact:	Users (perceived)	Non-Users (expected)
Improvement in anatomic understanding	46.9%; n=15	50.0%; n=33
Exclusion of differential diagnoses	65.6%; n=21	66.7%; n=44
Confirmation of clinical impression	59.4%; n=19	75.8%; n=50
Increased confidence in established diagnosis	50.0%; n=16	72.7%; n=48
Patient reassurance	75.0%; n=24	48.5%; n=32
None	0.0%; n=0	0.0%; n=0
Other	6.3%; n=2	4.5%; n=3
Choose not to answer	0.0%; n=0	0.0%; n=0

anatomic understanding, 65.6% (n=21) exclusion of differential diagnoses, 59.4%, (n=19) confirmation of clinical impression, 50% (n=16) increased confidence in an established diagnosis, and 75% (n=24) patient reassurance. Among those who selected 'other' benefits, in the open response section, one respondent reported that the results of the musculoskeletal ultrasound examination provided insight into the cause for inadequate response to care and allowed treatment plans to be modified to better align with the patient needs. Another indicated that the parent of a young patient appreciated being able to see the scan and have everything explained by the radiologists. Others noted the lack of radiation exposure and cost-effectiveness of the examination.

Of those who did not use musculoskeletal ultrasound, when asked to identify why they had not had an ultrasound interaction, the most commonly indicated response was "no indication for imaging at this time" (76.8%, n=53). Another identified barrier was patient ineligibility at the time of the survey (14.5%, n=10). The final barrier identified, lack of awareness that the service was available, was selected by 7.2%(n=5) of respondents. Of those respondents that did not report use, 96% (n=66) reported interest in future utility. These data are included in Table 1 and Table 4.

Table 4.
Reported barriers to accessing musculoskeletal ultrasound services.

Barriers to Use:	
External patient (ineligible)	14.5%; n=10
No indication for Imaging	76.8%; n=53
Did not know it was available	7.2%; n=5
Patient opted not to have further imaging	0.0%; n=0
Other	13.0%; n=9
Choose not to answer	0.0%; n=0

Of those who were not interested in accessing musculoskeletal ultrasound (n=3) the most commonly reported barrier to interest was that they did not think it would be helpful (n=2). The other reported barrier was the perceived difficulty in interpretation (n=1). Data regarding barriers to interest are shown in Table 5.

Table 5.
Reported barriers to interest from non-users.

Barriers to Interest	
Don't think it would be helpful	66.7%; n=2
Too difficult to access	0.0%; n=0
Scheduling issues	0.0%; n=0
Other	33.3%; n=1
Choose not to answer	0.0%; n=0

Of those who did not access musculoskeletal ultrasound at the time of survey, the expected benefits reported include: confirmation of clinical impression (75.8%, n=50), increased confidence in established diagnosis (72.7%,

n=48), exclusion of differential diagnoses (66.7%, n=44), improvement in anatomic understanding (50.0%, n=33) and patient reassurance (48.5%, n=32). These data, pertaining to expectations of non-users, are included in Table 3.

Discussion

The authors collected data to investigate the role that musculoskeletal ultrasound may play not only within a chiropractic clinic but particularly within a chiropractic educational clinic setting. This survey addressed Kirkpatrick's first level of effectiveness (reaction) but did not attempt to quantify the learning opportunity or impacts on the application of the knowledge in patient treatment.[31]

The American Institute of Ultrasound in Medicine (AIUM) identifies two types of ultrasound training. The first type is exposure, where students view others perform a scan, watch a video, or listen to a lecture. The second type is focused training, which is defined as hands on, active learning where students perform and interpret the scans themselves. Exposure is the most common method employed in medical schools and is the level of involvement evaluated in this study.[20,32]

The responses to this survey suggest that most students have a positive attitude regarding the addition of ultrasonography within the imaging component of their clinical education. Although only 31.7% (n=32) of respondents reported using the services, those respondents who had experience with the ultrasonography services all indicated that their experiences were either somewhat or extremely positive. Most respondents also reported that they were somewhat (18.8%, n=6) or extremely likely (78.1%, n=25) to recommend them to their patients and colleagues. These positive attitudes are similar to those within other professional and educational settings and support the addition of these services in this setting.[1,6,18]

Both users and non-users had similar attitudes regarding improvements in anatomic understanding and exclusion of differential diagnoses. Similar distributions were seen regarding these perceived and expected benefits accordingly. More non-users expected to have confirmation of their clinical impression compared to what was perceived among users. A similar trend was seen regarding increased confidence in an established diagnosis. However, more users reported increased patient reassurance than was expected among non-users.

We found high levels of interest in future use of musculoskeletal ultrasound among interns who had not yet accessed these services. This is similar to the findings from a survey of experts within chiropractic education and specifically diagnostic imaging [4]. These high levels of interest provide support for exploring implementation of ultrasonography within educational clinic settings moving forward.

Among respondents who did not use musculoskeletal ultrasound, the most frequently identified barrier was "no indication for imaging at this time." While we would like to see more interns learning from the available experiences with musculoskeletal ultrasound, this is encouraging as it suggests that interns are using clinical information and corresponding published guidelines to inform decisions about patient imaging.

Other identified barriers included patient ineligibility at the time of the survey. At the time of the survey the services were only available to internal patients: including fellow students, faculty, staff and their families. This was a temporary barrier and has been eliminated since the conclusion of this study. Musculoskeletal ultrasound services are now available to all patients within the institution's educational clinic.

A small number of interns were not interested in accessing musculoskeletal ultrasound, among them the most common reported barrier to interest was that they did not think it would be helpful (66.7%, n=2). This may be due to the relatively small amount of information that these students had been presented regarding the benefits and advantages of ultrasound within the curriculum. The other reported barrier was the perceived difficulty in interpretation (33%, n=1). At this institution, we attempted to mitigate this barrier by not requiring the students to perform interpretation, instead providing them access to the radiologist's interpretation and reports. However, this may have not been adequately communicated to the interns. Increased communication with the interns and their supervising clinicians regarding these expectations should be considered to help eliminate this barrier.

Reported benefits, which included patient reassurance, confirmation of clinical impression and exclusion of differentials were similar to those reported in other studies.[1,6,9] The addition of diagnostic ultrasonography within a chiropractic educational clinic may have positive effects on the learners' educational experiences.

Limitations

While the results of this survey are encouraging, there are limitations which must be acknowledged. First this was a convenience sample of limited size from a single educational institution both of which limit the generalizability of the results. An additional factor that must be considered is the impact of the COVID-19 pandemic. During data collection for this study, the COVID-19 pandemic was declared a national emergency, and the clinic at the institution was closed temporarily in response. As a result, the students were required to continue their clinical education virtually and were unable to report to the clinic or interact with patients. Musculoskeletal ultrasound services were also halted during this time. This further limited the opportunities for interns to interact with patients in addition to temporarily eliminating access to the musculoskeletal ultrasound services. The COVID-19 pandemic may have also impacted the response rate of the study as the authors were only able to contact the potential respondents virtually which may be associated with lower response rates.

Furthermore, while the survey instrument was adapted from another study[9], this is the first use of the finalized questionnaire. Thus, the instrument is not validated which may affect the reliability of the results and limit comparability to other studies.

Future directions

Since the conclusion of this study, availability of musculoskeletal ultrasound services has been expanded to all clinic patients. A follow up study is in progress to see if the increased availability has impacted use or attitudes. This follow up study will allow for validation testing of the questionnaire. Additional efforts have also been made to improve communication with the supervising clinic faculty doctors, and the interns to decrease the number of perceived barriers.

In future studies it may also be beneficial to survey patients who receive the services and compare this to their clinical outcomes. In other settings, musculoskeletal ultrasound has been shown to decrease the overall number of follow up visits, decrease the need for more costly follow up imaging, and can offer reassurance to the patient regarding their condition and potential outcome.[6,12]

Conclusions

The findings of this study demonstrate positive attitudes among interns toward the initial implementation of musculoskeletal ultrasound in a chiropractic educational clinic setting. This may result in enhanced student learning and confidence, as well as increasing patient satisfaction.

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Presentation and management of a patient with rapid progression of degenerative cervical myelopathy during pregnancy: a case report

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Objective: To describe the clinical presentation and management of a patient with degenerative cervical myelopathy (DCM) during pregnancy.

Case presentation: A 34-year-old female, who was 21-weeks pregnant, presented for chiropractic evaluation with acute left upper-back pain.

Intervention and outcome: For the initial symptoms, the patient completed multidisciplinary treatment with progressive improvement in pain. At the nine-week follow-up visit, the patient described a rapid onset of extremity paresthesia and balance change. The physical examination revealed hyperreflexia. DCM was established as the working diagnosis based on clinical examination. Spinal cord compression was confirmed by MRI (magnetic resonance imaging). The patient had a cesarean delivery and anterior cervical discectomy and fusion (ACDF) surgery was performed at four-weeks

Présentation et gestion d'une patiente présentant une progression rapide de la myélopathie cervicale dégénérative pendant la grossesse: un rapport de cas
Objectifs: Décrire la présentation clinique et la gestion d'une patiente atteinte de myélopathie cervicale dégénérative (MCD) pendant la grossesse.

Présentation de cas: Une femme de 34 ans, qui était enceinte de 21 semaines, s'est présentée pour une évaluation chiropratique en raison d'une douleur aiguë dans le coin supérieur gauche du dos.

Intervention et résultats: Pour les symptômes initiaux, la patiente a suivi un traitement multidisciplinaire qui a offert une amélioration progressive de la douleur. Au cours de la visite de suivi à la neuvième semaine, la patiente a décrit un début rapide de paresthésie des extrémités et un changement au niveau de l'équilibre. L'examen physique a révélé une hyperréflexie. On a établi un diagnostic de travail de MCD fondé sur l'examen clinique. On a confirmé la compression de la moelle épinière au moyen de l'IRM (imagerie par résonance magnétique). La patiente a accouché par césarienne et on a réalisé une disectomie cervicale antérieure suivie d'une fusion (DCAF) quatre semaines

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The involved patient provided consent for case publication.

postpartum.

Summary: Symptoms associated with DCM may be wide-ranging. DCM diagnosis is commonly delayed and timely recognition and management is essential. This case highlights the importance of awareness of DCM and appropriate management for this condition.

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KEY WORDS: *case report, cervical, myelopathy, pregnancy, surgery, chiropractic*

après l'accouchement.

Résumé: Les symptômes associés à la MCD peuvent être variés. Le diagnostic de MCD est souvent retardé, et la reconnaissance et la gestion en temps opportun sont essentielles. Ce cas souligne l'importance de la sensibilisation à la MCD et de la gestion appropriée de cette maladie.

(JCCA. 2025;69(1):70-79)

MOTS CLÉS : *rapport de cas, cervical, myélopathie, grossesse, chirurgie, chiropratique*

Introduction

Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction in the adult population worldwide.[1] The prevalence of DCM is estimated to be at least 605 individuals per million in North America.[2] DCM is a chronic and progressive disorder that is characterized by compression of the cervical spinal cord due to spondylosis, degenerative disc disease, ligamentous ossification, and other degenerative conditions.[3] Patients with DCM may experience slow or rapid development of symptoms, such as decreases in manual dexterity, pain, weakness or numbness of the upper and lower extremities, gait disturbances, and bladder or bowel dysfunction.[4] Due to the degenerative nature of DCM, the older population is most often affected, with an average diagnosis at greater than 50 years of age.[3] However, DCM is not exclusively found in the older population and can affect younger adults as well.

The clinical presentation of DCM can be classified as mild, moderate, or severe,[5] based on the Modified Japanese Orthopaedic Assessment Score (mJOA) which assesses bladder control and sensory and motor function of the extremities.[5] Surgical intervention to remove spinal cord compression is the only intervention shown to prevent further disability caused by DCM.[6] Surgical cases for DCM are increasing, with an estimated prevalence of DCM related surgeries of 1.6 per 100,000 annually.[7] Although surgical decompression of the spinal cord is an effective treatment option for DCM, many patients with DCM endure an incomplete neurological recovery.[8]

Delayed diagnosis of DCM remains common and early diagnosis of DCM is imperative to preserve function and minimize disability that may result from spinal cord compression associated with DCM.[4,9,10] Studies have shown an association between delayed diagnosis, disease progression, and incomplete recovery following surgical intervention.[11,12] This highlights the importance for an increase in public and professional awareness of DCM. Despite calls for an increase in awareness of DCM, delayed diagnoses of DCM remain common with studies showing that average delays in symptom onset to diagnosis ranges between 2.2-6.3 years.[9,10,13,14]

The purpose of this paper is to discuss the diagnosis and management of a case of rapidly progressive DCM in a pregnant patient. This paper highlights diagnostic challenges and treatment approach of DCM in the setting of pregnancy.

Case presentation

A 34-year-old female presented for chiropractic evaluation at an academic tertiary medical center with a chief complaint of acute left upper trapezius musculature pain and generalized left upper back pain (Figure 1). At the time of initial chiropractic evaluation, the patient was 21-weeks pregnant and was referred for chiropractic evaluation by her obstetrician. The patient was employed as a mental health counselor and primarily worked from a home-based computer workstation. The patient described an insidious mechanism of onset of approximately six-week duration with progressive worsening of pain intensity. Pain was rated as variable in nature, between 2 to 10 out of 10 on a numerical pain rating scale. She denied antecedent fall, trauma, injury, or specific inciting incident. She described her pain as a tight and aching qual-

ity with intermittent sharp sensations. Furthermore, the patient described transient tingling along the anterolateral portion of the left arm. Swinging her left arm while walking and sitting at a computer for greater than 10-minutes were provocative in nature, exacerbating the symptoms of left upper trapezius and left upper thoracic pain. Self-stretching of the cervical spine into lateral bending was palliative in nature. Before the initial evaluation, the patient described using Tylenol and cyclobenzaprine (15 mg daily) prescribed by the referring obstetrician for pain management, with limited relief. However, heat and ice application provided temporary pain relief. She denied gait abnormalities, lower extremity symptoms, fine motor deficits in the hands or fingers, saddle anesthesia, bladder or bowel dysfunction, or issues with balance or falls.

A chart review of the patient's past medical history revealed plain film imaging of the cervical spine secondary to a motor vehicle collision approximately 10 years prior to the initial chiropractic evaluation. Imaging of the cervical spine revealed no abnormal findings. Physical examination performed during the initial chiropractic evaluation revealed blood pressure, pulse, and temperature to be within normal limits. Additionally, motor strength testing was 5+ equal and bilateral throughout the upper and lower extremities. Sensation to light touch was intact equal and bilateral throughout the upper and lower extremities.

Figure 1.

Timeline graphic representation of management. This timeline demonstrates an overview of the patient's clinical journey, from initial presentation through multidisciplinary management, collaborative care decisions, and subsequent interventions.

Biceps, brachioradialis, patellar, and achilles deep tendon reflexes were 2+ equal and bilateral. Pathological reflexes were evaluated through testing of the Hoffman reflex and assessment for sustained ankle clonus, both of which were grossly unremarkable on examination. Lhermitte's sign was unremarkable. Cervical ranges of motion were moderately limited in extension, flexion, lateral bending, and rotation bilaterally with provocation of the patient's

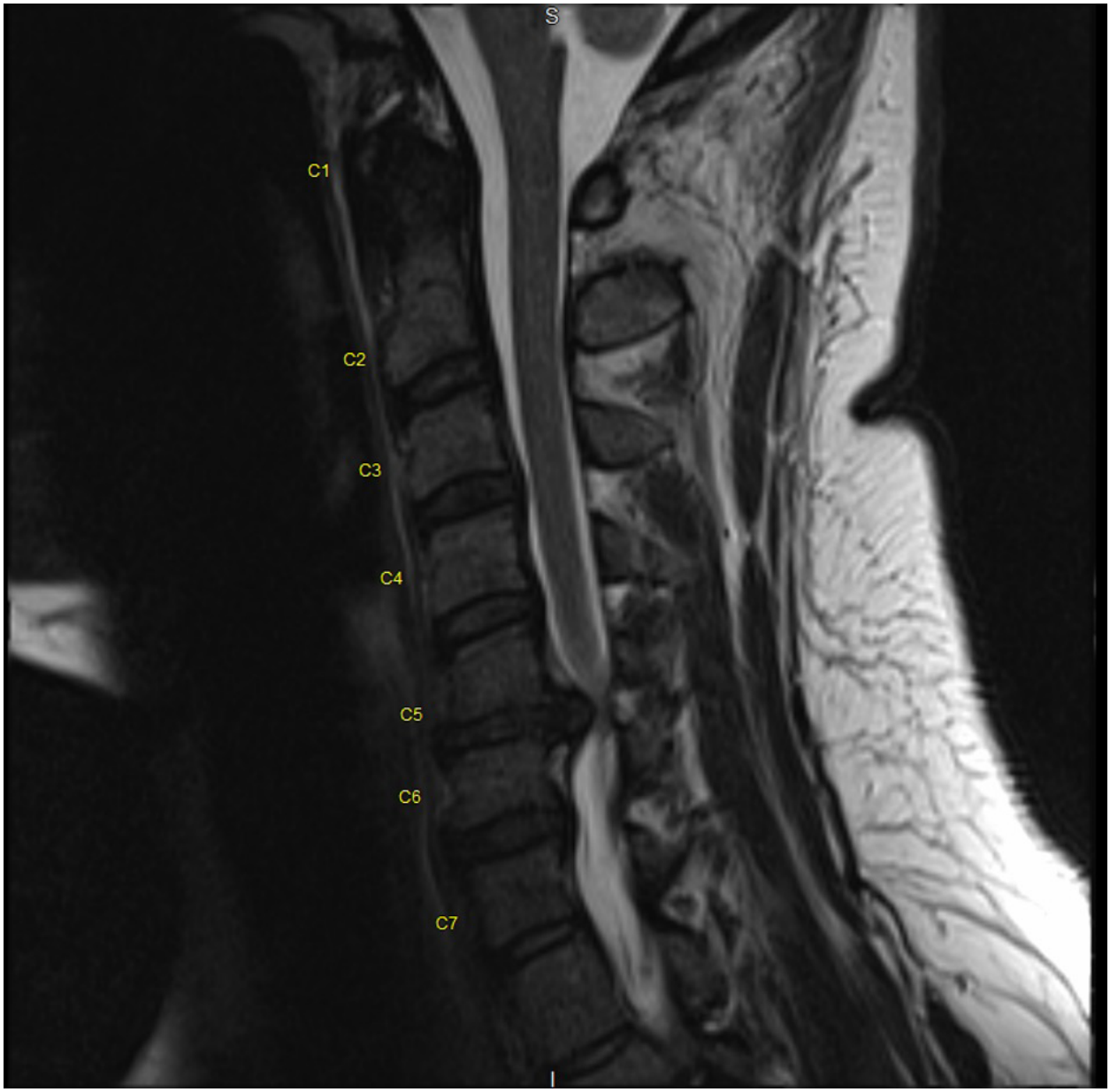

Figure 2.
Magnetic resonance imaging (MRI) confirming clinical diagnosis of cervical myelopathy. MRI sagittal view shows severe central canal stenosis at C5-C6 with 10 millimeters of disc extrusion causing cord compression with complete effacement of surrounding cerebrospinal fluid.

chief complaint. Maximum foraminal compression testing re-produced the patients' pain complaints on the left. Gentle manual cervical traction was relieving. Upper limb tension test (A) on the left and Spurling's test on the left provoked diffuse pain at the cervicothoracic junction.

A primary working diagnosis of cervical radicular pain

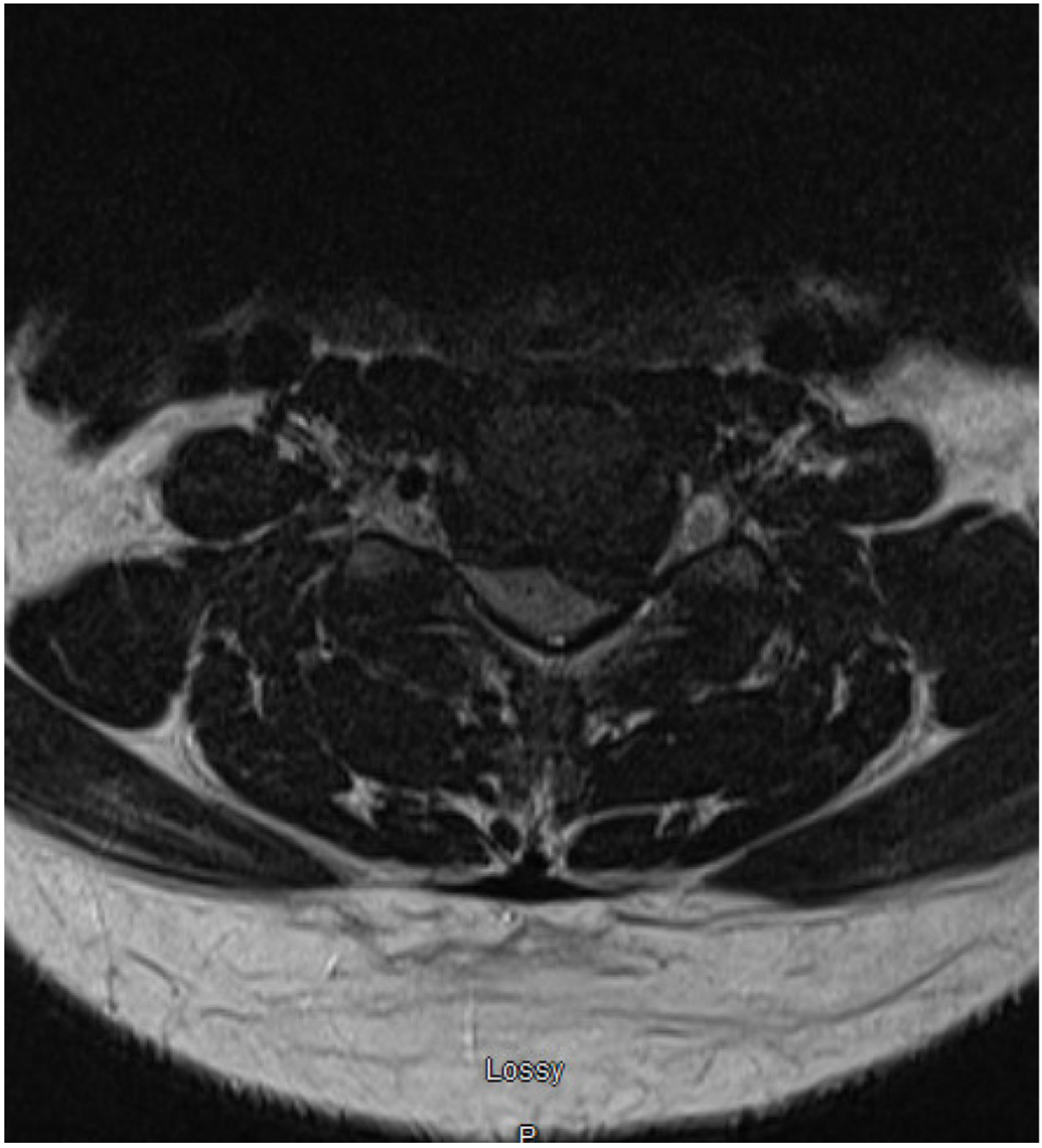

Figure 3.

Magnetic resonance imaging (MRI) confirming clinical diagnosis of cervical myelopathy. MRI axial view shows severe central canal stenosis at C5-C6 with 10 millimeters of disc extrusion causing cord compression with complete effacement of surrounding cerebrospinal fluid.

with acute nonspecific musculoskeletal related pain in the cervicothoracic spine was established. Through a shared decision-making process with the patient, a plan of care was established to proceed with a multidisciplinary care approach, including physical therapy, occupational therapy, and chiropractic care. Over a six-week period, the patient completed two physical therapy sessions, one occupational therapy session, and four chiropractic treatment sessions. Physical therapy sessions included supervised exercise with home exercise prescription focused on repeated cervical spine retraction exercise and scapular stabilization exercises. Occupational therapy evaluation included an assessment of workstation and home ergonomics with recommendations to optimize body mechanics and lifting techniques. Chiropractic treatments consisted of soft tissue manipulation of the upper trapezius and cervical paraspinal musculature, as well as upper thoracic joint manipulation. The patient responded favorably to this multidisciplinary management plan over the 6-week period. She described progressive reductions of pain level variability with a report of pain variability rated 1 to 5 out of 10 on a numeric pain rating scale at the sixth week of care. Due to progressive reduction of pain by the sixth week of care, the patient was invited to return for chiropractic care on an as needed basis.

The patient returned to the chiropractor nine weeks after the initial evaluation with reports of continued improvement in her pain complaints. However, she described an insidious mechanism of onset of numbness and tingling in the bilateral hands and thighs that was most prominent with cervical extension. The patient also described a new onset of balance dysfunction, though denied falling. She denied deficit in fine motor control of the hands/fingers, saddle anesthesia, and bladder and bowel incontinence/retention. Physical examination revealed 3+ patellar deep tendon reflexes bilaterally and 2+

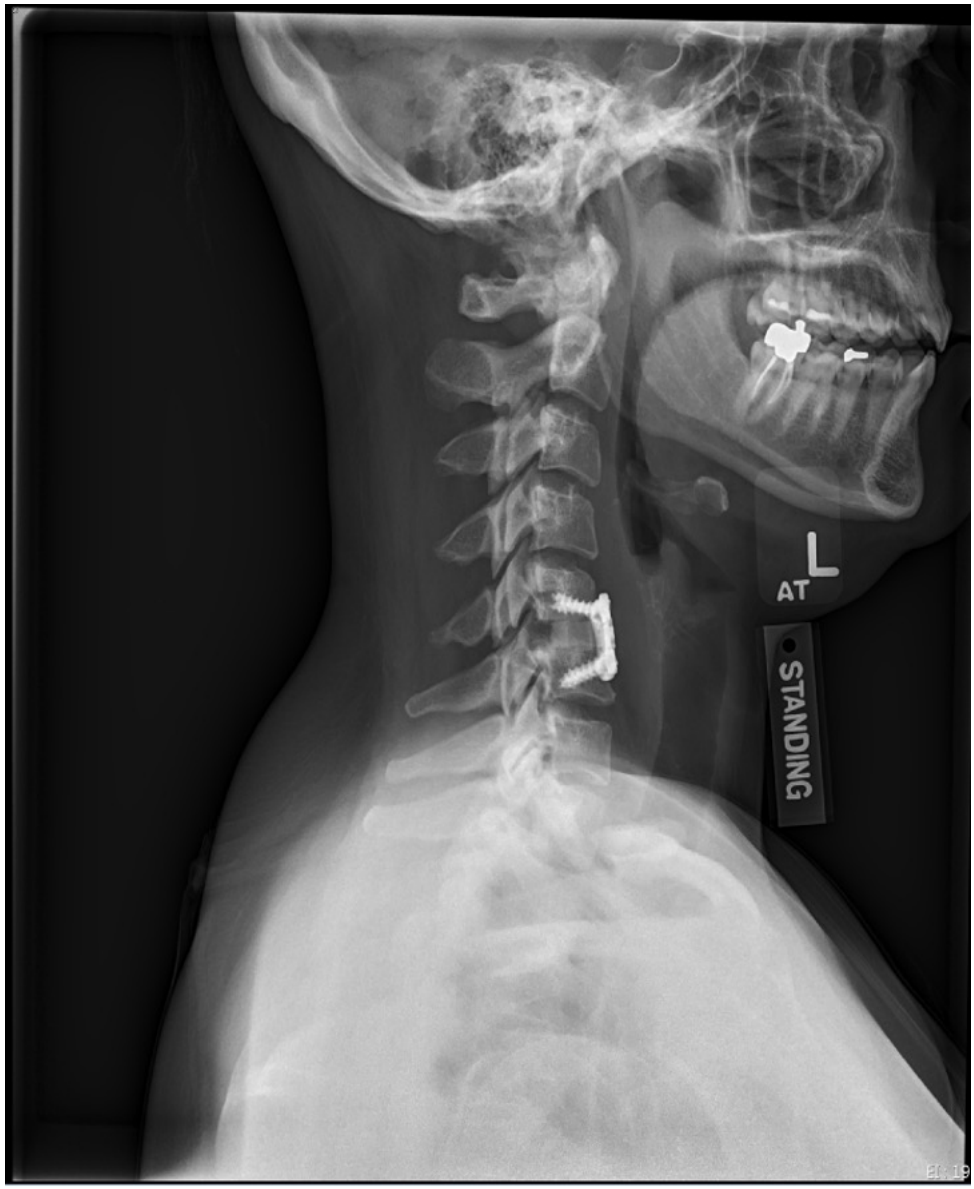

Figure 4.
Lateral view of cervical spine x-ray at 6-weeks following anterior cervical discectomy and fusion (ACDF) surgery for degenerative cervical myelopathy (DCM). X-ray shows normal postoperative healing without hardware complication.

achilles, biceps, and brachioradialis deep tendon reflexes bilaterally. Sensation to light touch was decreased equally and bilaterally in the medial thighs, within the L2 and L3 dermatomes. Hoffman sign was absent and there was no ankle clonus appreciated on physical examination. A primary working diagnosis of cervical myelopathy was established. A cervical magnetic resonance imaging (MRI) study was completed and confirmed cervical spinal cord compression. MRI revealed severe central canal stenosis at C5-C6 with 10 millimeters of disc extrusion causing complete effacement of surrounding cerebrospinal fluid (Figure 2, Figure 3).

The patient was referred for neurosurgical evaluation. At the time of neurosurgical evaluation, the patient was 35-weeks pregnant. The plan of management for this complaint was cervical spine surgery following labor. The neurosurgical and obstetric team recommended a caesarean section at 37 weeks followed by cervical spinal cord decompression early postpartum. There are no definite guidelines for timing of cervical spine surgery in the postpartum period. Therefore, the neurosurgery team and the obstetric team came to a consensus on timing for surgery that would be safe and feasible for the patient. At four-weeks postpartum, a C5-C6 anterior cervical discectomy and fusion (ACDF) surgery was performed. At six-weeks postoperative neurosurgery follow-up, the patient described resolution of paresthesia with no abnormal neurologic findings upon examination. Postoperative x-rays were completed which revealed normal postoperative healing without hardware complication (Figure 4).

Discussion

We present a case illustrating the evaluation and management of DCM in a pregnant patient. This case is unique as it describes the rapid progression of symptoms and the management of a patient diagnosed with DCM during pregnancy. In this case, the recognition of a new onset of distinct features associated with DCM, despite the patient's progressive improvement in pain complaints, was critical for timely diagnosis of DCM. Symptoms associated with DCM have been reported to mimic other, less severe, neurological disorders such as peripheral neuropathies.[15] However, the clinical signs and symptoms associated with DCM may mimic other severe pathologies such as multiple sclerosis, amyotrophic lateral sclerosis, and acute transverse myelitis.[16] It is critical that spinal pathologies caused by other disease processes are not overlooked in patients presenting with neurological symptoms suggestive of myelopathy and a timely and accurate diagnosis is established. A summary of differentiating features associated with neuromusculoskeletal pathologies that can mimic DCM is described in Table 1. Further detailed discussion regarding the differentiation of various pathologies mimicking DCM has been discussed elsewhere.[16]

Additionally, the term "degenerative cervical myelopathy (DCM)" has recently been identified as the preferred terminology to broadly define a disease state characterized by compression on the cervical spinal cord resulting in progressive neurological dysfunction. The term DCM was decided upon by a multi-disciplinary stakeholder group, which included persons living the disease. In the past, this condition has been labeled with multiple different names which created confusion and limited scientific progress. The term DCM was decided upon to unify the field and we have chosen to reflect that in the manuscript.[17]

As in the current case, the diagnosis of DCM was largely dependent upon an appropriate history and physical examination. Significant history findings may include a wide range of symptoms manifesting as a result of cord compression. For example, patients may describe difficulty opening a jar, buttoning a shirt, writing, balance impairments, and neck pain. The physical examination for DCM should include testing with moderate to high sensitivity and specificity to ensure appropriate diagnosis and management.[18] A recent systematic review and meta-analysis found that Tromner test and hyperreflexia are the most sensitive clinical tests for diagnosing DCM; Babinski sign, Tromner test, clonus, and inverted supinator sign are the most specific clinical tests for diagnosing DCM.[18] Guideline recommendations suggest that if there is a suspicion of DCM, additional imaging is needed to confirm or refute the diagnosis.[18] MRI is currently the gold standard for confirmation of spinal cord compression in DCM.[19]

Current clinical practice guidelines recommend that patients with mild DCM should be offered surgical intervention or the option to participate in structured rehabilitation.[6] However, surgical intervention is recommended for patients with moderate and severe DCM.[6] In this case, the patient initially presented with radicular pain and non-specific acute musculoskeletal pain. Guidelines rec-

ommend a multimodal approach to managing musculoskeletal pain,[20] which in this case consisted of supervised exercise, patient education, soft tissue therapy, and spinal manipulative therapy. After 6-weeks of conservative therapy the patient reported improvement of musculoskeletal pain associated with DCM, though described and demonstrated new neurologic symptoms which required surgical intervention. In the current case, the patient had severe spinal cord compression due to a disc herniation with rapidly progressive cervical myelopathy. As straining

Table 1.
Differentiation of clinical features of neuromusculoskeletal pathologies from degenerative cervical myelopathy (DCM).[16, 22, 23, 24]

Pathology	Signs and Symptoms	Differentiating Features from DCM	Diagnostic Confirmation
Multiple sclerosis	Vision changes, bladder disturbances, gait abnormalities, fatigue, unilateral extremity paresthesia	Vision changes including diplopia and loss of vision, unilateral extremity paresthesia, fatigue, Uhthoff phenomenon (worsening in warm environment)	White matter lesions on MRI, oligoclonal bands present in cerebrospinal fluid, 2 episodes of disturbances, raised IgG
Amyotrophic lateral sclerosis	Hoffmans sign, Babinski sign, gait abnormalities, muscular atrophy, loss of fine motor skills, fasciculations and weakness in the face or extremities	Fasciculations, speech changes, dysphagia, unintentional weight loss	EMG reveals lower motor neuron disease, bilateral changes within the corticospinal tracts on MRI
Parkinson disease	Tremors, rigidity, bradykinesia, initial onset is unilateral then progresses to a bilateral distribution, decreased dexterity, shuffling gait	Shuffling gait, tremors, speech changes, dysphagia, small handwriting, involuntary movements	Nigral signal changes on MRI, changes on EMG
Carpal tunnel syndrome (CTS)	Unilateral or bilateral hand pain, numbness and tingling in the median nerve distribution, nocturnal symptoms, dysesthesia, thenar atrophy in late stages	Symptoms isolated to unilateral or bilateral hand or forearm, absence of Hoffmans sign and Babinski sign, positive CTS provocative tests on examination	Diagnosis is largely based on history and physical exam, however electrodiagnostic studies may help guide clinical decision making
Cubital tunnel syndrome	Numbness and tingling in the ulnar nerve distribution, Wartenberg sign, hand weakness specifically in the fourth and fifth digits	Symptoms isolated to hand or forearm, absence of Hoffmans sign and Babinski sign, positive cubital tunnel syndrome provocative tests on examination	Diagnosis is largely based on history and physical exam, however electrodiagnostic studies may help guide clinical decision making
Acute transverse myelitis	Weakness or paralysis of the extremities, well-defined sensory level distribution, autonomic dysfunction	Flaccid paraparesis of the extremities, difficulty flexing legs and extending arms, autonomic dysfunction	T2 signal changes on MRI
Syringomyelia	Cape-like sensory distribution, weakness, loss of pain and temperature sensation, vision changes, gait disturbances, dizziness	Cape-like sensory distribution, loss of pain and temperature sensation, vision changes, dizziness	Diagnosis is confirmed by the presence of a syrinx on MRI

during labor can induce further disc herniation and may lead to neurological deterioration[21], a cesarean section was recommended to protect both the mother and baby. This recommendation facilitated early surgical intervention to address the DCM.

The early recognition of signs and symptoms of DCM ensured timely imaging and an appropriate clinical plan. This case further emphasizes the need for timely recognition of DCM and early referral for appropriate intervention.

Summary

This unique case which describes the diagnosis and management of DCM in a pregnant patient features the importance of timely recognition and diagnosis of DCM. Diagnostic delays are common and are likely associated with low awareness of DCM and the wide range of symptoms associated with DCM which may be subtle in nature. Given the potential rapid progression of the disease with functional deterioration, it is important that portal-of-entry health care professionals be aware of the clinical features and management of DCM.

Limitations

The case report is subject to limitations due to being based on a single individual's clinical presentation and outcomes. Moreover, the findings in the case report cannot be generalized to a larger population. Additionally, the retrospective nature of the case report limits the ability to account for potential documentation and recall bias. Although efforts have been made to provide a comprehensive description of the clinical presentation and management, additional variables such as psychosocial factors, and other concurrent unknown treatment may have influenced the described outcomes. Potential additional variables were not investigated or reported in the case report. Finally, the patient's perspective was not explored as a component of the case report.

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Ewing sarcoma of the clavicle: a case report

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The aim of this case study is to demonstrate an unusual location of Ewing Sarcoma and promote awareness of the effects of patient care regarding delay in diagnosis. A 23-year-old male presented with a painless soft tissue mass over the left clavicle of two months. Initial radiographs of the clavicle were reported negative. Approximately one year later the patient stated the mass had become painful and increased in size. Repeat radiographs demonstrated permeative destruction within the left clavicle with adjacent soft tissue mass. Follow up imaging of CT, MRI, and PET-CT characterized the lesion and demonstrated metastatic disease. Subsequent biopsy confirmed a diagnosis of primary Ewing sarcoma.

Sarcome d'Ewing de la clavicule: un rapport de cas
L'objectif de cette étude de cas est de présenter un emplacement inhabituel du sarcome d'Ewing et de promouvoir la sensibilisation aux effets des soins aux patients concernant le retard dans le diagnostic. Un homme de 23 ans s'est présenté avec une masse de tissu mou indolore sur la clavicule gauche présente depuis deux mois. Les radiographies initiales de la clavicule se sont révélées négatives. Environ un an plus tard, le patient a déclaré que la masse était devenue douloureuse et que sa taille avait augmenté. Des radiographies répétées ont montré une ostéolyse ponctuée au niveau de la clavicule gauche accompagnée d'une masse de tissu mou adjacente. Un suivi par imagerie au moyen de la tomographie par ordinateur, de l'IRM et de la tomographie par émission de positons (TEP) tomographie par ordinateur a permis d'identifier la lésion et de déceler une maladie métastatique. Une biopsie subséquente a confirmé un diagnostic de sarcome d'Ewing primaire. Le patient a été aiguillé pour une prise en charge en oncologie, comprenant de la

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The involved patient provided consent for case publication.

The patient was referred for oncologic management including chemotherapy and radiation with initial remission post treatment. Unfortunately, the tumor recurred two years later. Timely diagnosis, appropriate management and referral of patients with suspicious presentation is critical to future outcomes.

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KEY WORDS: chiropractic, clavicle, delay of diagnosis, diagnostic imaging, Ewing sarcoma, management

chimiothérapie et de la radiothérapie, qui a entraîné une rémission initiale après le traitement. Malheureusement, la tumeur est réapparue deux ans plus tard. Un diagnostic rapide, une gestion appropriée et un aiguillage des patients présentant des signes suspects sont essentiels pour les résultats à venir.

(JCCA. 2025;69(1):80-87)

MOTS CLÉS : chiropratique, clavicule, retard de diagnostic, imagerie diagnostique, sarcome d'Ewing, gestion

Introduction

Ewing sarcoma is an aggressive tumor that can occur in both osseous and soft tissue structures. The most common locations involve the long bone, with the femur being the most common.[1] Ewing sarcoma is part of the small round blue cell tumor family, also known as the Ewing sarcoma family of tumors, which also includes primitive neuroectodermal tumor and Askin tumor.[2]

The clavicle is a rare site of primary bone tumors, which may be related to its development, lack of medullary cavity, and sparse vascular supply.[3] This case demonstrated an aggressive lesion in an unusual location and the importance of timely diagnosis.

Case presentation

A 23-year-old male presented to the Veterans affairs medical center with a painless soft tissue mass noted over the left clavicle that began approximately two months prior. An initial radiographic clavicle series was performed and read as negative (Figure 1) and no further imaging was recommended. Approximately six months later, the soft tissue mass had grown in size and become painful. The patient reported back to the primary due to the change in symptoms, and a second radiographic series of the clavicle was performed which demonstrated a moth eaten to permeative pattern of bony destruction with a laminated periosteal reaction on both the superior and inferior as-

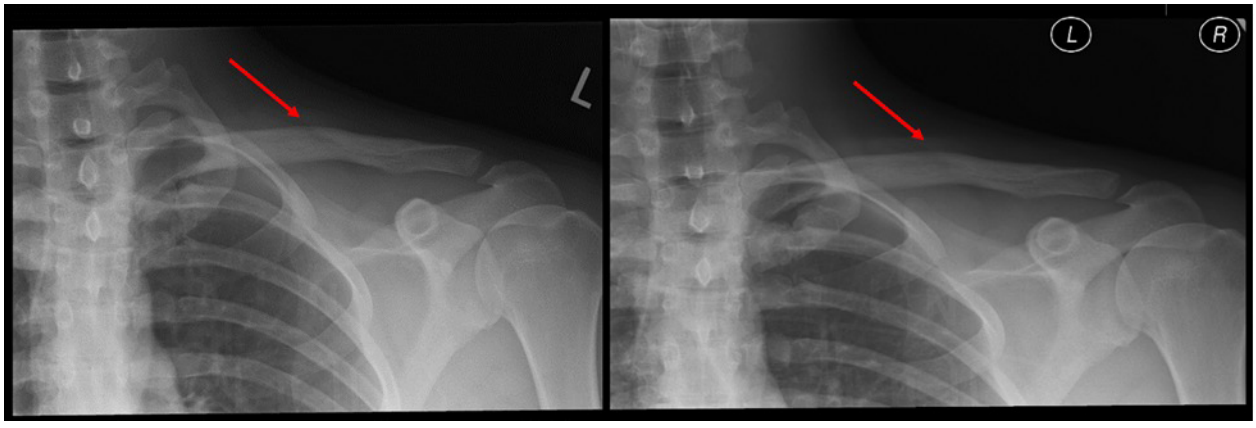

Figure 1.

I*nitial clavicle radiographs: AP and Axial views. Initial AP projection exhibits apparent ill-defined destruction cortex of the midshaft of the diaphysis of the clavicle on retrospective review. Initial axial clavicle projections exhibited a faint single lamination periosteal reaction at the superior cortex of the clavicle in the same region.*

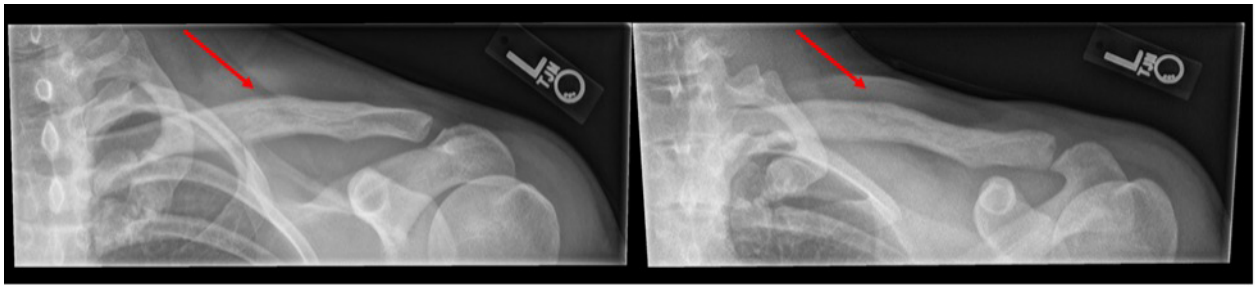

Figure 2.
Follow up AP clavicle radiographs 6 months later: AP and Axial views. Follow-up radiographs revealed an ill-defined moth eaten to permeative pattern of lytic destruction with a laminated periosteal reaction and cortical destruction.

pects of the clavicle (Figure 2). Mild prominence is noted within the soft tissues directly superior to the clavicle. Retrospectively, the initial study had questionable loss of the cortical margin on the superior aspect of the clavicle with a mild periosteal reaction.

Follow-up imaging was performed to further characterize the lesion and determine the extent of involvement to include computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) CT of the thorax. The CT study confirmed the permeative bony destruction of the left clavicle and demonstrated a soft tissue mass with attenuation similar to adjacent musculature (Figure 3).

The MRI demonstrated high signal intensity within the marrow of the clavicle with an adjacent high signal intensity of the surrounding soft tissue mass resulting in

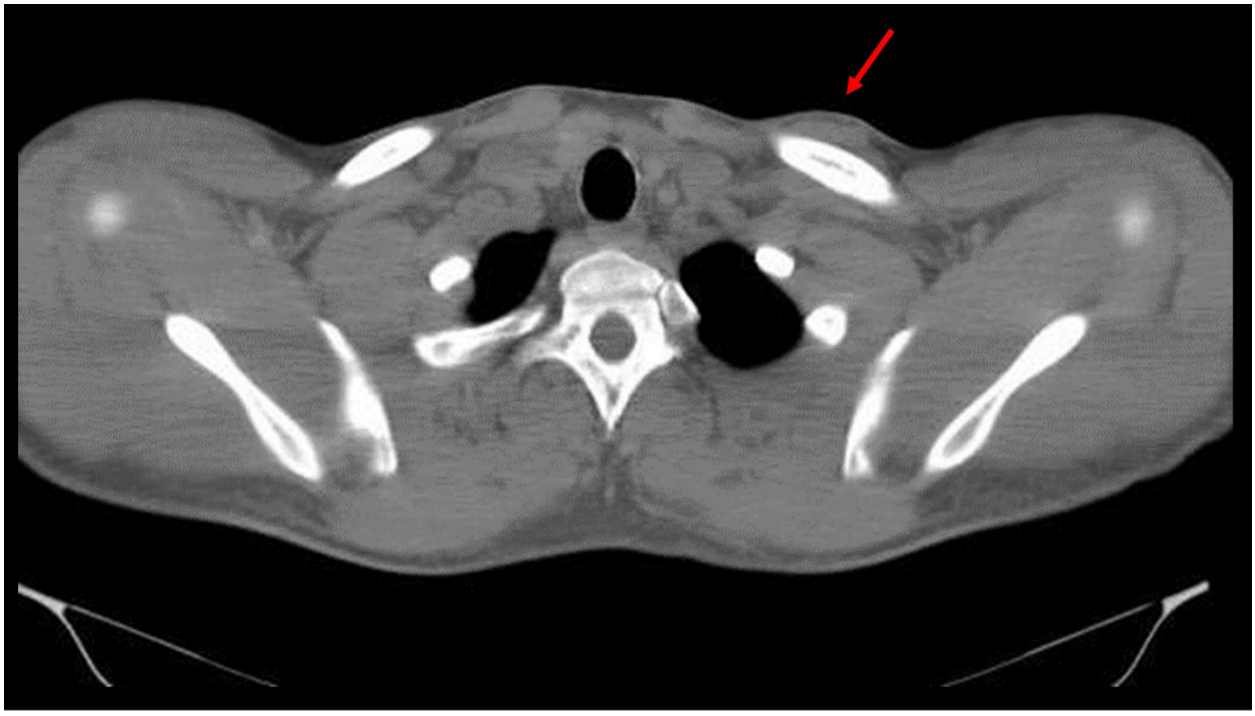

Figure 3.
Axial CT of the clavicle. Axial CT demonstrated the permeative pattern of osseous destruction with an adjacent soft tissue mass.

mass effect on the adjacent soft tissue planes on the T1 sequence with fat suppression. The laminated periosteal reaction is also well noted on this study (Figures 4a and 4b).

The PET CT demonstrated metastasis to the right ilium, right scapula, and C4 vertebral body (Figure 5a and 5b). The MRI of the cervical spine demonstrated low signal intensity on T1 and high signal intensity on T2 with the

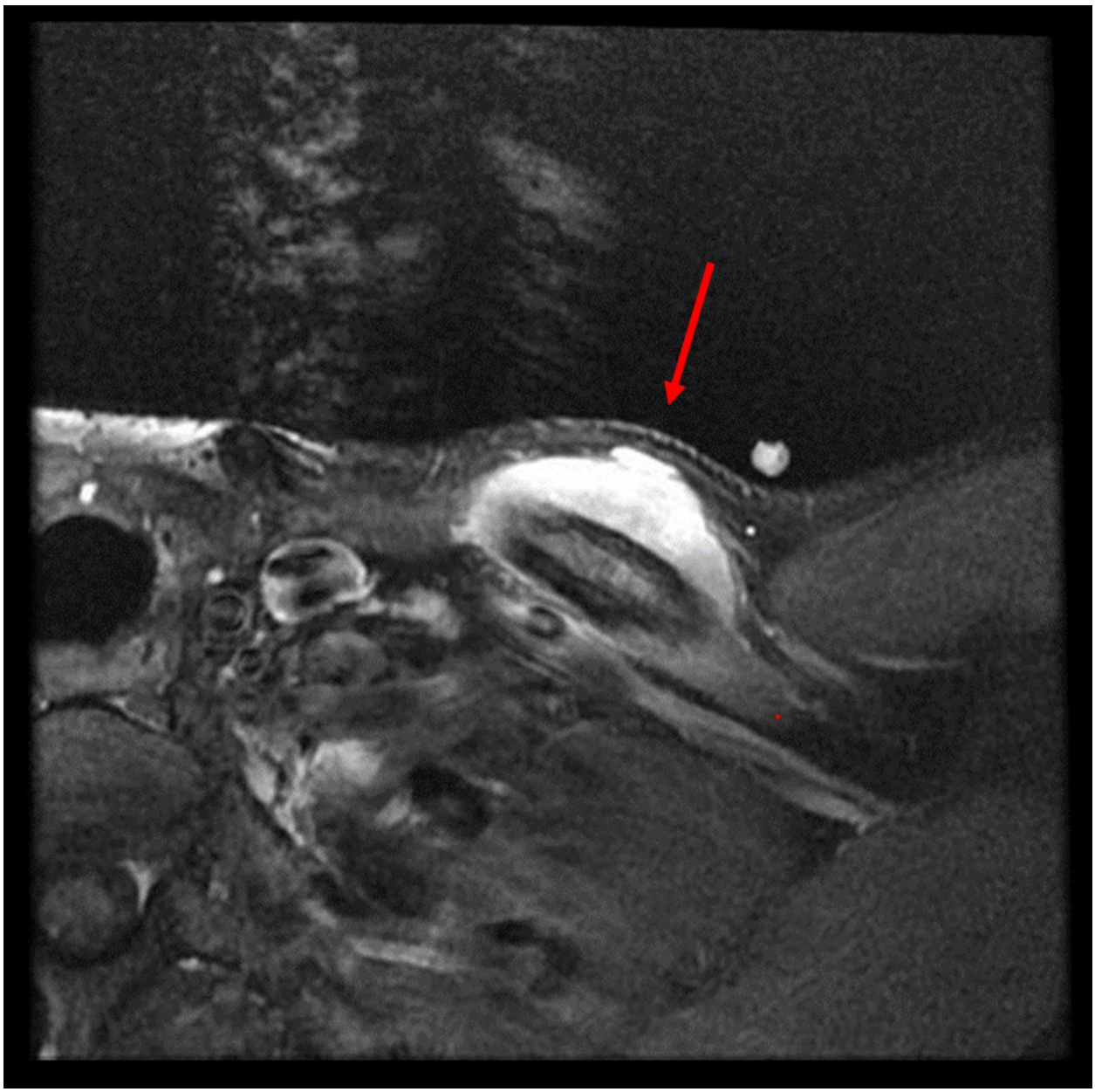

Figure 4a.

Axial T1 fat suppression with contrast MRI. Large homogenous contrast-enhancing soft tissue mass with heterogeneous medullary and various areas of cortical enhancement about the midshaft of the clavicle. Similar findings were noted throughout the length of the clavicle (not shown).

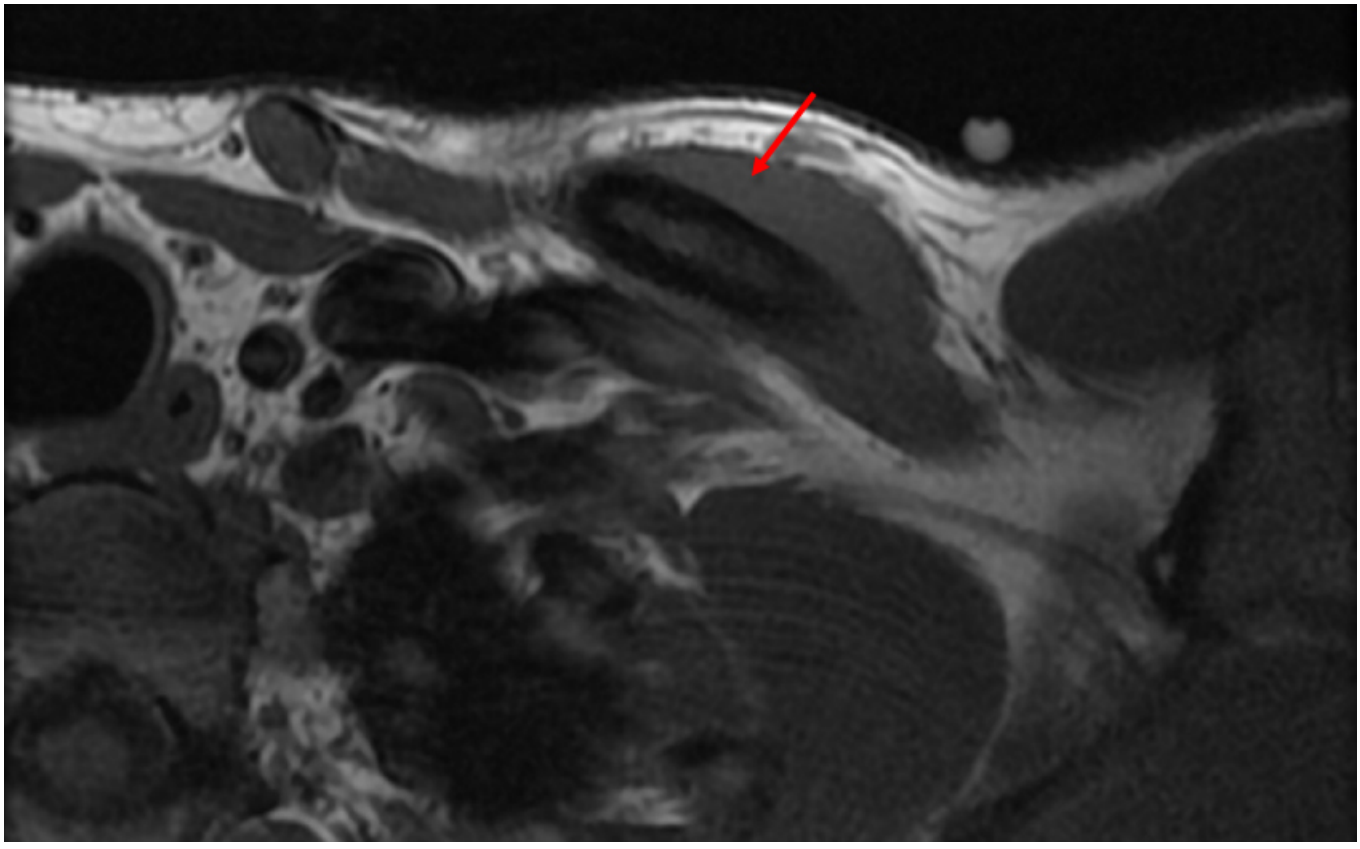

Figure 4b.
Axial T1 fat suppression without contrast MRI. Large soft tissue mass with diffusely low signal noted in the medullary aspect of the midshaft of the clavicle. Again, similar findings were seen throughout the length of the clavicle (not shown).

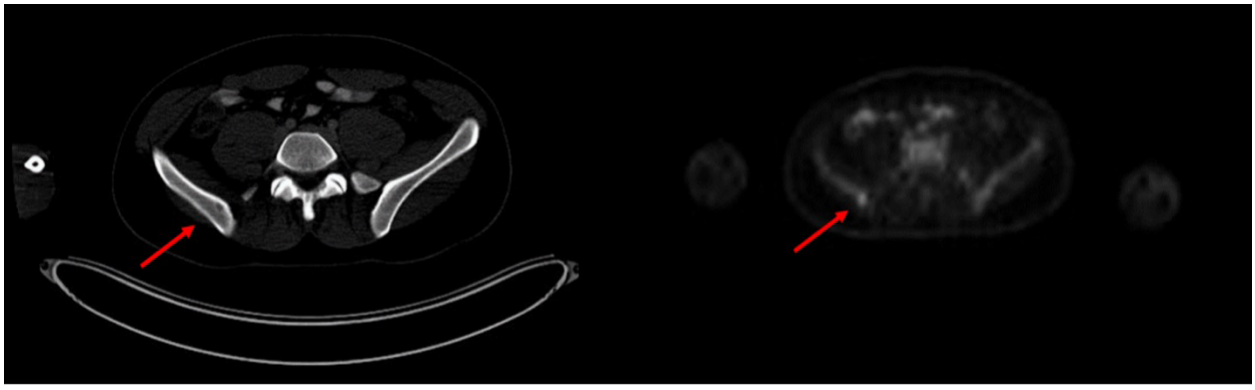

Figure 5a.
Axial PET-CT. Circular hypoattenuating lesion about the medial aspect of the posterior portion of the ilium measuring approximately 6.2mm x 3.5 mm (arrow), consistent with osseous metastasis.

left aspect of the vertebral body and transverse process of C4. Increased uptake was also noted in the lymph nodes of the upper cervical spine which was suspected to be a reactive or inflammatory reaction rather than a true site of metastasis (Figure 6).

The initial working diagnosis based on imaging was

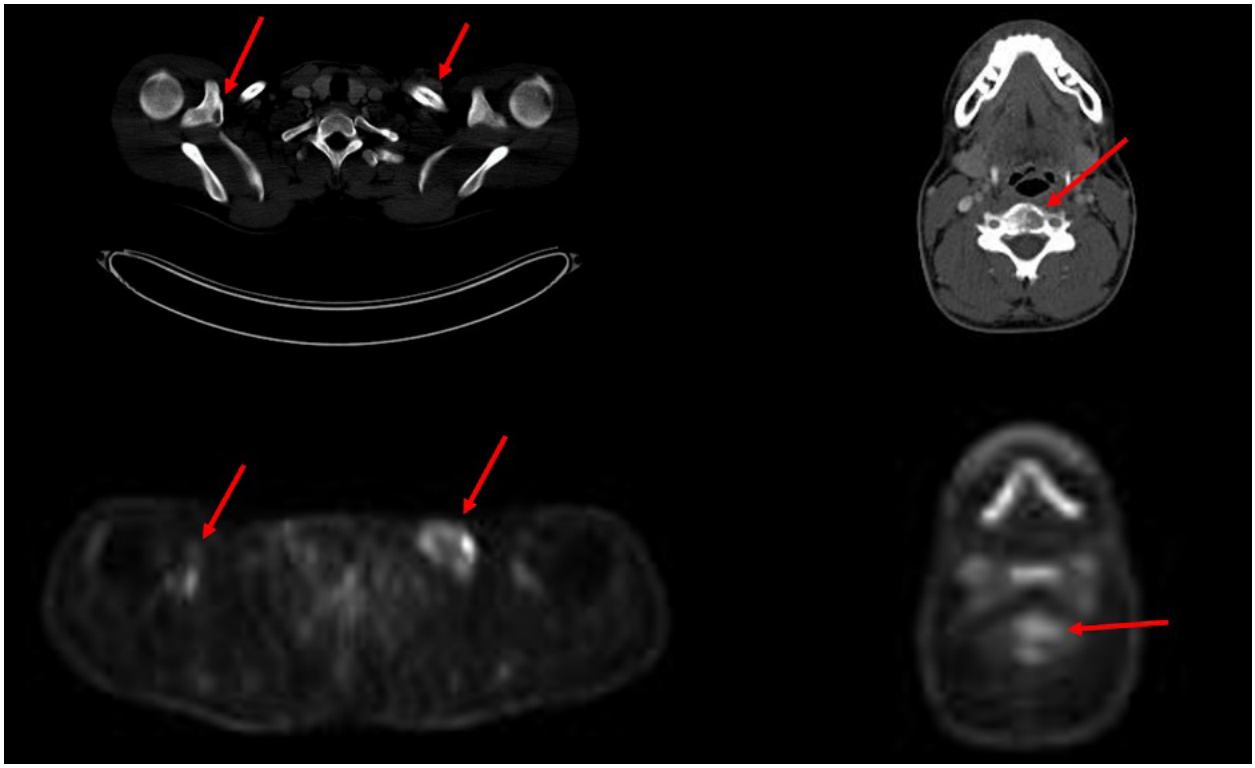

Figure 5b.

Axial PET-CT at the levels of the clavicle and C4. Images demonstrate primary lesion of the left clavicle as well as right scapular metastasis (arrows on left image) and metastasis to the C4 vertebral body (arrow on right image).

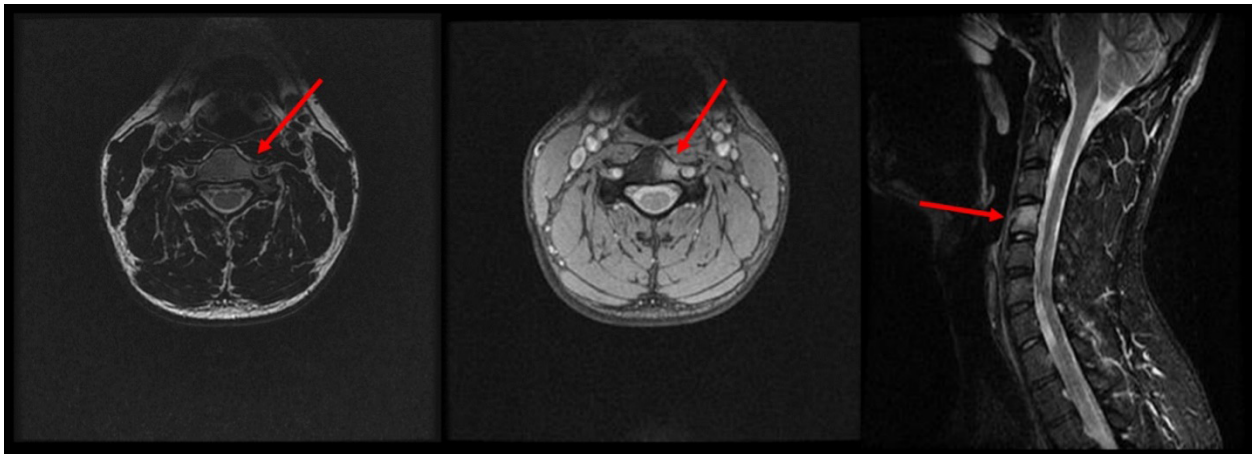

Figure 6.

Cervical MRI. Axial and sagittal MRI images with metastasis to the C4 vertebral body and left transverse process.

osteosarcoma. The lesion was then biopsied and demonstrated crushed small round blue cells within both the osseous and soft tissue components, which is consistent with Ewing Sarcoma. The fluorescence in situ hybridization (FISH) test was positive for the EWSR1 gene rearrangement, which changed the final diagnosis to Ewing Sarcoma.

The patient was referred back to the primary care physician with subsequent oncology referral for staging and treatment. Treatment included chemotherapy and radiation therapy. Following treatment the patient went into remission. Reoccurrence of the tumor occurred two years later, again treated with chemotherapy. The patient has since passed due to related complications.

Discussion

This case demonstrated a primary malignant tumor of the left clavicle. The clavicle is an unusual location for Ewing sarcoma. Almost half of the patients who develop Ewing sarcoma are between the ages of 10 to 20 years old, with up to 70% being under the age of 20.[4] Clinical presentation of this lesion typically includes pain and swelling in the region, as well as general constitutional symptoms.[5] In our case, the primary presentation was a soft tissue mass with a delayed onset of pain.

The most common locations, which account for 86% of cases, include the pelvis, extremities, and ribs.[6] The clavicle accounts for 1% of involved sites,[5] making our case an unusual location.

Radiographs, computed tomography, magnetic resonance imaging, and nuclear imaging should be utilized in the diagnosis of Ewing Sarcoma.[7] Typical imaging features include an aggressive moth-eaten or permeative destructive pattern with a laminated periosteal reaction.[5] Cortical destruction is often noted, however may not be obvious on radiographs[4]. Lytic lesions are often accompanied by a large soft tissue component that often does not contain calcification.[6] Biopsy is utilized to recognize round blue cells.[8] Cytogenetic testing to identify the specific chromosomal aberration may also be performed.[4,8]

The most common sites of metastasis secondary to Ewing sarcoma include lung, bone, or a combination.[6] Metastasis to bone occurs in 40%.[2,6] Metastasis occurs to the lungs in 80% of cases, however this was not present in our patient, also an interesting component of this case.[2,6]

A study by Yu *et al*.[3] found that of tumorous lesions of the clavicle 61.7% were malignant, with metastatic disease, plasma cell myeloma, and osteosarcoma being the most common. The mean age of this study was 53.5 years old, which is outside our patient demographic, however osteosarcoma was the initial working diagnosis for this lesion.[3] This study also found that malignant tumors had a lower incidence of periosteal reaction, but with a higher incidence of a soft tissue mass.[3] Interestingly a study by Kapoor, Tiwari, and Kapoor[9] found Ewing Sarcoma to be the most common primary malignant lesion of the clavicle in patients aged 12-22 years old, in contrast to our case where the patient was just outside this demographic.

The most common location for the EWSR1 gene rearrangement is on chromosome 22 and 11, which leads to the EWSR1 and FL1 gene fusion that is responsible for 80% of Ewing sarcomas.[4]

Unfortunately, delayed diagnosis with Ewing Sarcoma occurs frequently with the average time between initial presentation and diagnosis being 3.7-6.3 months.[10] Up to 21% of patients have metastasis at the time of presentation.[7,10] A study done by Bacci *et al*.[7] found that the time to diagnosis did not correlate with the stage of disease, however patients with metastatic disease at the time of presentation were often diagnosed sooner than with localized disease. Five-year survival rate for patients with metastatic disease is approximately 0-34%.[2] Osseous metastatic disease carries a poor prognosis.[2] In this case, the delay in diagnosis was approximately seven months, and there was evidence of osseous metastatic disease at diagnosis.

Management for aggressive clavicular lesions can include en bloc resection, which Li *et al*.[11] found resulted in good tumor control, however less favorable outcomes still occurred if metastatic disease was present.[11] Ewing Sarcoma is more sensitive to chemotherapy and radiation when compared with an osteosarcoma.[12] These were the only treatment modalities used in our case.

This case emphasizes the importance of delay in diagnosis and possible treatment options. It is important as treating clinicians to utilize all diagnostic imaging and physical exam findings when unusual patient symptomatology presents.

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Migraine resolution in a patient receiving Cox® flexion-distraction and thoracolumbar spinal manipulative therapy: a case report

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Objective: *This case report describes the use of flexion-distraction as a chiropractic treatment for a 46-year-old woman experiencing acute-onset migraine headaches.*
Clinical features: *A 46-year-old woman with acute-onset migraine headaches sought an evaluation at our chiropractic clinic. She reported experiencing 10 headaches per month for the past two months. Prior to visiting our clinic, she consulted several doctors and tried several medications for relief of her migraine headaches.*

Intervention and outcome: *A trial of conservative care using flexion-distraction was applied to the cervical spine as a primary intervention for managing her acute migraine headaches, along with the application of thoracolumbar spinal manipulation. After 13 sessions over six weeks, the patient reported less pain, a notable*

Résolution de la migraine chez une patiente recevant une thérapie par manipulation vertébrale thoracolombaire et en flexiondistraction Cox®: un rapport de cas
Objectifs: *Ce rapport de cas décrit l'utilisation de la flexiondistraction comme traitement chiropratique pour une femme de 46 ans atteinte de migraines aiguës.*

Caractéristiques cliniques: *Une femme de 46 ans atteinte de migraines aiguës a demandé une évaluation à la clinique chiropratique. Elle a déclaré avoir éprouvé 10 maux de tête par mois au cours des deux derniers mois. Avant de se rendre à la clinique, elle a consulté plusieurs médecins et a essayé plusieurs médicaments pour soulager ses maux de tête.*

Intervention et résultats: *Un essai de traitements conservateurs au moyen de la flexiondistraction a été appliqué à la colonne cervicale comme intervention principale pour gérer ses migraines aiguës, en plus de l'utilisation de la manipulation de la colonne thoracolombaire. Après 13 séances sur six semaines, la patiente a signalé une diminution de la douleur, une diminution notable de la fréquence de ses migraines*

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The involved patient provided consent for case publication.

decrease in the frequency in her migraine occurrences and in her use of pain medication, increased sleep, and an improved mood.

Summary: *The flexion-distraction chiropractic approach effectively managed acute migraine headaches in a middle-aged woman.*

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KEY WORDS: classic migraine, headache, case report, chiropractic, spinal, manipulation, flexion-distraction

et de son utilisation de médicaments contre la douleur, une augmentation du sommeil et une amélioration de l'humeur.

Résumé: *L'approche chiropratique de flexiondistraction a efficacement géré les migraines aiguës chez une femme d'âge moyen.*

(JCCA. 2025;69(1):88-94)

MOTS CLÉS : migraine classique, mal de tête, rapport de cas, chiropratique, vertébrale, manipulation, flexiondistraction

Introduction

Migraine represents one form of primary headache without an identifiable cause, but several theoretical models of causation have been proposed, as discussed below. Notably, the one-day prevalence of headache suggests that 15.8% of the global population have a headache, and almost half of them (7%) have a migraine.[1] The World Health Organization (WHO) recognizes migraines as a major public health concern due to their high prevalence and substantial societal costs in terms of healthcare expenses and lost productivity.[2,3] Symptoms of migraine can include nausea, vomiting, photophobia and phonophobia.[3]

Research has revealed some mechanisms for the cause of migraines, such as neck pain, cutaneous allodynia, and nausea.[4-6] Neck pain has been reported as a common trigger for migraine,[4] and is also frequently reported with cervicogenic headaches, a secondary headache type arising from cervical spine issues, with a prevalence of 4.1%.[7] Cervicogenic headaches are often caused by cervical facet arthropathy and occipital neuralgia, resulting in neck pain that radiates to the head.[8] While migraines and cervicogenic headaches are distinct, neck pain is a common feature of both.[2,9-11] Cutaneous allodynia can accompany a migraine and is considered a clinical manifestation of central nervous system sensitization. It is characterized by pain triggered by skin stimulation that would normally not be painful.[5] Nausea is a common symptom of migraine.[6] Research has indicated that nausea can occur as a premonitory symptom in migraines, independent of pain and trigeminal activation.[6] In addition, the clinical presentation of migraine evolves over a person's lifespan. For example, childhood migraines tend to be of shorter duration and may include symptoms such as vomiting, abdominal pain and vertigo, while older adults often experience fewer autonomic symptoms and often have bilateral headaches.[12]

Traditional management of migraines primarily involves pharmacological interventions, which may not always be effective and can lead to adverse side effects.[13,14] Chiropractic care has emerged as a potential non-pharmacological intervention for migraine relief.[13,14] Spinal adjusting involves applying controlled force, leverage, direction, amplitude, and velocity to specific joints and nearby tissues, which includes manual therapies, instruments such as activators, pelvic blocks, specialized tables, such as drop and traction tables, and other low-force methods. A subset of this is spinal manipulative therapy, which involves high velocity, low amplitude (HVLA) thrusts that usually cause joint cavitation.[15] Chiropractic treatment focuses on the manual adjustment or manipulation of the spine. There are several theories explaining its effectiveness, with one suggesting that spinal alignment affects overall physical health, including headache management.[16] A study has shown a high prevalence of musculoskeletal dysfunctions in individuals with migraine, which suggests that cervical muscular dysfunction may be associated with migraine symptoms.[17] The Cox® Technic Flexion-Distraction method, a chiropractic joint manipulation and mobilization technique, is used for conditions such as cervical radiculopathy, cervical spine disorders, and low back pain.[18-21]

The objective of this case report is to chronicle the successful management of a patient presenting with acute migraines using Cox® Flexion-Distraction and thoracolumbar HVLA-SMT.

Case presentation

The patient consented to the authors chronicling the details of her case (consent form available upon request). A 46-year-old female, who had recently started experiencing acute-onset migraine headaches, sought an evaluation at a private chiropractic clinic. Her headaches had been ongoing for approximately four months at a frequency of approximately one episode per week. She has no history of previous migraines. She reported that her headaches were accompanied by symptoms of nausea along with photophobia and phonophobia. She also reported experiencing visual field disturbances, described as an aura, before the onset of the headache. The patient reported waking up with a headache, which would intensify as the day progressed. Her headaches persisted throughout the day and required time off from work and rest. The patient reported no slips, falls, other precipitating trauma, or other exacerbating factors that might have been linked to these cephalalgic episodes.

System review was unremarkable other than idiopathic scoliosis during adolescence, which was successfully treated with a Milwaukee brace. The patient reported that she had received chiropractic treatment in the past for her scoliosis and for the occasional back ache. She reported that these treatments were always effective. She has no family history of migraine or major diseases. She was not taking any medications and was not being monitored for any other health conditions. She reported that she does not smoke, drink alcohol, use cannabis, or exercise. She described herself as a picky eater, with normal sleep patterns, and no known allergies. She works as a librarian at a school and is a married mother with two children.

The patient first tried over-the-counter medication (Excedrin for migraine), with no symptomatic relief. She then went to her primary care physician, who referred her to a neurologist. She was under the care of a neurologist prior to presenting to the chiropractic clinic and had been prescribed standard migraine pharmacotherapy, (sumatriptan), which provided minimal symptomatic relief. Neuroimaging, including brain scans, did not reveal any pathological abnormalities. The patient did not have any positive cervical orthopedic signs that would justify a radiograph. Due to the patient's budget constraints, magnetic resonance imaging (MRI) was not ordered. Additionally, Blue Cross and Blue Shield of Nebraska requires six weeks of conservative care before approving an MRI. Consequently, the patient recovered before an MRI would have been covered by her insurance.

At the time of her initial evaluation, her pain intensity, as quantified using the Visual Analog Scale (VAS), was significant, registering a score of 9 out of 10. A comprehensive assessment using the Migraine Disability Assessment Scale (MIDAS)[22] yielded a score of 28, indicating severe functional impairment caused by the migraines.

Treatment

After a discussion about the proposed treatment, the patient provided consent for the doctor to proceed with the proposed management plan (consent form available upon request). The patient received a series of treatments utilizing the Cox® Technic Flexion Distraction Decompression (CTFDD) long Y-axis cervical spine flexion-distraction, Protocol 1.[23] She was positioned prone on the Cox®8 Table for these sessions (see Figure 1). The treatment protocol (Protocol 1)[23] involved applying long Y-axis traction to the upper cervical spine contacting the occiput only. This was executed in a slow manner, in four-second pumps. Each set consisted of five repetitions, and three sets were completed during each visit. The thoracic and lumbopelvic spine was treated using HVLA-SMT based on pain on palpation with static palpation. Additionally, compensatory issues in the rest of the spine that were related to the prior scoliosis were addressed as required in each session.

The treatment schedule was initially intensive, with the patient receiving therapy three times a week for the first two weeks. This was then tapered to bi-weekly sessions for the following two weeks and was eventually transitioned to a maintenance phase of once-weekly visits. The patient received treatment 13 times over six weeks. The patient was discharged from care with instructions to follow-up as needed.

Outcome

Upon follow-up evaluation after having undergone six weeks of chiropractic treatment using the Cox® CTFDD long Y-axis cervical spine flexion-distraction, Protocol 1,

Figure 1.
The patient is positioned prone on the Cox®8 Table.

the patient reported a marked improvement in her symptoms. The VAS score had reduced significantly from an initial score of 9 to a score of 2 out of 10. The MIDAS assessment correspondingly improved from an initial score of 28 to a score of 4, suggesting minimal to no disability. During the chiropractic treatment period, the patient was not receiving any other medical or pharmacological treatment that could have provided an alternate explanation for the improvement in her symptoms. At three- and six-months follow-up, the patient indicated a substantial reduction in the frequency of her migraine headaches, with the patient reporting only two instances of tension-type headaches and no migraines since the completion of the treatment protocol.

Discussion

This case report describes the successful use of chiropractic therapy which included using the Cox® CTFDD long Y-axis cervical spine flexion-distraction, Protocol 1, for the treatment of migraine headache. The patient's symptoms improved following treatment that focused on Cox® flexion-distraction of the cervical spine. The authors attribute this improvement to the reduction of the upper cervical spine discs through flexion and distraction, suggesting a potential link between these discs and the occurrence of migraines.

It is important to note that the cervical region contains anatomical and physiological mechanisms that enable referral of pain to the head, including the frontal regions of the head, and can extend to the orbit in patients who experience pain originating from these neck structures.[10]

Several studies have investigated the possible mechanisms of action for the beneficial effects of chiropractic therapy to the cervical spine in treating headaches.[24,25] Research suggests that spinal manipulation may be effective in treating some headache types, particularly tension-type headaches and migraines.[13,26,27] For example, manual therapy using cervical flexion-distraction was effective in reducing neck and thoracic pain as well as in reducing headache frequency in a 21-year-old with neurofibromatosis type 1.[28] In addition, a reduction of headaches and neck pain was observed in a patient with a prior spinal fusion from C4-C7 using Cox® CTFDD spinal manipulation.[29] Another case report detailed a patient with left shoulder, arm, and neck symptoms due to a C6/C7 left posteromedial disc herniation, who showed symptom relief following Cox® flexion-distraction to the cervical spine.[18] In addition, Cox® flexion-distraction decompression manipulation was used on a patient with radiculopathy from a C6/C7 disc herniation, leading to a positive clinical outcome. This improvement was confirmed by pain scale and objective examinations, even at the two-year follow-up.[19]

However, the evidence supporting chiropractic care for migraines remains a subject of ongoing research and debate. While some studies suggest a beneficial effect of chiropractic interventions on migraine frequency, intensity, and duration,[30,31] others call for more rigorous research to establish clear clinical guidelines.[14] A systematic review of randomized controlled trials has found that massage therapy, physiotherapy, relaxation, and chiropractic spinal manipulation therapy might be as effective as medications in managing migraines.[10] The author points out that these conclusions need to be evaluated through well-conducted randomized controlled trials.[10] Additionally, a meta-analysis and systematic review has found that spinal manipulation might be an effective technique to

reduce the duration and pain of migraines, though large-scale randomized controlled trials are needed to confirm this finding.[15]

It is important to point out that current research on cervical impairments in migraine sufferers is limited and complicated by varying underlying causes of neck pain and the influence of hypersensitivity.[32] Research indicates that there are identifiable subgroups among those with migraine, identified by their cervical musculoskeletal function and hypersensitivity.[32] For example, the ICD-11 coding tool,[33] includes the following classifications: common migraine (without aura) 8A80.0, migraine, unspecified 8A80.Z, migraine with aura, 8A80.1Z, and vestibular migraine, AB31.1. Consequently, the findings regarding chiropractic treatment for the cervical spine for those with migraine are inconsistent, showing different neck pain types in migraine patients.

Some migraine sufferers experience neck pain as a part of their migraine symptoms without significant cervical musculoskeletal impairment, while others may have neck pain stemming from cervical issues, showing patterns similar to cervical disorders. In addition, there may be an association between low cervical disc prolapse and cervicogenic headache, with 80% of patients reporting an improvement in their headache and neck pain following surgery for cervical disc prolapse.[34] Another study looked at whether nerve root compression in the lower cervical spine could lead to headaches.[35] After a selective nerve root block, 59% of patients with headache reported a reduction of headache by 50% or more, and 60% of these patients experienced complete relief of their headache.[35] Furthermore, findings from a study suggest that referral of head pain from the upper cervical region could be an overlooked feature of migraine headache.[24]

The role of cervical musculoskeletal dysfunction in migraine is not well understood, which affects treatment decisions. For example, findings from a systematic review suggest that neck pain associated with migraine does not indicate the existence of cervical muscular dysfunction,[36] while another study that included 200 patients with migraine found a high prevalence of musculoskeletal dysfunctions.[17]

While cervical musculoskeletal interventions might benefit those with identified cervical dysfunction, further research is needed to understand patient-specific outcomes, the influence of co-existing migraine-related neck pain, and how migraine hypersensitivity might affect treatment effectiveness.

Limitations

A limitation of this case report is its lack of generalizability, as it pertains to a single patient. Although the patient's cervical spine was treated with only cervical flexion-distraction, her entire spine received treatment as needed. Consequently, the overall spine treatment might have contributed to the improvement in her migraine symptoms. In addition, the patient's improvements might have naturally occurred as part of the typical progression of her migraine headaches. However, the results of our case suggest that further research into the use of Cox® flexion-distraction as a possible treatment option for migraine headaches is warranted.

Summary

After a six-week course of care using Cox® Technic cervical spine flexion-distraction, the patient experienced an alleviation of pain, and a notable decrease in the frequency in her migraine occurrences. Furthermore, she discontinued the use of her prescribed medication. She also reported an enhancement in her activity level and functionality both at home and in her work.

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