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Ontario chiropractor's knowledge of exercise guidelines for pregnant patients

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Objective: *To describe the Ontario chiropractors' knowledge regarding the current guidelines for exercise during pregnancy through a knowledge score and exploring its distribution across different strata of interest including gender, experience, location of practice and type of practice.*

Methods: *A previously used survey was modified and sent to 500 randomly selected Ontario chiropractors. Demographic and continuing education questions were included, and the knowledge score was calculated using 10 items.*

Results: *The differences between the knowledge score values across the four strata of interest were not statistically significant. The average knowledge score in the sample of respondents was low (5.2 out of 10) and highly variable (SD=1.8).*

Conclusion: *The average knowledge score of the*

Objectif : *Décrire les connaissances des chiropraticien(ne)s de l'Ontario sur les lignes directrices actuelles en matière d'exercice pendant la grossesse au moyen d'un score de connaissances et explorer leur répartition dans différentschamps d'intérêt, notamment le sexe, l'expérience, le lieu de pratique et le type de pratique.*

Méthodologie : *Un sondage (ayant déjà servi) a été modifié et envoyé à 500 chiropraticien(ne)s choisi(e) s au hasard domicilié(e)s en Ontario. Des questions démographiques et de formation continue ont été ajoutées, et le score de connaissances a été calculé selon 10 critères.*

Résultats : *Les différences entre les valeurs du score de connaissances parmi les quatre champs d'intérêt n'étaient pas statistiquement importante. Le score moyen de connaissances dans l'échantillon des personnes interrogées était faible (5,2 sur 10) et très variable (SD= 1,8).*

Conclusion : *Le score moyen de connaissances des*

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respondents was found to be low and highly variable but not statistically or practically different across various strata of interest. A well-designed curriculum or post-graduate courses may be beneficial for practicing chiropractors in Ontario.

(JCCA. 2019;63(1):5-17)

KEY WORDS: chiropractic, exercise, knowledge, pregnancy, prenatal

personnes interrogées s'est avéré faible et très variable, mais pas statistiquement ou pratiquement différent parmi les différentes champs d'intérêt. Un programme d'études ou des cours universitaires supérieurs bien conçus peuvent être bénéfiques pour les chiropraticien(ne)s de l'Ontario.

(JCCA. 2019;63(1):5-17)

MOTS CLÉS : chiropratique, exercice, connaissance, grossesse, prénatal

Introduction

Obstetric medical associations, such as the Society of Obstetricians and Gynecologists of Canada (SOGC) and the American College of Obstetricians and Gynecologists (ACOG), encourage their patients to exercise as long as they are experiencing a healthy, uncomplicated pregnancy. In general, exercise is a vital part of a healthy pregnancy as there are both physical and emotional benefits[1-7];including, decreasing low back and pelvic girdle pain[8], improving sleep[4, 5], reducing nausea[4], fatigue[4], and headaches[4], preventing excessive maternal obesity[1, 2, 6], reducing depression[8], and improving health perception[4], to name a few. It has also been shown repeatedly that exercise, in moderation, does not have adverse effects on either the mother or the fetus.[1-3, 7, 9] ACOG suggests that pregnant women should partake in 30 minutes of moderate activity on most, if not all days of the week.[3, 9] SOGC suggests that sedentary pregnant women should start at 15 minutes of exercise and progress up to 30 minutes, while previously active pregnant women can continue their exercise regime.[7] SOGC, in conjunction with the Canadian Society of Exercise Physiology (CSEP), developed the Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy) tool to use in screening for contraindications to exercise during pregnancy, educating prenatal patients, ongoing medical surveillance and creating exercise programs.[10] This tool was developed for health care providers (medical doctors, chiropractors, physiotherapists, etc.) and other professionals (personal trainers, coaches, etc.) and included specific exercise prescription such as frequency, intensity, timing and type of activity.[10]

However, not all health care professionals routinely counsel their pregnant patients regarding exercise and pregnancy.[11-13] Bauer *et al*.[12] and others[11, 14] surveyed the knowledge, beliefs, and practice guidelines of various healthcare providers, including certified midwives, obstetricians/gynecologists, medical and osteopathic doctors. Respondents in each of the studies believed that exercise was beneficial and reported that they would recommend exercise to their patients.[12] However, despite the overall positive response to exercise, respondents either lacked the knowledge and/or awareness regarding antenatal physical activity and current guidelines or there is a disconnect translating that knowledge.[11,12,14] In addition, women believe they receive insufficient or no counseling on exercise during pregnancy.[11] However, they believe if they had received information on how to safely and effectively exercise during pregnancy it would have facilitated their engagement in physical activity.[11] A healthcare professional's knowledge or communication skills should never be a factor that limits a pregnant patient's participation in a proper exercise program.[11,14]

Chiropractic care is one of the top three choices selected by pregnant women to help alleviate aches and pains. Yuen *et al*., who surveyed 755 Ontario chiropractors, established that a variety of methods are used to treat pregnant patients, including Diversified Technique, soft tissue therapy, the Activator and exercise prescription.[6] Sadr *et al*. interviewed chiropractors and patients and determined that exercise prescription is an important component of a chiropractic treatment plan for pregnant women.[5] However, the respondents in their study stated they would not begin an exercise program during pregnancy if their pa-

tient had not been previously active nor would they introduce anything new at a later stage of pregnancy. Both of these strategies are not consistent with the current exercise guidelines for pregnancy.[5] The questions concerning exercise in both of these studies were general in nature and did not establish which guidelines, if any, the chiropractors used to design their exercise regimes, nor did they quantify the chiropractors' overall knowledge regarding exercise and pregnancy.[6] Therefore, the purpose of this paper is to explore the Ontario chiropractors' knowledge regarding the current guidelines for exercise during pregnancy by establishing a knowledge score (KS). It is also to determine the association of this measure with a provider's gender, years of experience, location and type of practice.

We chose these four strata to examine our belief that female patients are more comfortable being treated by a practitioner of the same gender. Female practitioners may have experienced pregnancy themselves. As a result, we believed that female chiropractors may be more knowledgeable with respect to the exercise guidelines. Chiropractors with less than 15 years of experience were expected to have a greater knowledge of exercise and pregnancy guidelines than those who have been practicing for more than 15 years, as they would have been more recently exposed to current guidelines. Most undergraduate programs include female care in their curriculum. Chiropractors in rural settings were expected to have a greater knowledge of pregnancy guidelines as they may be the only primary health care provider available and are likely required to provide prenatal advice on a more regular basis. Finally, practitioners who treat prenatal patients on a regular basis were expected to be more up to date with the latest research and information on this population. Therefore, we hypothesized that respondents with higher knowledge scores would more likely be female chiropractors, more experienced chiropractors, chiropractors practicing in rural areas and those whose practice was focused in prenatal care.

Methods

Study Design

A survey was developed investigating various aspects of Ontario chiropractors' knowledge regarding the exercise guidelines in the pregnant patient population (Appendix A). The questionnaire for current study was modified to target chiropractors and consisted of 20 questions grouped in five sections. The questions were written with simple, short phrases, and presented in the English language. Table 1 describes each section of the instrument in detail. The Office of Research Administration at the Canadian Memorial Chiropractic College (CMCC) approved this study (1510X06).

Survey Development and Pilot

The questionnaire originated from an unpublished study (through personal communication with the faculty supervisor), which examined the knowledge regarding exercise and pregnancy in sports medicine doctors, family phys-

Table 1.
Sections of the questionnaire

Section	Description	# of questions
1	Informed consent	1
2	Demographics information such as age, practice years, etc.	8
3	Agree/Disagree questions (7) and multiple-choice questions (3) used to calculate the Knowledge Score (KS) outcome	4*
4	Individual preferences of the respondent with respect to exercise advice given to patients and desired format for continued education.	6
5	E-mail information should the respondent want more information about the study. This was independent to their responses to the survey in order to maintain confidentiality.	1

**7 items make up the Agree/Disagree question and there are 3 multiple-choice questions*

icians and obstetricians. The exercise-based questions on the survey were developed from the information presented in the Canadian guidelines[7, 15, 16] at the time. Since the guidelines have been updated since the original survey was developed, the current survey was pre-tested by four researchers (two experts/medical professionals involved in the original survey, and two experts in exercise and pregnancy research) to determine the correct answers to the KS questions. For any discrepancies in the 10 questions, the majority rule was utilized.

Originally, this study was designed for physicians, so it was slightly modified for the chiropractic population. Modification of the survey included the addition of an age category, asking female respondents if they had ever been pregnant, what percentage of their practice included prenatal care, if they prescribed exercises for their pregnant patients and what type of post-graduate prenatal training, if any, they had received. As this was part of a master's thesis, the original questionnaire underwent partial feasibility testing and scrutiny through the University Ethics Board.

Prior to distributing the survey, a pilot study was conducted. Five chiropractic teaching faculty at CMCC were asked to review a paper copy of the survey. The purpose of the pilot study was to receive feedback from the selected chiropractors regarding potential problems with the wording, clarity and intention of the questions asked in the survey. The research group reviewed the proposed feedback from the returned surveys (4 out of 5) and incorporated the suggested grammatical changes into the final draft of the questionnaire. The five chiropractors from the pilot study were removed from the randomization process in order to preserve the integrity of the responses.

Knowledge Score Outcome

A continuous outcome measure, named "knowledge score" (KS), was calculated as a number of correct answers to each of the 10 items in the questionnaire: seven Agree/Disagree questions and three case studies with four multiple choices (questions 13 and 14-16, respectively; see Appendix A), only one of which is correct. Therefore, the KS takes values from 0 to 10.

Participant selection and survey distribution

Determination of the sample size of this survey required several assumptions and approximations since KS has not been measured or studied previously. Keeping in mind that the outcome variable is a scale variable with the values from 0 to 10, we assumed that the highest most commonly seen value in the sample would be 9 (H=9) and the lowest most commonly seen value in the sample would be 2 (L=2). Then, the SD of the knowledge score was approximated as (H-L)/4, equaling 1.75 in our case. In addition, we targeted to detect a difference of 1.2 points in comparison between the two groups, leading to the estimated effect size of 0.7 (1.2/1/75). Standard sample size calculations under these assumptions implied a sample size of approximately 33 people in each group to ensure that the predefined difference between the two groups could be detected with the power of 80%.

We expected that there might be various technical difficulties reaching potential respondents, and a very low response rate for this population (around 20%). Therefore, we concluded with a sample size of n=500.

The survey was distributed through the web-based interface Survey Monkey®. Five hundred out of 3052 chiropractors in active practice, registered through the 2015–2016 electronic directory of the College of Chiropractors of Ontario (CCO)[17], were randomly selected using a computer algorithm and invited to participate in the study. As the survey was e-mail based, individuals were not invited to participate if their email address was not registered with the CCO, or if their category for membership was "inactive".

The first page of the email survey contained the informed consent; participants selected "Yes" if they agreed to the terms of the survey and continued to the survey itself, or "No" if they did not. The informed consent described the goals of the study, outlined participant's responsibility if they opted to participate, related any potential risks or harm, and detailed participants' ethical rights. Participants were able to withdraw at any time and/or not answer any of the questions. Participants had four and a half weeks to complete the survey. A total of three reminder emails, eight days apart, were sent out to the participants who had not completed the survey in order to increase the response rate.[18]

Statistical Analysis

Means and standard deviations were obtained to characterize the survey respondents by age, gender, years of experience, clinic location and clinic type. In addition, sur-

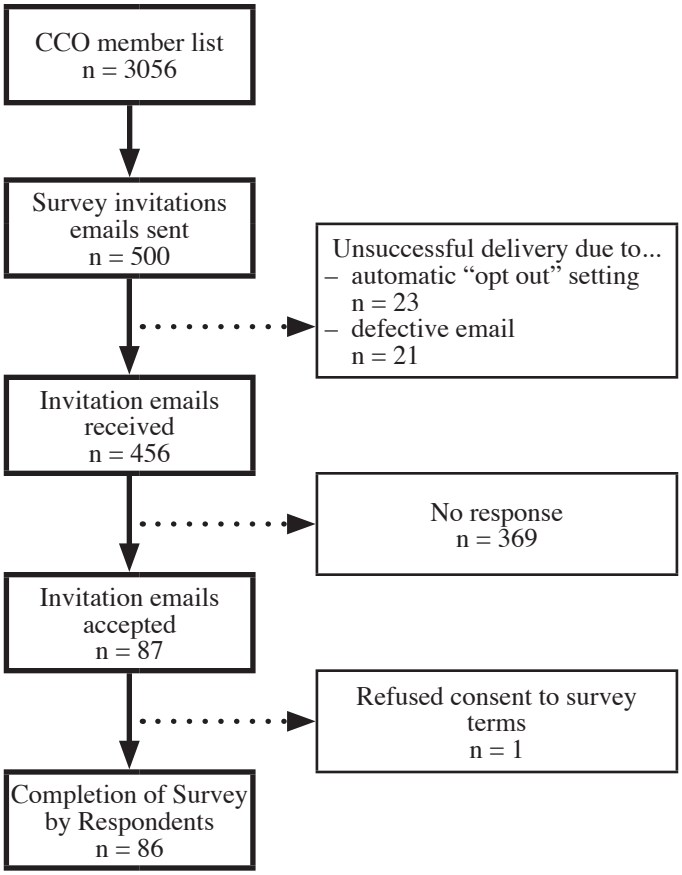

Figure 1:
Process of subject selection and number of respondents

vey respondents were compared to the general population of registered chiropractors by age, gender and years of experience.

The mean and standard deviation of the KS were obtained for the entire sample of respondents and for the subgroups of interest. Specifically, the KS scores were compared across two genders (males vs females); two levels of experience (more than 15 years in practice vs 15 or less years in practice); three levels of practice location (rural, urban and both); and two levels for type of practice (providing prenatal care vs not providing prenatal care). The comparisons between the groups were performed using analysis of variance (ANOVA) method.

Results

Of the 500 surveys that were sent out, 44 were not successfully delivered. In total, 87 subjects out of 456 accepted the invitation to participate in the survey; one participant declined the consent and 86 surveys were completed, a response rate of 18.9% (Figure 1). The comparison between the demographic characteristics of the respondents and practicing chiropractors registered through 2015-2016 CCO database showed borderline statistically significant difference in gender distribution (with slightly higher proportion of females in the sample than in the population). The age distribution as well as the distribution of the number of years in practice were not found statistically different between the respondents and the general population of all registered chiropractors (Table 2). Based on these results, we believe that the sample of respondents provides a fair representation of the general population.

The overall score on each of the items comprising the KS score was determined first. Overall, the Agree/Disagree statements were answered correctly more often than the case studies (Table 3). The average KS value in the sample was 5.2 (SD=1.8; q(0.25)=4; Median = 5; q(0.75)=6; Inter-Quantile Range (IQR) = 2)). Comparison of the KS scores between male and female practitioners as well as between practitioners practicing for less than 15 years and for more than 15 years do not show any statistically significant differences in the average score (p-values equal 0.7042 and 0.8816, respectively). Additionally, average KS value of practitioners who provide prenatal care are similar to those who do not provide this type of care (p-value = 0.5927). No statistically significant difference in KS values was found between practitioners whose practice is located in urban vs rural vs both rural and urban areas (p-value = 0.6856). These findings are summarized in Table 4.

Over 60% of the participants have not encountered the current exercise and pregnancy guidelines (Table 5). When asked how often they would typically prescribe certain exercise advice to prenatal patients, including whether or not to be active, examples of exercises, as well as their intensity, frequency and duration, four out of five statements were given to prenatal patients "often', "frequently" or "always" more than 55% of the time. At the same time, 56% of the time, the advice regarding exercise intensity for pregnant women was "occasionally" or "never" suggested (Table 6). When asked what type of postgraduate education respondents had received regarding exercise and pregnancy, approximately a third of all participants indicated that they had received no postgrad-

uate training. Of the knowledge gained after graduation, almost half of the participants reported that they were self-taught and approximately 40% of chiropractors learned guidelines through conferences and seminars. Finally, respondents were asked their preference with respect to continuing education on this topic and it was found that web-based seminars best suited the respondent's needs.

Discussion

The benefits of exercise during a healthy non-complicated pregnancy are no longer disputed[19] and as such health care professionals, including chiropractors, should have a current, working knowledge of exercise guidelines for prenatal patients to ensure safety for the mother and fetus. In this study, we aimed to explore the chiropractor's know-

Table 2.
Demographic analysis of sample of respondents and the population of chiropractors registered with the CCO (for available variables).

	Sample of respondents n = 86 (n, %)	Population registered with the CCO N = 3056 (n, %) p-value
Age p = 0.4479		
<30	8 (9.3%)	426 (10.1%)
30-40	30 (34.9%)	1334 (31.2%)
41-50	30 (34.9%)	1406 (32.9%)
51-60	14 (16.3%)	635 (14.9%)
60>	4 (4.7%)	468 (11.0%)
Gender p = 0.0414		
Female	41 (47.7%)	1577 (36.9%)
Male	45 (52.3%)	2692 (63.1%)
Number of Years in Practice p = 0.5638		
<5	17 (19.8%)	866 (20.3%)
5-14 years	29 (33.7%)	1580 (37.0%)
15-25 years	26 (30.2%)	1016 (23.8%)
25>	14 (16.3%)	808 (18.9%)
Location		
Urban (pop. ≥50,000)	61 (70.9%)	N/A
Rural (pop. <50,000)	20 (23.3%)	N/A
Both (Urban & rural)	5 (5.8%)	N/A
Provide Prenatal Care		
Yes	66 (77.6%)	N/A
No	19 (22.4%)	N/A

Table 3.
Agree/Disagree (A/D) questions and case scenarios that define the knowledge score and percentage of correct answers (n=86). See Appendix A for correct answers and description of case studies.

KO Item	**Correct**	**Incorrect**
A/D 1: Regular moderate exercise is beneficial to most low risk pregnancies (n=84)	93.0%	7.0%
A/D 2: Frequency of exercise should be limited to twice weekly (n=84)	83.7%	16.3%
A/D 3: Moderate exercise for pregnant women consists of 1-hour duration (n=84)	19.8%	80.2%
A/D 4: Most pregnant women will have some sweat while exercising (n=84)	86.0%	14.0%
A/D 5: Light to moderate aerobic exercise is considered appropriate for pregnancy (n=83)	86.0%	14.0%
A/D 6: Twin gestation after the 28th week is a relative contraindication to exercise during pregnancy (n=84)	29.1%	70.9%
A/D 7: A woman with uncontrolled hypertension should not exercise during pregnancy (n=84)	45.3%	54.7%
Scenario 1: Terry & Yoga, n=81	16.3%	83.7%
Scenario 2: Rebekah & Running, n=78	17.4%	82.6%
Scenario 3: Galina & Swimming, n=81	40.7%	59.3%

ledge regarding exercise and pregnancy by calculating a KS based on the number of correct answers to the survey questionnaire. The mean KS for the current study was low (5.2 out of 10) and diverse, indicating a great variability in the knowledge scores of the participants. This finding is further strengthened by the fact that over 60% of respondents reported they never saw or referenced any guidelines and, in more than half cases, did not give out pertinent advice, such as exercise intensity. In addition, we examined the KS across strata of interest and found no statistically or practically important difference in KS between gender, years of experience, practice location and type of practice with respect to providing prenatal care.

Up to 40 years ago, the research on exercise during

Table 4.
Stratified analysis of the knowledge score measure by gender, years in practice, practice location and provision of prenatal care.

Variable	Mean	Standard Deviation	p value
Gender			
Male	5.10	1.87	0.7042
Female	5.24	1.71	
Years in Practice			
<15 years	5.22	1.81	0.8116
≥15 years	5.13	1.76	
Prenatal Care Provision			
Yes	5.12	1.77	0.5927
No	5.37	1.83	
Location	df	F	P value
Between Groups	2	0.38	0.6856
Within Groups	83		

Table 5.
Exposure to pregnancy and exercise guidelines of active, practicing chiropractors in Ontario (n= 65).

Exposure to Guidelines	Respondents
n (%)	
Have not seen them	54 (63.5%)
Have heard about them through a colleague	10 (11.8%)
Have attended an educational event about the guidelines	12 (14.1%)
Refer to them regularly before advising appropriate patients	11 (12.9%)
Use the ParMed-X for Pregnancy Screening Tool	10 (11.8%)

Percentages may be greater than 100% because participants were able to select more than one detractor.

Table 6.
Frequency of exercise advice given by chiropractors to prenatal patients (n= 64).

Advice Given to Prenatal Patients	Never	Occasionally	Often	Frequently	Always
Encouraging exercise in an inactive woman	16.9%	20.0%	29.2%	13.8%	20.0%
Specified the recommended frequency of exercise during pregnancy	14.1%	28.1%	32.8%	10.9%	14.1%
Provided examples of appropriate types of exercises during pregnancy	10.8%	21.5%	33.8%	13.8%	20.0%
Given examples of measuring exertion intensity during exercise	36.9%	20.0%	16.9%	9.2%	16.9%
Specified the duration of recommended exercise in minutes	18.5%	26.2%	26.2%	18.5%	10.8%

pregnancy was almost non-existent. Since that time, there have been many iterations of the exercise guidelines and PARmed-X for Pregnancy set out by CSEP and SOCG[7, 10, 15, 20] reflecting the most current research for that period of time. Staying current with the pace and amount of the new research available can be challenging[14] and may explain the deficit in knowledge. In fact, the guidelines and the PARmed-X for Pregnancy are going through another iteration, due out late 2018. This deficit may imply a lack of formal educational training, as the specific guidelines may not have been presented as part of the chiropractic curricula. Finally, our study reveals that clinical intuition may play a large role in guiding the respondent's decision-making process for this patient population. Over half of the respondents had not even heard of the current published guidelines such as the PARmed-X for Pregnancy, let alone used them. Despite the variability in knowledge, over half (55%) of the surveyed respondents reported that they tried to provide exercise advice to their patients "often", "frequently" or "always".

Bauer *et al*. confirm the existence of a willingness amongst chiropractors to improve their knowledge based on current evidence, standards of practice and willingness to learn.[12] Bussieres *et al*. suggested that Canadian chiropractors have a positive attitude towards evidence-based research but have difficulty implementing it into daily practice.[21] Combining the conclusions from these and our studies, it seems that there is an opportunity to create a post-graduate course, such as a web-based seminar, to disseminate the most current research and practical applications for chiropractors. These standardized guidelines may be the key solution to closing the knowledge gap. By increasing the awareness of chiropractors of the availability of nationally approved screening tools, such as PARmed-X for Pregnancy, or specific guidelines put out by various medical associations, it is possible to create better consistency in chiropractic prescription of exercise in prenatal patients that can be maintained between locations and practitioners.

Strengths and Limitations

One of the key design features of this study was selection of a random sample of 500 chiropractors from the CCO database. Only about 20% of the selected sample agreed to participate and answered the survey questions. However, our comparison of respondent characteristics (age, gender and years in practice) to the population of chiropractors registered with the CCO, showed that the sample of respondents is fairly consistent with the population of interest, and thereby we believe that our results can be generalized to all chiropractors in Ontario. One demographic item we did not ask about was college of graduation; as chiropractic colleges curriculum differ, this would have been an interesting piece of information to compare. Although we did not test the survey validity rigorously, which can be considered a limitation to the study, the survey questionnaire was tested on a small number of chiropractors before being sent to the sampled individuals. We utilized a majority rule by experts in the field of exercise and pregnancy for questions. Both of these approaches improved the overall quality of the final questionnaire and precision of the KS estimates. A low response rate in this survey (18.9%) can be considered a limitation. We understand that it is important to consider some additional design elements, such as mailing a paper survey to respondents[22, 23], which would potentially help to increase the response rate.

Conclusions

In this study we developed a KS outcome measure to explore the knowledge of practicing chiropractors in Ontario regarding prenatal exercise guidelines which was found to be low and highly variable. Stratified analysis by gender, years in practice, practice location and provision of prenatal care did not reveal any statistically significant differences. A well-designed curriculum or post-graduate courses, such as web-based seminars, may be beneficial for the practicing chiropractor in Ontario.

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Appendix A.
Cover Letter and Survey Questionnaire

Chiropractor's Knowledge of Exercise Guidelines for Pregnant Populations

Dear Chiropractor

We are conducting a research study to gain a better understanding of chiropractor's knowledge of the exercise guidelines during pregnancy. We are kindly asking for your cooperation in completing the survey that follows this letter. Please answer each of the 20 questions listed in this survey. It should take less than 15 minutes to respond by checking the one box (unless otherwise stated) that best reflects your answer to each question.

The survey will be open for 8 weeks; if a response has not been received, a reminder email will be sent approximately once every 2 weeks, until a completed survey is received or the survey itself is closed. If you prefer, we can send the survey as an email attachment and you can fill it out and return it by email; please communicate this request by email: XXXX@XXXX.XX.

There may not be any direct benefit to you by participating in this survey. You can choose whether to complete this survey or not, by choosing the "I agree to participate" button or the "I do not wish to participate" button following this information letter. All participants will be entered into a draw for a $50 Starbucks gift certificate. The draw will take place after the study closes, where one entry will be randomly selected to receive the certificate. You have the ability to withdraw participation at any time during the process without consequence. You may also refrain from answering any of the items within the survey and continue to be part of the study.

Any resulting publication of the data gathered from this survey will be presented in aggregate form. Consideration to exclude identifying information from discussion will be given to prevent the potential identification of participants, or a small group of participants who partook in the study. To protect confidentiality, your answers to the survey shall remain anonymous and will not be linked to your specific email. The survey responses will be kept on a secure database that can only be retrieved by the investigators of this study.

You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the Academic Institution Research Ethics Boards (REB). The REB office can be contacted by phone:

- Research Administrator of the Academic Institution Research Ethics Boards at xxx-xxx-xxxx ext. xxx

If you consent to participate in this study, please click the following link: www.surveymonkey.com

Thank you for your time and effort.

Sincerely,

Student Investigators: And Faculty Supervisor:

Survey:

Chiropractor's Knowledge of Exercise Guidelines for the Pregnant Populations

1. Do you consent to participate in this survey?
   - ❑ Yes
   - ❑ No

2. Age
   - ❑ <30
   - ❑ 30-40
   - ❑ 41-50
   - ❑ 51-60
   - ❑ >60

3. How many years have you been in practice?
   - ❑ <5
   - ❑ 5-14
   - ❑ 15-25
   - ❑ >25

4. Where is the location of your practice?
   - ❑ Urban (population >50,000)
   - ❑ Rural (population <50,000)
   - ❑ Both

5. Gender
   - ❑ Male
   - ❑ Female

6. Have you ever been pregnant? (Females only)
   - ❑ Yes
   - ❑ No

7. Did you exercise during your pregnancy? (Females only)
   - ❑ Yes
   - ❑ No

8. Have you come across Exercise and Pregnancy guidelines?
   - ❑ Have not seen them
   - ❑ Have heard about them through a colleague
   - ❑ Have attended an educational event about the guidelines
   - ❑ Refer to them regularly before advising appropriate patients
   - ❑ Use the ParMed-X Screening Tool

9. Approximately how many prenatal patients do you treat per week?
   - ❑ 0
   - ❑ 1-5
   - ❑ 6-10
   - ❑ 11-20
   - ❑ 21-30
   - ❑ greater than 30

10. Do you prescribe exercises for your pregnant patients?
    - ❑ Yes, regularly
    - ❑ Yes, sometimes
    - ❑ No

11. Please name the Exercise and Pregnancy reference you refer to the most.
    - ❑ Unable to name; do not know
    - ❑ Guideline used (Please list guidelines below)

    _____

12. In your daily practice, with low risk pregnant patients, how often would you say you have provided the following advice in the last 12 months? Please choose one of the following: Never, Occasionally, Often, Frequently, Always.
    a. Encouraging exercise in an inactive woman
    b. Specified the recommended frequency of exercise during pregnancy
    c. Provided examples of appropriate types of exercises during pregnancy
    d. Given examples of measuring evectional intensity during exercise
    e. Specified the duration of recommended exercise minutes

13. Please state where you agree or disagree with the following statements:
    (Note: A = Agree, D = Disagree)
    a. Regular moderate exercise is beneficial to most low risk pregnancies (Correct answer: Agree)
    b. Frequency of exercise should be limited to twice weekly (Correct answer: Disagree)
    c. Moderate exercise for pregnant women consists of one-hour duration (Correct answer: Disagree)
    d. Most women will have some sweat while exercising (Correct answer: Agree)
    e. Light to moderate aerobic exercise is considered appropriate for pregnancy (Correct answer: Agree)
    f. Twin gestation after the 28th week is a relative contraindication to exercise during (Correct answer: Agree)
    g. A woman with uncontrolled hypertension should not exercise during pregnancy (Correct answer: Agree)

Note:

14. (Terry & Yoga). Terry had her first prenatal visit with you at 8 weeks gestation, healthy low risk pregnancy and states that she has been inactive for the last 2 years but would like to join a prenatal yoga class. Please choose one response
    a. Yes, she can join the class as long as the instructor is certified for prenatal exercise
    b. Yes, she can join the class now and attend twice weekly
    c. Yes, she may attend the class but only after she has completed her first trimester
    d. Yes, she may attend the class but must warm up for 20 minutes to ensure she does not strain herself
    (Correct answer: C)

15. (Rebekah and running). Rebekah has her first prenatal visit with you at 8 weeks gestation, healthy low risk pregnancy and states she has been an avid runner for 2 years and she would like to continue running 4-5 times per week for 60-90 minutes duration. Please choose one response.
    a. She can continue running at her previous frequency and duration but must wait until 2nd trimester
    b. She can continue running at her previous frequency and duration from her first trimester onwards
    c. She can continue running from her first trimester but should reduce the frequency from 2-3 times per week
    d. She can continue running from her first trimester but should reduce her duration to 30-40 minutes per session
    (Correct answer: B)

16. (Galina and swimming). Galina visits you in her 2nd trimester at 18 weeks and she has just found out that she is carrying twins; she has asked if she can continue to swim 4 times a week for 30 minutes duration? Please choose one response
    a. Yes, swimming is safe to continue for the duration of the pregnancy
    b. No, she should discontinue all exercise except walking now
    c. Yes, she can continue but will have to reduce or eliminate exercise past 28 weeks gestation
    d. No, she may not swim 4 times a week, but she can swim 2 times a week
    (Correct Answer: C)

17. Please specify the type of post-graduate education regarding pregnancy and exercise you have obtained? Please select all that apply.
    - ❑ Web seminar
    - ❑ Grand rounds
    - ❑ Mentorship
    - ❑ Conferences/seminars
    - ❑ Personal research/textbooks/ research papers
    - ❑ Personal trainer
    - ❑ Other
    - ❑ None

18.	Which of the following educational formats would best suit your learning needs as a clinician. Please rank in order of preference, with 1 being your most desirable and 5 being your least desirable. a. Web-based seminars b. Patient-professional workbook and text c. Clinical information pocket tools d. Conferences and grand rounds e. Mentorship/small group training f. Other
19.	If you wish to receive a letter containing a summary of the study results please provide your email address here: _____

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Does a light pressure instrument assisted soft tissue mobilization technique modulate tactile discrimination and perceived pain in healthy individuals with DOMS?

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This investigation measured the effects of a light pressure instrument assisted soft tissue mobilization (IASTM) technique on tactile discrimination and pain perception in individuals after strenuous exercise. Twenty-three subjects underwent three different testing sessions: baseline measures and exercise, 24-hours (post) treatment and measures, and 48-hours (post) treatment and measures. Outcomes included two-point discrimination (TPD) and pressure pain threshold (PPT). Statistical analysis included parametric tests. For TPD, a significant difference was observed between all time points ($p < .001$). Post-hoc testing revealed a significant difference from baseline to 24 hours post

Cette étude a mesuré les effets d'une technique de mobilisation des tissus mous assistée par un instrument de pression légère (IASTM) sur la discrimination tactile et la perception de la douleur chez les individus après un exercice intense. Vingt-trois sujets se sont prêtés à trois séances d'évaluation différentes : mesures et exercices de base, 24 heures et 48 heures après le traitement et les mesures. Les résultats comprenaient la discrimination de deux points et le seuil de douleur à la pression. L'analyse statistique comprenait des tests paramétriques. Pour la discrimination de deux points, une importante différence entre tous les points dans le temps ($p < 0{,}001$) a été observée. L'examen post-hoc a révélé une importante différence entre le début de l'étude et les 24 heures ($p < 0{,}001$) et 48 heures ($p < 0{,}001$) qui ont suivi l'étude. Selon le seuil de douleur à la pression, une importante différence entre tous les points dans le temps ($p < 0{,}001$) a été observée. L'examen post-hoc a

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(p <.001) and 48 hours post (p <.001). For PPT, a significant difference was observed between all time points (p <.001). Post-hoc testing revealed a significant difference from baseline to 24 hours post (p =.005) and 48 hours post (p =.003). A significant difference was not observed between 24 to 48 hours post for TPD and PPT (p =1.00). The results suggest that a light IASTM technique may produce a neuromodulation effect on local tactile descrimination and pain perception in individuals with DOMS.

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KEY WORDS: mobilization, muscle soreness, perceived pain, recovery

révélé une importante différence entre le début de l'étude et les 24 heures (p = 0,005) et 48 heures (p = 0,003) qui ont suivi l'étude. Aucune différence importante n'a été observée entre les 24 à 48 heures après la discrimination de deux points et le seuil de douleur à la pression (p = 1,00). Les résultats suggèrent qu'une technique de mobilisation des tissus mous assistée par un instrument de pression légère (IASTM) pourrait produire un effet de neuromodulation sur la discrimination tactile locale et la perception de la douleur chez les individus présentant des courbatures.

(JCCA. 2019;63(1):18-25)

MOTS CLÉS : mobilisation, douleur musculaire, douleur perçue, récupération

Introduction

Instrument assisted soft-tissue mobilization (IASTM) has become a popular myofascial intervention utilized by allied health professionals across the world. The popularity has stimulated the creation of many different tools and treatment techniques. This popularity has stimulated a growth in research over the past 10 years. The body of IASTM research has produced variable outcomes with most of evidence coming from case reports or case studies.[1] The amount of high level evidence (e.g. randomized controlled trials) has grown but a disparity still exists.[1] Current published research suggests that IASTM may improve joint ROM,[2-5] modulate pain perception,[3] and increase local circulation.[6,7] However, little effects on muscle performance have been documented.[8,9]

Presently, there are several scientific theories regarding the effects of IASTM, most notable, mechanical and neurophysiological. The mechanical theory suggests that pressure and shearing from the instrument may release and breakdown scar tissue, adhesions, and fascial restrictions, and aid in tissue healing.[7,10,11] The only studies supporting this theory have shown enhanced healing in rodent ligaments.[7,11] No human studies have been conducted that support this theory. In contrast, the neurophysiological theory suggests that the compression from the instrument may stimulate local mechanoreceptors, nociceptors (e.g. C-tactile fibers),[12-14] and ascending afferent pathways which may stimulate other physiological responses by the body.[10] Portillo-Soto *et al*.[6] reported local blood flow changes in the gastrocnemius after a 10 minute IASTM session. Ge *et al*.[10] reported changes in mechanoreceptor activity after a 10 minute IASTM treatment to the anterior thigh. These researchers found a statistically significant post-treatment increase in 2-point discrimination (40.2 ± 9.4 mm to 44.9 ± 12.0 mm) but no significant changes in pressure pain threshold (PPT) with algometry (18.2 ± 6.6 lbs to 18.7 ± 6.8 lbs). The researchers concluded that the IASTM treatment may have a greater effects of mechanoreceptors than nociceptors.[10]

Despite the emerging research and popularity of IASTM, there is no consensus on the optimal treatment parameters such as: tool type, tool angle, stroke type (vector), rate, and amount of pressure being applied.[1] Due to this gap in the literature, a clinician may choose their own preferred treatment parameters or follow the parameters taught by non-evidence based sources.[1]

Concomitantly, there are a limited number of controlled studies on the efficacy of IASTM with individuals in pain or with injury. The majority of evidence comes from case reports and case series.[1] The existing evidence does suggest favorable outcomes after IASTM treatment for individuals with shoulder impingment,[2] chronic ankle instability,[15] carpal tunnel syndrome,[16] and chronic low-back pain.[3]

Table 1.
Experimental procedures.

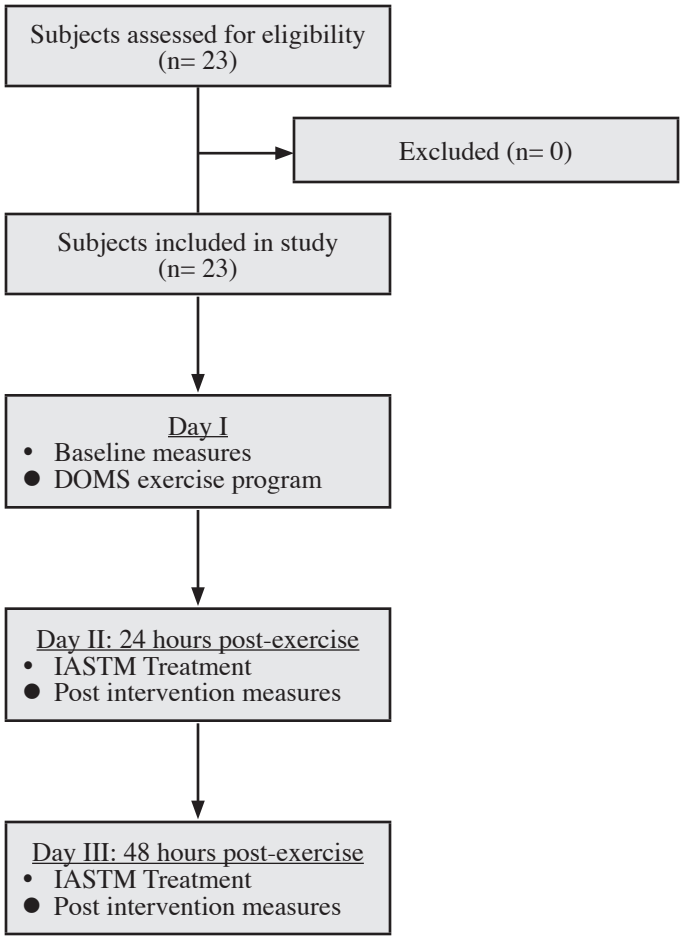

Figure 1.
Rock Blades® Mohawk tool.

Of interest are the therapeutic effects of IASTM as a posttreatment intervention after strenuous exercise. To the authors knowledge, no studies have measured these effects. The purpose of this investigation was to measure the therapeutic effects of a light pressure IASTM technique on tactile discrimination and pain perception in healthy individuals after strenuous exercise. The researchers hypothesized a light pressure IASTM technique may have a modulatory effect on local mechanoreceptors and ascending pain pathways.

Methods

Subjects

Twenty-three recreationally active adults (M=14, W=9) were recruited via convenience sampling (e.g. flyers) (Table 1). Recruited subjects reported participating in recreational fitness activities (e.g. walking) with no prior experience with IASTM treatment (naïve subjects). Exclusion criteria included the presence of any neurosensory impairments, musculoskeletal, systemic, or metabolic disease that would affect lower extremity tolerance to IASTM treatment, pressure pain threshold (PPT) testing, two-point discrimination (TPD), and the inability to avoid medications that may affect testing.[10] This prestest, posttest clinical study was approved by the Institutional Review Board at California State University Dominguez Hills, Carson, CA, USA (#18-177).

Instruments

For PPT, the Wagner (Midvale, UT) FDX algometer was used for this investigation. The manufacturer reports an accuracy error of $< \pm 0.3\%$ for this technology.[17] Algometry is a valid and reliable tool for measuring pressure pain thresholds.[18-21] Algometry has also been used in prior IASTM research.[10] For TPD, the Baseline (Fabrication Enterprises, Inc, White Plains, NY) two-point discrimination (12-1480) caliper was used to administer the testing. Calipers are a valid and reliable tool for measuring two-point discrimination[22,23] and have been used in prior IASTM research.[10]

IASTM Treatment

For IASTM treatment, the Rock Blades® Mohawk tool (RockTape®, Campbell, CA) was used to administer the treatment. The Mohawk is a stainless steel shaped

metal instrument with several beveled edges (Figure 1). The investigator administered a 90 second light pressure "feather stroke" using the weight of the tool (208 grams) intervention in line with the fibers of the rectus femoris using a rate of 120BPM with the Mohawk angled at 30°.[24] The investigator used a metronome (The metronome by Soundbrenner App 2017) to ensure a consistent rate during treatment and calibrated the instrument angle with a digital goniometer prior to each subject's treatment.

Outcome Measures

Two outcome measures were used for the baseline, 24 hours, and 48-hours post exercise measures. For PPT, the subjects dominant (kicking leg) quadriceps group was tested with the subject lying supine on a mat table (2 measurements).[25-27] The 1.0-cm^2 probe of the algometer was placed in a predetermined area (see procedures) along the midline of the dominant quadriceps (rectus femoris).[28,29] The graded force was applied at a constant rate of 50-60 kilopascals per second (kPa/sec), perpendicular to the tissues, until the subject verbally reported the presence of pain.[25-27] These outcome measures have been used in prior research.[30-32] For TPD, subjects laid supine on the mat table. The examiner used the two-point discrimination caliper to the predetermined area using the 4-2-1 stepping algorithm for tactile sensory testing.[33,34]

Pilot Study

Prior to data collection, a two-session pilot training was conducted to establish intrarater reliability. The primary investigator took all measurements. The primary investigator is a licensed physical therapist with over 13 years of experience and board certified in orthopaedics. Ten independent subjects were recruited and tested for this portion of the study. The intrarater reliability was calculated using the Intraclass Correlation Coefficient (ICC model 3, k).[35] There was good intrarater reliability for PPT with algometry (ICC= 0.95; 95% CI 0.83-0.99) and TPD (ICC= 0.94; 95% CI 0.61-0.97).

Procedures

All eligible participants were given an IRB approved consent form to read and sign before testing. Participants then completed a questionnaire to provide demographic information. All participants were tested by the primary investigator and were blinded from the results and other participants enrolled in the study. A second investigator administered the IASTM treatment and was blinded to the results. The second investigator is a Certified Athletic Trainer with over 24 years of experience and certified in several IASTM intervention techniques. Testing was conducted between the hours of 11 A.M. and 3 P.M. and subjects were instructed to refrain from any strenuous activity five hours prior to testing and from taking any medications or supplements that would interfere with testing. All subjects underwent three days of testing which included: baseline measures and exercise, 24-hours (post) treatment and measures, and 48-hours (post) treatment and measures. The soreness that occurs after exercises arises 24 hours after exercise and peaks in intensity by 48 hours post-exercise.[36]

Day I: Baseline measures and exercise. The primary investigator first explained and demonstrated the testing process to each subject and answered any questions. The investigator then measured and marked two ends of a 6.4 cm (2.5 in) line approximately 7.62 cm (3.0 in) above the patella in the midline of the subjects dominant quadriceps.[37] Baseline measures were conducted on all subjects which included PPT and TPD within the predetermined area.[28,29] Participants then underwent an induced muscle soreness exercise protocol which included a five-minute treadmill warm-up followed by 100 drop jumps (5 sets of 20 repetitions) from a 0.5 m box.[38] The primary investigator monitored each subject and provided feedback to ensure adequate form and safety during the activity.

Day II: 24 hours post. The second investigator confirmed the predetermined marked area from Day I and administered the 90 second IASTM treatment to each subject. Upon completion, the second investigator left the area and the primary investigator retested each subject. The primary investigator confirmed the predetermined area and tested subjects within the marked area.

Day III: 48 hours post. The second investigator again confirmed the predetermined marked area from Day I and II and administered the 90 second IASTM treatment to each subject. Upon completion, the investigator left the area and the primary investigator then retested each subject within the predetermined marked area.

Statistical Analysis

Statistical analysis was performed using SPSS version 24.0 (IBM SPSS, Chicago, IL, USA). Subject descriptive

Table 2.
Baseline and post-intervention descriptive results (N=23).

	Baseline	24 hours	p-value	Baseline	48 hours	p-value
Two Point Discrimination (cm)	4.33 ± 1.12	2.98 ± 1.28	*<.001	4.33 ± 1.12	2.83 ± 1.57	*<.001
Pressure Pain Threshold (kPa)	1132.08 ± 244.26	1214.91 ± 261.25	*=.005	1132.08 ± 244.26	1207.22 ± 248.80	*=.004

data was calculated and reported as the mean and standard deviation (SD) for age, height, body mass, and body mass index (BMI). Baseline and post exercise differences were calculated using the repeated ANOVA statistic.[39] Post hoc testing was calculated using the Bonferroni statistic. Effect size (ES) was calculated ($d = M_1 - M_2 / s_{pooled}$). Effect size of > 0.70 was considered strong, 0.41 to 0.70 was moderate, and < 0.40 was weak.[40] Statistical assumptions were met for the ANOVA including normality and homgeneity of variance.[35] Statistical significance was considered p< .05 using a conservative two-tailed test.

Results

Twenty-three subjects completed the study (M=14, W=9; mean age= 24.22 ± 3.07 years; height= 172.08 ± 8.53 cm; body mass=80.43 ± 16.18 kg; body mass index (BMI)= 26.60 ± 4.05 kg/m^2). There were no adverse events or subject attrition during data collection.

For TPD, there was a significant difference between baseline, 24 hours, and 48 hours post [F (1, 21) =30.50, p <.001, partial η^2 =.744]. Post-hoc testing revealed a significant difference from baseline to 24 hours post (p <.001, ES =1.12) and baseline to 48 hours post (p <.001, ES =1.10) (Table 2). There was no significant difference between 24 to 48 hours post (p =1.00, ES =.10). For PPT, there was a significant difference between baseline, 24 hours, and 48 hours post [F (1, 21) =9.56, p <.001, partial η^2 =.477]. Post-hoc testing revealed a significant difference from baseline to 24 hours post (p =.005, ES =.33) and baseline to 48 hours post (p =.004, ES =.30). TA significant difference was not observed between 24 to 48 hours post for TPD and PPT (p =1.00, ES =.03) (Table 2).

Discussion

This was the first investigation to measure the efficacy of a predetermined IASTM technique on local tactile discrimination and pain perception in healthy individuals 24 and 48 hours after strenuous exercise. DOMS is a common condition that arises 24 hours after strenuous exercise and peaks in intensity by 48 hours post-exercise.[36] This soreness can affect an individual's tactile sense and pain perception.[12,38,41] The results of this study suggest that a light pressure longitudinal IASTM intervention using specific parameters may produce changes in local TPD and PPT for up to two days after strenuous exercise.

In related research, Ge *et al*.[10] used similar methods to measure the immediate post-intervention effects of a 10 minute IASTM treatment to the anterior thigh using TPD and PPT in non-exercised healthy individuals. The researchers found a statistically meaningful change with TPD but not PPT. Additionally, the researchers reported using the Graston® concept for treatment, but only completed an IASTM intervention and did not follow the recommended steps in the paradigm.[1] Furthermore, the researchers did not report any specific treatment parameters such as: tool angle, stroke rate, predetermined area, and pressure which created a methodological weakness and may have influenced the outcomes.[10]

In this investigation, the researchers attempted to use a strict treatment strategy to control for multiple variables. For TPD, the results revealed a post-intervention decrease in distance at 24 and 48 hours which suggests that subjects may have experienced improved local tactile sense through mechanoreceptor stimulation.[10] For PPT, the results revealed a decrease in perceived pain (higher tolerance to pressure) at 24 and 48 hours after strenuous exercise which suggests that the light IASTM treatment modulated nociceptive activity (C-tactile fibers). C-tactile fibers are low threshold afferent mechanoreceptors that innervate the human skin and contribute to pain percep-

tion.[24] These receptors respond to light tissue compressive forces (e.g. light brushing) and have been reported to modulate pain[14] and mediate allodynia in DOMS.[12] Thus, the light pressure (i.e. weight of tool) IASTM stroke at a 30° angle for 90 seconds at a rate of 120 BPM may have produced a short-term modulation of local C-tactile pain fibers at 24 and 48 hours post. Further research is needed to validate these findings.

Clinical Implications and Future Research

The results of this investigation suggests to clinicians that there may be merit in using a light IASTM stroke to stimulate local mechanoreceptors and nociceptors when treating patients in pain or following injury. The results of this study are preliminary evidence. Clinicians should consider this before integrating these treatment and assessment techniques into their clinical practice. Future research should focus on three gaps in the current literature. First, research should continue to study different treatment parameters such as pressure, dose time, stroke rate, and tool angle. Second, the therapeutic efficacy of the tool architecture needs to be studied such as type of metal, edge angle, tool surface, and weight. Third, the therapeutic effects of the treatment area need to be investigated. The optimal size of treatment area where changes occur may help clinicians become more efficient with their treatments.

Limitations

There are specific limitations to the investigation that need to be discussed. First, this investigation tested healthy subjects after a specific strenuous exercise protocol which limits the generalizability of the results to this population. Second, the IASTM technique used predetermined parameters on the dominant quadriceps muscle group. Other IASTM techniques may have produced different results. Third, a pre-determined small area on the quadriceps was investigated. A different or larger area on the body many have produced different results. Fourth, only the short-term effects (24 and 48 hours) of the IASTM intervention were measured. Future studies should measure the long-term effects of this intervention. Fifth, a randomized, larger sample size with a comparison control group may have produced other results. The researchers considered this investigation as exploratory and plan to use such methodology in future investigations.

Conclusion

IASTM is a popular intervention that is significantly understudied. This is the first investigation to study the effects of a light IASTM stroke and specific parameters on individuals with DOMS. Clinicians should consider these results as exploratory before integrating such strategies into their clinical practice.

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Would adopting a revised landmark rule for the spinal level of the iliac crests improve the accuracy of lumbar level identification?

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This is a secondary analysis of two previous systematic reviews demonstrating cephalad bias in using palpation to enumerate lumbopelvic levels, based on the conventional landmark rule that the spinal level of the palpated iliac crests=L4. Our study included 7 articles which enumerated lumbopelvic levels based on this rule, and furthermore reported data such that the direction and magnitude of errors could be abstracted from the article. The primary goal was to determine if enumeration accuracy would have improved had examiners known that the spinal level of palpated crests was closer to the L3-4 or L3 spinal level, as shown in our previous review. For the articles included, the mean error in spinal level enumeration diminished from 0.79 to -0.21 spinal levels, while accuracy increased from 26.3% to 46.9%. Since accuracy remained <50%,

Il s'agit d'une analyse secondaire de deux études méthodiques antérieures démontrant un biais céphalique dans l'utilisation de la palpation pour dénombrer les niveaux lombopelviens, basée sur la règle repère conventionnelle selon laquelle le niveau spinal des crêtes iliaques palpées est de L4. Notre étude comprenait sept articles qui énuméraient les niveaux lombopelviens basés sur cette règle, et qui, de plus, rapportaient des données telles que la direction et l'ampleur des erreurs. Ces éléments peuvent être extraits des articles. L'objectif principal était de déterminer si l'exactitude du dénombrement se serait améliorée si les examinateurs avaient su que le niveau spinal des crêtes palpées était plus près du niveau spinal L3-4 ou L3, comme nous l'avons démontré dans notre étude précédente. Pour les articles en question, l'erreur moyenne dans le dénombrement du niveau spinal a diminué de 0,79 à - 0,21, tandis que la précision a augmenté de 26,3 % à 46,9 %. Étant donné que la précision est restée inférieure à 50 %, il est peu probable que d'autres

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further refinements in iliac crest palpation are unlikely to improve enumeration accuracy, suggesting another method might best be sought.

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améliorations dans la palpation de la crête iliaque augmentent la précision du dénombrement, ce qui suggère la recherche d'une autre méthode.

(JCCA. 2019;63(1):26-35)

MOTS CLÉS : chiropratique, ilium, imagerie, vertèbre lombaire, palpation, radiographie

Introduction

It is widely believed that the spinal level of the iliac crests corresponds to the L4 spinous process (SP) or the L4-5 interspinous space[1]. A previous meta-analysis[2] conducted by the authors found that on *imaging* the iliac crests were found to be nearest the L4-5 interspace in females and the L4 spinous process (SP) in males. This same study found that the spinal level of the *palpated* iliac crests is cephalad to the imaged crest, nearest to the L3-4 interspace in both males and females. The palpated crest line was 0.7 levels cephalad to the imaged crest line in males, and 1.0 levels cephalad to the imaged line in females. The apparent reason why the palpated iliac crest is cephalad to the imaged crest is that during manual palpation an examiner's fingers contact soft tissue overlying the iliac crests, thereby reaching the L3-4 spinal level rather than the assumed L4-5 level. The greater discrepancy in females than males between the palpated and imaged iliac crests can be explained by the greater amount of suprapelvic subcutaneous fat in females compared to males.[1, 3-7]

All 12 of the included palpation studies in our previous meta-analysis[1, 3, 7-16] reported how often in percentage terms the examiner found the iliac crest to identify the L4 spinal level, and usually the percentage of caudal and cephalad errors. Since percentage reporting can be misleading, our previous study performed a secondary analysis of the included articles to calculate the mean difference between the palpated and imaged iliac crests. We were not aware of any other systematic reviews of this literature that summarize how often the spinal level of the iliac crest is at L4, in either percentage terms or as mean differences. Although some of the included studies, in addition to addressing the spinal level of the iliac crests, addressed the accuracy of identifying sacral and spinal levels other than L4 (in some cases including the lower thoracic spine), our meta-analysis only addressed the accuracy of identifying the L4 level. By comparison, our present study investigates accuracy in identifying spinal levels in a wider sense, both as originally reported and as might have been reported had the landmark rule for identifying spinal levels been different, as per our previous research on the actual spinal level of the palpated crest.

It may be assumed that an examiner who is unaware that the palpated iliac crest is generally cephalad to the imaged crest is likely to make many errors in in numerating lumbopelvic and thoracic spinal levels, and furthermore exhibit a systematic bias toward cephalad errors. As expected, most studies on the accuracy of lumbar spinal palpation have reported just that; errors are very common and tend to be cephalad.[1, 9, 14-18] Although examiner enumeration errors in these studies were no doubt due partly to random mistakes and patient variability, the cephalad systematic bias in these studies suggested there was also a flaw in the method by which the subjects were examined.

We hypothesized that reported accuracy rates and cephalad bias could be re-interpreted (i.e., recalculated) by assuming the palpators were not so much errant in their palpatory skills as at the mercy of a flawed landmark rule. Reported accuracy might have been higher had the palpators deployed a revised landmark rule whereby the palpated iliac crest identified the L3-4 interspace, instead of either the L4 SP or L4-5 interspace. Chakraverty, who was well aware of this cephalad bias, had suggested as follows: "It may be more appropriate to consider that palpation of the intercristal line [a line drawn across the iliac crests] is a guide for identifying the L3 or L3–4 spinal levels rather than the L4 or L4–5 levels, particularly in females and patients with higher body mass indices"[1].

The primary objective of the present study was to perform a secondary analysis of previous studies on the

accuracy of lumbopelvic level numeration based on palpation of the iliac crests, to determine if revising the customary understanding that this level is L4 (given evidence that the actual spinal level of the palpated iliac crests is more cephalad) could improve accuracy in identifying lumbar spinal levels.

Methods

The first author had conducted two earlier studies on the accuracy of static spinal palpation. The first study concerned the accuracy of using a variety of palpatory methods to identify cervical, thoracic, and lumbar spinal levels compared with an imaging reference standard.[19] The second study focused on the spinal level of the iliac crests as established by imaging, as compared with the spinal level of the palpated iliac crests.[2] For an article to be included in these prior reviews it had to concern the accuracy of enumerating various spinal levels (first study) or the spinal level of the palpated and/or imaged iliac crests (second study) using static palpation. Cadaveric studies (e.g, Windisch [20]) were excluded.

The two prior studies combined included a total of 28 unique articles.[1, 3, 6-18, 21-33]. Starting from this body of articles, we selected a subset of articles in which it seemed the examiners may have explicitly relied either entirely or primarily on iliac crest palpation to enumerate lumbopelvic levels, according to the rule the iliac crests identify L4. Articles in which the palpatory method did not uniquely or primarily depend on iliac crest palpation were excluded[17, 23, 30], because the clinical utility of this specific palpatory method was the primary focus of this article. Also excluded were articles in which the subjects were pregnant[13-15, 29] or pediatric[8, 21, 22], since our previous study[2] had demonstrated that the spinal level of the imaged and palpated iliac crests in these special populations differed from what is seen in a more general population of males and females. We also excluded studies that reported data in ways that precluded the calculation of the magnitude and direction of errors [24, 26-28, 31] or involved imaging but not palpation[6, 12, 32, 33].

We also excluded two studies with obvious bias, Duniec *et al*.[25] and Furness *et al*.[10]. In the Duniec study[25], the authors themselves stated the examiners had been biased and had urged caution in interpreting the results of their study; the anesthesiologists performing ultrasound imaging were not experienced, and furthermore were not blinded as to the results of the palpation performed by another anesthesiologist. In the Furness study[10], the examiners were aware of previously published articles finding cephalad bias in enumerating lumbar levels, suggesting they may have shifted their findings in a caudal direction to take this into account.

Although the articles we selected for this study reported data in a variety of tabular and graphic formats, we extracted the data from each study such that we could determine how often an attempt to identify a lumbopelvic spinal had been accurate, and to what extent errors were made in a cephalad or caudal direction. All seven studies provided a percentage estimate for exact accuracy in enumerating lumbopelvic levels, in addition to providing data as to the direction and frequency of errors. The provision of the raw data permitted us to calculate re-analyzed error rates, according to the hypothetical use of a revised landmark rule. A weighted average was calculated to determine the mean error in identifying lumbopelvic landmarks, both as originally reported and in accordance with the hypothetical revised spinal landmark rule.

For group analysis, we divided the studies into two subgroups. In the first group, the studies identified spinal levels to the nearest SP or interspinous space, using increments of half a spinal level. In the second group, the studies simply identified the nearest SP, thus using increments of a full-spinal level. After tabulating the accuracy of lumbopelvic enumeration based on the traditional understanding that the iliac crests identified the L4 SP, we then determined the hypothetical accuracy that would have been achieved if the examiners had used a revised landmark rule, whereby the spinal level of the palpated iliac crests corresponded to the L3 SP (for studies reporting data in full-level increments) or the L3-4 interspace (for studies reporting data in half-level increments). For each of the two groups a weighted average was calculated to provide a heuristic estimate of the difference between the palpated and the imaged lumbopelvic levels.

Results

Seven articles (Table 1) satisfied the inclusion criteria, including a total of 668 enumerations of a lumbopelvic level based on iliac crest palpation as a landmark. Table 2 provides the raw data extracted from the included articles, indicating the frequency and magnitudes of differences, in terms of the number of spinal level off in lumbopel-

Table 1.
Included studies on the accuracy of spinal level enumeration using static palpation.

	Subjects*	**Method**	**Reference standard**
Amin, 2014[3]	100 patients: 94 males, 6 females. Age 37 (9) both genders; BMI 26.6 (SD not provided)	Examiners identified spinal level of the iliac crests.	Videofluoroscopy, supine; palpated level identified with A radio-opaque marker
Broadbent, 2000[9]	200 patients, both genders; age 52 (range 18-87], BMI 26 (range 19-40)	Examiners asked to identify various lumbopelvic/thoracic spinal levels T11-S1.	MRI, supine; palpated level identified by fish oil capsule used as marker
Chakraverty, 2007[1]	75 patients, 65% female; age 45.0 (range 18–71), BMI 25.8 (range 19-38)	Examiners identified spinal level of iliac crests.	Videofluoroscopy, prone; palpated level identified with a radio-opaque marker
Kim, 2007[11]	72 volunteers: 19 males, mean age 25.4 (6.5), mean BMI 21.9 (3); 53 female, mean age 36.2 (11.6), BMI 20.9 (2.6)	Examiners identified spinal level of iliac crests.	X-ray, anterior to posterior (prone?); palpated level identified with A radio-opaque marker
Lin, 2015[7]	52 patients. 17 males, age 46.9 (16.8), BMI 23.4 (4.3); 35 females, age 48 (14.5), BMI 23.4 (3.7)	Examiners identified L2-3 or L3-4 spinal levels.	X-ray, anterior to posterior, sagittal; palpated level identified with A radio-opaque marker
Parate, 2016[18]	122 patients, 35% female. Age 40.52 (13.23), BMI 25.35 (3.99)	Examiners identified lumbopelvic/thoracic spinal levels, T12-L1 to L5-S1.	Ultrasound, sitting (posterior to anterior) or lateral; palpated level identified by skin mark identified palpated level
Whittey, 2008[16]	101 post-partum; age not reported. BMI 28 (5)	Examiners identified L2-3, L3-4, or L4-5 spinal levels.	Ultrasound, posterior to anterior, sitting; palpated level identified by puncture mark related to neuraxial procedure
*Values in parentheses indicate Standard Deviation unless range is denoted.			

Table 2.
Frequency and magnitude of errors in lumbopelvic spinal enumeration based on iliac crest palpation in previous studies.

SLMs	Full-spinal level studies:				Half-spinal level studies		
	Broadbent[9]	Whittey[16]	Lin[7]	Parate[18]	Amin[3]	Chakraverty[1]	Kim[11]
4	1						
3.5							
3	2						
2.5							
2	31	39		2	1	3	1
1.5					7	12	2
1	102	67	12	16	13	34	11
0.5					67	17	32
0	**58**	**15**	**30**	**26**	**12**	**9**	**26**
-0.5							
-1	6		10	4			
-1.5							
-2	0						
Subjects N=668	200	121	52	48	100	75	72

In far-left column, SLMs=magnitude of Spinal Level Misidentification, the error in terms of the number of spinal levels. The number in each cell represents the frequency of this SLM in each of the included studies. A positive number signifies cephalad misidentification, and a negative number caudal misidentification. Numbers in bold type signify zero error, the number of times there was no error in spinal level identification.

Table 3.
Reported and re-analyzed accuracy rates in lumbopelvic enumeration.

Studies reporting data in 1/2 spinal level increments			
Study	**N**	**Reported accuracy**	**Re-analyzed accuracy**
Amin[3]	100	12 (12.0%)	67 (67.0%)
Chakraverty[1]	75	9 (12.0%)	17 (22.7%)
Kim[11]	72	26 (36.1%)	32 (44.4%)
Sub-total	247	47 (19.0%)	116 (47.0%)
Studies reporting data in full-spinal level increments			
Broadbent[9]	200	58 (29.0%)	102 (51.0%)
Lin[7]	52	30 (57.7%)	12 (23.1%)
Parate[18]	48	26 (54.2%)	16 (33.3%)
Whittey[16]	121	15 (12.4%)	67 (55.4%)
Sub-total	421	129 (30.6%)	197 (46.8%)
GRAND TOTAL	668	176 (26.3%)	313 (46.9%)

vic spinal enumeration. The bolded row where the spinal level error=0 indicates perfect accuracy, when palpation and imaging perfectly agreed. Table 3 summarizes the accuracy of identifying lumbopelvic spinal levels both as reported and as might have been reported had a revised landmark rule been used ("re-analyzed accuracy"). Combining the data for all studies (Table 2), the examiners were reported to have been accurate 26.3% (range 12.0, 57.7%) of the time. Assuming the hypothetical use of a revised landmark rule, the examiners would have been accurate 46.9% (range 22.7, 67.0%) of the time.

Table 4 sums up the frequencies of accurate, caudal, and cephalad enumerations across all seven included studies, both as reported and for re-analyzed data. It reports data from studies reporting to the nearest half-spinal level separately from those reporting to the nearest full-spinal level. Both subsets of articles clearly demonstrated a systematic cephalad bias as originally reported: the accuracy of examiners in the pooled data for all seven studies was 26.3%; caudal errors occurred 3.0% and cephalad errors 70.7% of the time. Assuming the hypothetical use of a revised landmark rule, the examiners would have been accurate 46.9% of the time; erring in a caudal direction 29.3% and cephalad direction 23.8% of the time.

Table 5 provides the mean difference between the reported and re-analyzed spinal level differences between

Table 4.
Frequencies of accurate, caudal, and cephalad lumbopelvic level enumeration.*

	As reported	**Re-analyzed**
Studies reporting data in 1/2 spinal level increments		
Accurate	47 (19.0%)	116 (47.0%)
Caudal	0.0%	47 (19.0%)
Cephalad	200 (81.0%)	84 (34.0%)
Total	247	247
Studies reporting data in integer spinal level increments		
Accurate	129 (30.6%)	197 (46.8%)
Caudal	20 (4.8%)	149 (35.4%)
Cephald	272 (64.6%)	75 (17.8%)
Total	421	421
Combined data for all included studies		
Accurate	176 (26.3%)	313 (46.9%)
Caudal	20 (3.0%)	196 (29.3%)
Cephalad	472 (70.7%)	159 (23.8%)
Total	668	668

*"Accurate" signifies correct identification of spinal level; "cephalad" and "caudal" signify identifying levels above or below the intended level, respectively.

Table 5.
Reported and re-analyzed mean difference between spinal level enumerated by palpation and imaging.

	Reported mean error	**Re-analyzed mean error**
Studies reporting data in 1/2 spinal level increments		
Amin[3]	0.59	0.09
Chakraverty[1]	0.89	0.39
Kim[11]	0.44	–0.06
Weighted mean error	0.64 (0.44, 0.89)	0.14 (–0.06, 0.39)
Studies reporting data in full spinal level increments		
Broadbent[9]	0.84	–0.16
Lin[7]	0.04	–0.96
Parate[18]	0.33	–0.67
Whittey[16]	1.20	0.20
Weighted mean error (range)	0.79 (0.04, 1.20)	–0.21 (–0.96, 0.20)
GRAND TOTAL, n=668	0.73 (0.04, 1.20)	–0.08 (–0.67, 0.20)

palpation and imaging for each of the included studies, reporting data from studies reporting to the nearest half-spinal level separately from those reporting to the nearest full-spinal level. Weighted by sample size, the mean error for the three half-level studies was 0.64 (range 0.44, 0.89) spinal levels as reported and 0.14 (range –.06, 0.39) spinal levels after re-analyzing. The mean error for the four full-level studies was 0.79 (range 0.04, 1.20) as reported, and –0.21 (range –0.96, 0.20) spinal levels after re-analyzing. The mean error for all seven included studies was 0.73 (range 0.04, 1.20) spinal levels as reported, and –0.08 (range –0.67, 0.20) after re-analyzing the data.

Four[1, 7, 9, 18] of the included studies investigated the impact of Body Mass Index (BMI) on the accuracy of lumbar level identification, with results varying from modest to no impact. Where there was an effect[1, 7, 9], larger BMI was associated, as might have been expected, with larger differences between the spinal levels identified by palpation and by imaging.

Discussion

This study hypothesized that systematic bias could be decreased, and enumeration accuracy increased through the adoption of updated anatomical research on the spinal level of the palpated iliac crests. Since the weighted mean difference between the imaged and palpated iliac crest in the half-spinal level studies was 0.64 levels, we rounded this off to one-half spinal level to derive the revised landmark rule applicable to these studies. Since the weighted mean difference between the imaged and palpated iliac crest in the full-spinal level studies was 0.64 levels, we rounded this off to one full level to derive the revised landmark rule applicable to these studies. The full-spinal level studies tended to achieve higher accuracy rates. This was not surprising, since in the half-spinal level studies an examiner who was nearly half a level off from the intended spinal level would have been judged to have been "inaccurate", while the same error would have been rounded off to the nearest level in the full-spinal level studies, so the examiner would have been judged "accurate".

For all 668 observations, although accuracy increased from 26.3% to 46.9% assuming a revised landmark rule, the examiners would still have identified the wrong level most of the time. The reason the improvement was not more dramatic is because there was considerable random variability in addition to the systematic bias. This was due to several factors, starting with the fact that the patient populations were varied in their age, gender, BMI, and clinical status. Furthermore, the studies differed in their methods, some reporting to the nearest full-level and others half-spinal levels.

The mean error of 0.62 spinal levels in the data as originally reported is broadly consistent with the results of our previous study[1], in which there was 0.88 spinal levels difference between the imaged and palpated iliac crests for a mixed population of males and females. We did not expect the magnitudes of the mean error in the current and prior study to necessarily agree, because the prior study only concerned errors in identifying L4, whereas the current study focuses on the accuracy of identifying *any* lumbopelvic spinal level based on an iliac crest landmark. Perhaps examiners, when asked to enumerate levels relatively distant for the crest level, draw upon other cues that slightly improve their accuracy. Since the difference between the mean error in the present and prior studies was 0.16 spinal levels, while the height of a lumbar spinal level is about 4cm[34], the difference in the mean errors reported in our prior and present studies was a mere 6.4mm.

There may be better strategies for identifying lumbar levels. Kim[11] suggested using the PSISs as a landmark for identifying spinal levels. Since the second sacral tubercle is very dependably situated between the posterior superior iliac spines[1, 11, 35], enumerating lower thoracic and lumbopelvic levels based on this landmark association might be more accurate. To our knowledge, using this sacral base method alone to identify lumbar spinal levels has not been validated. Jung *et al*.[4] suggested, but did not validate, that using the tenth rib line (an imaginary line that joins the lowest points of the rib cage on the flanks) could serve as an anatomical landmark for identifying lumbar vertebral levels. These authors argued this method was preferable to using the iliac crests, because the tenth rib method would be immune to the errors using the crest method that are due to subcutaneous fat. Borghi *et al*.[36] compared two methods for locating the L4-5 interspace in order to perform a lumbar plexus block, including using the iliac crest method as well using the soft-tissue skin depression at the iliac crest prominence ("Borghi's approach") as an anatomical landmark. Their argument was that using the skin depression at the iliac crest prominence method is more reliable in a population of obese patients

or those with larger amounts of subcutaneous fat. We are not aware of any follow-ups to this study that would support or reject the method described.

Some authors have suggested using a combination of methods to accurately enumerate lumbar spinal levels. Ambulkar *et al*.[37] compared the accuracy of manual palpation to that of ultrasound in identifying spinal levels, using MRI as a reference standard. The manual palpation method deployed three spinal landmark rules: the vertebra prominens was said to correspond to the SP of C7, the inferior tips of the scapulae to the SP of T7, and the iliac crests to the SP of L4. However, each of the landmark rules upon which the Ambulkar study depended has been questioned: the vertebra prominens is at the C7 SP only about 70% of the time[38], the spinal level of the inferior tip of the scapula is quite variable but closest to the T8 SP[39], and the palpated (as opposed to imaged) iliac crests are on average closest to the L3-4 interspace[2]. Snider *et al*.[17] studied the accuracy of identifying the L1-L4 SPs using a combination of five different anatomical landmarks: T12 (smaller SP), twelfth rib (attaches to T12), iliac crests (vertebral body of L4), sacral base (body of L5), and the L5 SP (smaller size). Faculty examiners were on average 74% accurate, whereas the residents were 51% accurate. Level identification did not significantly vary among the four lumbar levels examined. Using this combination of landmarks, especially among more experienced examiners, appears to have increased accuracy by more than could be achieved by depending solely on a revised iliac crest landmark role, which we found hypothetically capable of achieving only 48.9% accuracy. Merz *et al*.[30] also used a combination of landmarks to identify the SP of L5: the examiner used either a single landmark – the iliac crests or the inferior aspect of the PSISs – or a combination of one of these landmarks with motion palpation. The highest accuracy recorded was obtained using PSIS identification plus motion palpation, achieving 61% accuracy. This was somewhat lower than the rate achieved by Snider's combined landmark method, but still higher than the hypothetical accuracy rate in our study based on a revised iliac crest landmark rule.

Although none of these combined landmark studies are definitive, there is some evidence suggesting the advantage of using multiple anatomical landmarks to improve spinal identification accuracy. That stated, manual therapists had best accept the reality that there will be errors made using the usual manual methods for lumbopelvic spinal enumeration. This need not be very troubling, in that the importance of abject specificity to ensuring good clinical outcomes has never been established.[40] Moreover, spinal interventions are inherently multi-segmental, directly impacting both a cephalad and a cadual motion segment, thereby spanning three vertebrae.[27, 41] It remains to be seen whether some clinicians would decide the need for greater accuracy warrants the use of an imaging procedure, such as diagnostic ultrasound.[42] The most important scenario in manual therapy likely requiring a high degree of segmental specificity is spinal intervention based on imaging or nerve conduction studies. In anesthesiology, much more is at stake in numerating spinal levels very accurately, which necessarily impacts the effectiveness and safety of the procedure.

Errors in either spinal level identification or enumeration pose several issues for the manual therapist:

- So long as the practitioner in fact directly treats the segment identified by manual examination as the optimal site for intervention, the clinical outcome need not necessarily be impacted by enumeration errors.
- That stated, enumeration errors will necessarily lead to charting errors.
- Charting errors may lead to sub-optimal or inappropriate interventions in multi-practitioner clinic settings or if the patient were to seek care in a different professional setting, when other practitioners must rely on chart notes that might be in error.
- If selecting an intended spinal site of care depends on a non-manual assessment procedure, such as imaging or neurological evaluation, errors in manual spinal level identification may lead to inappropriate interventions.
- In a research setting, errors in either spinal level identification or enumeration can confound reliability and validity studies.

Errors in identifying or numerating lumbopelvic spinal levels pose greater problems for anesthetists and other health care professionals, for whom errors in segmental specificity inherently involve more risk. Since spine patients are generally injected between vertebrae, anesthe-

tists focus on numerating interspinous spaces. Accuracy in identifying and numerating spinal levels is essential to the practice of anesthesiology, both to ensure effective and safe anesthesia.[43] Injecting lumbar interspaces above the L3-4 interspace increases the risk of neurological injury, since the conus medullaris may extend as low as the upper body of L3.[16]

Limitations

We excluded five studies[24,26-28,31] that reported data in ways that precluded the calculation of the magnitude and direction of errors; the results may have been different if the findings of these studies could have been included. These five excluded studies included a total of 198 subjects. This study did not concern the possibility of improving lumbar spinal level identification in specialized patient populations, such as pregnant women, morbidly obese patients, or pediatric patients. The patient populations used in the included studies differed in various demographic and clinical factors, suggesting caution in applying the results of this review to patients in different clinical settings. The particular lumbopelvic and lower thoracic segments that examiners were asked to find were not evenly dispersed throughout the lumbopelvic region included, there having been a preponderance of studies addressing the L4 level. The data from studies using full-level and those using half-level increments were combined for data analysis, which may have impacted the results.

Conclusions

The results of our exploratory study are consistent with Chakraverty's suggestion[1] that deploying a revised landmark rule for the spinal level identified by iliac crest palpation would almost certainly increase accuracy in lumbopelvic spinal level identification: a heuristic calculation suggested accuracy would increase from 26.3% to 46.9%. Moreover, palpation based on the revised rule eliminated the systematic bias toward cephalad errors, such that the frequency of caudal and cephalad errors (29.3% and 23.8% respectively) very evenly distributed. However, random errors due to patient variability and stochastic examiner mistakes would still be very common, occurring about half the time.

Future research might best explore alternatives to using the iliac crests alone as a landmark for spinal level enumeration, such as using a different single landmark (such as the S2 tubercle) or a combination of manual methods. Even were a more accurate spinal level enumeration method found, it would still be necessary to determine if clinicians could be reliably trained to use that method. Future research might also investigate to what extent clinical outcomes depend on specificity in level enumeration, both in manual therapy and especially anesthesiology settings.

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Comparison of chiropractic student lexicon at two educational institutions: a cross-sectional survey

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Objective: *To evaluate student perceptions of chiropractic cultural authority, role in healthcare and use of terms at two chiropractic institutions, the Canadian Memorial Chiropractic College (CMCC) and Parker University (Parker).*

Methods: *A unique survey was developed and administered electronically to Year 2-3 students (n=387) at CMCC and as a paper-based surveys to trimester 4-5 (comparison with Year 2) and 6-7 (comparison with Year 3) (n=277) students at Parker. Responses were anonymous. The survey assessed the likelihood that students at both chiropractic programs would use eight different chiropractic terms. The survey also assessed their preference toward different options with respect to chiropractic's cultural authority.*

Results: *Response rates were 36.2% and 78.1% at CMCC and Parker, respectively. Students at both institutions reported that chiropractic cultural authority*

Objectif : *Évaluer la perception des étudiants sur l'autorité culturelle de la chiropratique, le rôle dans les soins de santé et l'utilisation des termes dans deux établissements chiropratiques, le Canadian Memorial Chiropractic College (CMCC) et l'Université de Parker (Parker).*

Méthodologie : *Un sondage unique a été élaboré et envoyé par courriel aux étudiants de 2e et 3e année (387 étudiants) du CMCC et en format papier aux étudiants du trimestre 4-5 (en comparaison avec la 2e année) et 6-7 (en comparaison avec la 3e année) (277 étudiants) de l'Université de Parker. Les réponses étaient anonymes. Le sondage a évalué la probabilité que les étudiants des deux programmes de chiropratique utilisent huit termes chiropratiques différents. Le sondage a également évalué leur préférence pour différentes options en ce qui concerne l'autorité culturelle de la chiropratique.*

Résultats : *Les taux de réponses étaient de 36,2 % au CMCC et de 78,1 % à l'Université de Parker. Les étudiants des deux établissements ont déclaré que l'autorité culturelle en chiropratique était les soins*

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was 'neuromusculoskeletal' (NMSK); however, CMCC students was more favorable toward 'musculoskeletal' (MSK) care compared to Parker students, whereas students at Parker favored 'wellness' (59.7%) compared to CMCC students (46.4%). Students at CMCC were more likely to use 'impingement' and 'joint dysfunction' whereas Parker students were more likely to use 'innate intelligence' and 'vertebral subluxation'. Both institutions were equally likely to use 'spinal lesion'.

Conclusion: *This survey found significant cultural authority differences between institutions. While this adds to the emerging need in the literature to evaluate the impact of curriculum and co-curriculum within chiropractic training programs on professional identity, explanations were not evaluated.*

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KEY WORDS: chiropractic, cultural authority, lexicon, survey, terminology

« neuro-musculo-squelettiques ». Cependant, les étudiants du CMCC étaient plus favorables aux soins « musculo-squelettiques » contrairement aux étudiants de l'Université de Parker, qui eux étaient plus favorables aux soins « bien-être » (59,7 %) contrairement aux étudiants du CMCC (46,4 %). Les étudiants du CMCC étaient plus susceptibles d'utiliser les termes « impact » et « dysfonctionnement articulaire », tandis que les étudiants de l'Université de Parker étaient plus susceptibles d'utiliser « intelligence innée » et « subluxation vertébrale ». Les deux établissements étaient également susceptibles d'utiliser « lésion épinière ».

Conclusion : *Ce sondage a révélé d'importantes différences d'autorité culturelle entre les établissements. Bien que, dans la documentation, cela s'ajoute au besoin émergent d'évaluer les répercussions du programme et du coprogramme d'études des programmes de formation en chiropratique sur l'identité professionnelle, les explications n'ont pas été évaluées.*

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MOTS CLÉS : chiropratique, autorité culturelle, lexique, sondage, terminologie

Introduction

It has been stated that the healthcare lexicon is more complex than the English language itself [1], which should make it no surprise that *chiropractic* lexicon, a lexicon containing many unique terms, is often contested within the chiropractic profession itself and adds an extra layer of complexity to the entire profession. For example, in a 2005 study, authors were able to classify US schools as 'liberal' *("interested in mixing elements of modern and alternative therapies into chiropractic practice*") or 'conservative' *("chiropractors who believe in continuing the traditions of chiropractic"*).[2] With differing educational viewpoints, one could assume that there would be differing and varying lexicon usage throughout the profession.

A 2013 Canadian study compared historical educational document lexicon to that of JCCA publications up until the 1950s.[3] The investigators found that the use of terms such as 'subluxation' and 'adjustment' (terms considered more 'conservative') had decreased over time and replaced with the evolution of language more commonly used in medicine (terms considered more 'liberal'), suggesting a trend toward a shared lexicon across manual medicine professions.[3] Similarly, other reviews specifically investigating the use of the term 'subluxation', also referred to as 'vertebral subluxation complex' (VSC), within chiropractic literature reported its use as either infrequent[4] or not at all.[5,6]

By contrast, a 2003 survey of North American chiropractors (*n=687*) reported that 88.1% of practicing chiropractors used the term VSC.[7] More recent surveys of chiropractic students in North America[8] and Australia/New Zealand[9] reported a preference for both (i) 'conservative' or traditional chiropractic theories and practices, which includes the VSC concept, as well as (ii) 'liberal' or exposure to evidence-based practice concepts. The authors of those studies suggested that, while this could be a potential degree of cognitive dissonance among chiropractic students, it could also be reflective of the spectrum

of diversity within the chiropractic profession to which students are being exposed. A deeper understanding of respective curriculums and environments may explain differences in student opinions.

To begin a deeper exploration of chiropractic institutions and the lexicon they preferentially use, the objectives of this study were to investigate students' perception of the profession's cultural authority, its role in healthcare and their use of specific chiropractic terms at two North American chiropractic institutions: the Canadian Memorial Chiropractic College (CMCC) and Parker University (Parker).

Methods

This cross-sectional survey was approved by the Research Ethic Board at CMCC (1501X05) and the Institutional Review Board of Parker (#A-00151).

Student Populations

Students at both CMCC and Parker were compared roughly midway in their educational training. Because CMCC is on a year calendar schedule with a total of four years and Parker is on a three semester (trimester) per year schedule with a total of 10 trimesters, the survey compared CMCC students in Year 2 with Parker students in trimester 4 and 5 and CMCC students in Year 3 with Parker students in trimester 6 and 7.

Survey Questions

Based on a review of the chiropractic literature, the authors of an earlier study conducted at only CMCC[10] generated the list of chiropractic terms used in this study.[11-17] Using that list of terms, students were asked what their thought best defined the "cultural authority" of the profession: m*usculoskeletal (MSK) expert, neuromusculoskeletal (NMSK) expert, wellness-based expert,* or *subluxation-based expert*. After that, students were asked which of the following terms best describes the "role of chiropractic in the health care delivery system": *primary care practitioners*, *portal of entry,* or *primary contact*.

Lastly, students were then asked which of the following chiropractic terms they would use: *vertebral subluxation, innate intelligence, dis-ease, spinal misalignment, nerve flow interference*, *spinal lesion, impingement,* and *joint dysfunction*. Based on our review of the literature, we concluded *vertebral subluxation, innate intelligence, dis-ease, spinal mis-alignment* and *nerve flow interference* to be terms mostly used by conservative chiropractors whereas *spinal lesion, impingement* and *joint dysfunction* to be terms most likely used by liberal chiropractors. Specifically, students were asked how likely (or unlikely) they would be to use these terms using a 5-point rating scale, with 5 being '*very likely'*, 4 being *'likely'*, 3 being '*somewhat likely* 2 being '*unlikely'* and 1 being '*very unlikely'*. If a respondent indicated they were *'somewhat likely'* (option 3), '*likely'* (option 4) or '*very likely'* (option 5) to use a particular term they were then prompted to indicate how likely they would use that term with different groups of people using the same 5-point rating scale). Options included: *Patients, Colleagues, Medical Doctors (MD), Legal Proceeding,* or *Complementary Alternative Medical Providers (CAM)*. Respondents were able to choose more than one option. Definitions of the chiropractic terms used in this survey were not provided to students. The survey questions are provided in Appendix 1.

Survey Distribution

The authors at CMCC administered the survey electronically via Survey Monkey to all Year II and Year III students during the 2014-2015 academic year. Survey Monkey only allows a respondent to reply to the survey once, based on their email address. The authors at Parker administered the survey via paper copies in June-July of 2016 during technique classes, since all students attended those classes. The authors at Parker ensured students only responded once to the survey. Both surveys were anonymous and confidential.

Both surveys included an informational letter that explained the purpose of the study and explained that the survey was anonymous and that its completion was voluntary. Consent was implied if the survey was completed.

Statistical Analysis

Survey data from both chiropractic programs were compared using cross-tabulations and chi squared statistics in Stata (StataCorp 2013).[18] Data were converted to percentages for ease of reading. Descriptive statistics were used for demographic information.

Results

Table 1 displays the response rates by student year with

the overall response rates as CMCC: 38.1% and Parker: 76.2%. The majority of students (82.6%) were between the ages of 21-29 (CMCC: 91.4% and Parker: 76.8%) and an almost equal distribution (overall male, 47.0%) of sex distribution (male, CMCC: 41.4% and Parker: 58.6%).

Cultural Authority (Table 2)

Overall, 65.7% of CMCC students and 35.6% of Parker students endorsed the option of *MSK experts,* a statistically significant difference (chi-square=30.7, p-value<0.001). Responses from the two programs were more similar, but still statistically significantly different in distribution for the *NMSK expert* option, with 87.9% of CMCC and 74.4% of Parker students endorsing this option overall (chi-square=9.4, p-value=0.002).

For the option of *wellness-based expert*, Parker students were more likely to endorse this at 59.7% overall, whereas only 46.4% of CMCC students endorsed this option (chi- square=6.0, p-value=0.014). The last option, *subluxation-based expert*, was endorsed by 54.5% of Parker students, but only by 9.3% of CMCC students (chi-square=74.0, p- value<0.001).

Role of Chiropractic in the Health Care Delivery System (Table 3)

Overall, 85.7% of CMCC students versus 74.1% of Parker students endorsed the option *primary care practitioners,* a statistically significant difference (chi-square=6.7, p-value of 0.01). There was a more pronounced and statistically significant difference between Year 3 student (CMCC: 85.6%, Parker: 70.9%, chi-square=6.4, p-value=0.011) respondents from both programs then the Year 2 students (CMCC: 86.1%, Parker: 76.2%, chi-square=1.8, p- value=0.185).

For *portal of entry*, 28.6% of CMCC students endorsed the term, as opposed to 44.6% of Parker students, indicating a significantly statistical difference between programs (chi-square=9.1, p- value=0.003). In this case, there was not a statistically significant difference for Year 3 students (CMCC: 34.0%, Parker: 44.6%, chi-square=2.4, p-value=0.122) at each institution, but there was a significant difference for Year 2 students (CMCC: 16.3%, Parker: 44.6%, chi- square=10.5, p-value<0.001). Finally, there was no overall or stratified statistically significant difference between responses for *primary contact*.

Table 1.
Response rates.

	CMCC	Parker
CMCC – Year 2 / Parker – Trimester 4 and 5	43/187 (23.0%)	101/150 (67.3%)
CMCC – Year 3 / Parker – Trimester 6 and 7	97/180 (53.9%)	110/127 (86.6%)
Overall	140/367 (38.1%)	211/277 (76.2%)

Table 2.
Comparison of student responses from CMCC and Parker to question on cultural authority.

Cultural Authority	CMCC	Parker
MSK	64.4%	33.6%
NMSK	87.9%	74.4%
Wellness-based	47.1%	59.7%
Subluxation-based	9.3%	56.3%

Table 3.
Comparison of student responses from CMCC and Parker to question on role of chiropractic in healthcare.

Role in Health Care	CMCC	Parker
Primary Care*	85.7%	74.1%
Primary Contact+	44.2%	36.8%
Portal of Entry^	28.6%	44.6%*

p<0.05% (overall and Year 3),
+ No overall or stratified statistically significant difference,
^ p<0/05% (overall and Year 2)

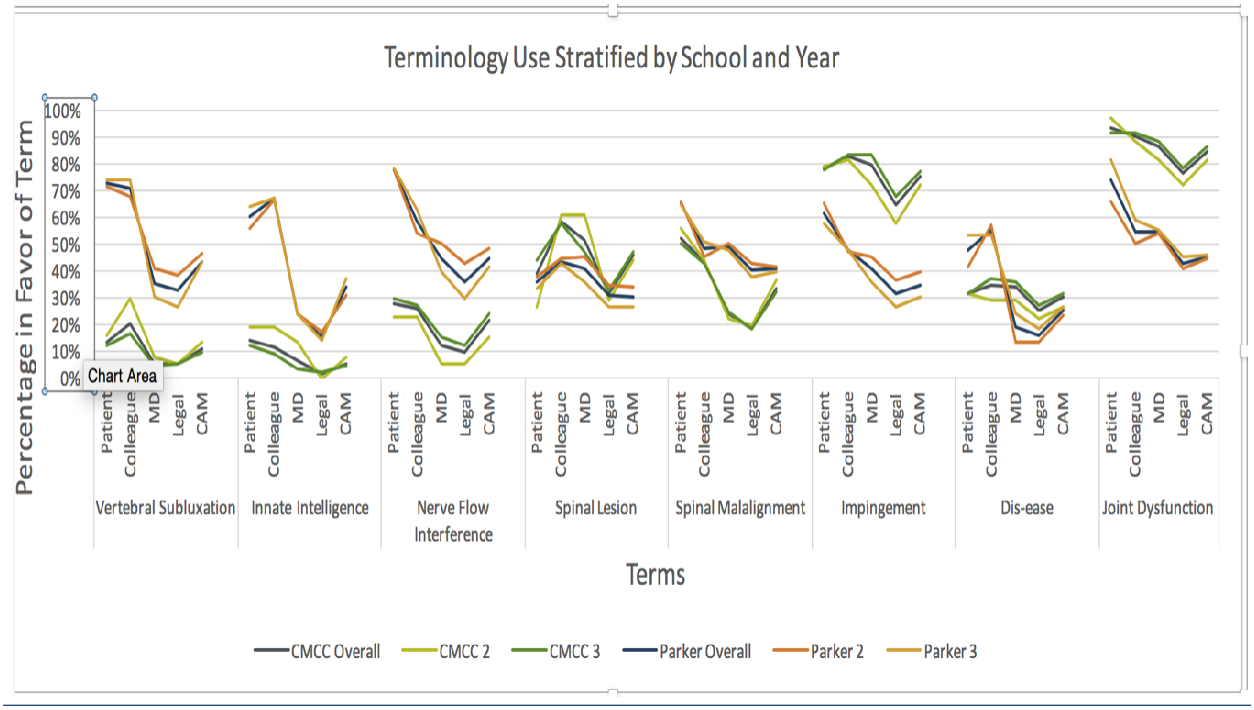

Figure 1.
Comparison of students' responses to use of chiropractic terms with different groups of people.

Use of Chiropractic Terms (Table 4)

Students at Parker were more '*likely*' or '*very likely´* to use all the terms we considered as 'conservative' compared with CMCC students. Conversely, 'liberal' terms were found to be statistically significantly more commonly used by CMCC students, except for *spinal lesion*, which was used only slightly higher than Parker students (48.8% vs 40.7%, respectively). When the terms were reviewed by years, similar findings were found for the conservative terms. However, for the liberal terms the Year 2 students were found to have similar and not statistically significant differences (*impingement:* CMCC – 86.1% vs Parker – 67.6% and *joint dysfunction:* CMCC – 93.0% vs Parker – 77.7%).

Use of Chiropractic Lexicon with Different Groups of People

Figure 1 displays the chiropractic lexicon use with different groups of people for those students stating they would commonly use the term. Lexicon used from each institution does not overlap for five of the terms. Another find-

Table 4.
Comparison of percentages Year 2 and Year 3 students to 'likely' or 'very likely' use of chiropractic terms.

	CMCC	Parker	p-value
Conservative Terms			
vertebral subluxation	8.6%	86.3%	<0.001
innate intelligence	7.9%	68.3%	<0.001
dis-ease	30.7%	50.0%	<0.001
spinal misalignment	32.9%	73.0%	<0.001
nerve flow interference	19.3%	83.4%	<0.001
Liberal Terms			
spinal lesion	40.7%	48.8%	0.007
impingement	87.8%	59.1%	<0.001
joint dysfunction	93.6%	75.2%	<0.001

ing was the differences between years in the program and use of terms. There are noticeable dips in most response sets when it comes to using the terms in a *Legal Proceeding*, and to a lesser degree when measuring likelihood of term use with *Medical Doctors*.

Discussion

This study found both similarities and differences in lexicon usage for chiropractic students at two different North American institutions. There were a few terms that had similarities by year of study, including 'spinal lesion', 'impingement', and 'joint dysfunction'. All other terms were different with Parker students more in favor of using more 'conservative' terms compared with CMCC students, who tended to use more 'liberal' terms.

Both groups of students were in favor of the chiropractic culture authority to be wellness-based (CMCC: 47.2%; Parker: 59.7%) and neuromusculoskeletal focused (CMCC: 87.9%; Parker: 74.4%), but differed with respect to subluxation-based (CMCC: 9.3%; Parker: 56.3%) and musculoskeletal focus (CMCC: 64.4%; Parker: 33.6%). Caution needs to be taken, as the response rate was low for one of the CMCC groups.

As of 2005, two-thirds of US chiropractic programs were classified as 'liberal' and one-third as 'conservative'.[2] Although CMCC was not specifically categorized in this report, according to these definitions CMCC would be in the 'liberal' category. Responses from Parker in our study were more mixed, suggesting that Parker students are exposed to both 'liberal' and 'conservative' concepts simultaneously. This differs from the 2005 placement of Parker as a strictly 'conservative' school.

CMCC teaches 'conservative' chiropractic concepts (i.e., the Palmer Postulates) from a historical perspective and focus more on 'liberal' concepts (PI personal communication). Parker, however, teaches both 'conservative' and 'liberal' concepts as part of their core curriculum (ER personal communication). Therefore, of the terms surveyed, 'innate intelligence', 'vertebral subluxation', and 'dis-ease' are found in the core curriculum of Parker to a greater extent as compared to CMCC. However, not all terms surveyed, such as 'nerve flow interference', are currently taught at Parker as part of core curriculum, but still had high usage. This could reflect co-curricular influence on students' chiropractic lexicon usage or pre-professional identity.[19] It may also reflect findings similar to Puhl *et al*.[20], which found that there are significant differences in the number of 'liberal' and 'conservative' chiropractors that graduate from different chiropractic institutes.

Innes *et al*.[9] sought to find out how frequent 'non-evidence-based beliefs' are held in Australian chiropractic students. Of particular relevance to our study, Innes *et al*.[11] reported the vast majority of student respondents reported they would advise patients about 'wellness' in the future and when asked about the effects of spinal adjustments, the majority of Australian students responded that it helped "the body function at 100% of its capacity". Roughly half of CMCC (46.4%) and Parker (59.7%) students in our study reported that chiropractic's role in the healthcare delivery system was 'wellness-based', which is consistent with Innes *et al*'s Australian cohorts.[9]

Our study reflected that Parker had similar results as the Gliedt *et al*. [8] and de Luca *et al*.[21] findings of both 'conservative' and 'liberal' beliefs / lexicon usage amongst the students surveyed. CMCC students, however, were found to have a more 'liberal' lexicon usage. These findings are also consistent with the McGregor *et al*.[22] study that surveyed 503 Canadian chiropractors (63% were CMCC graduates) that found the majority of respondents held mostly 'liberal' viewpoints. By contrast the McDonald *et a*l.[7] survey of North American chiropractors reported most had a more mixed viewpoint similar to Parker students.

Mirtz and Perle[23] sought to determine the prevalence of the word 'subluxation' within North American chiropractic programs curricula. They reported that term subluxation was found in all but two American chiropractic programs and not in the curriculum of CMCC, although Budgell[24] investigated the use of the word subluxation at CMCC in more detail, reporting the term is used in a limited manner. According to Mirtz and Perle[23], Palmer College (Florida) had the most prevalent use of the term subluxation (22% of courses) whereas 8% of courses at Parker University used that term.

Worldwide, Funk *et al*.[25] found the use of term subluxation was much more varied across chiropractic programs, but still highest among those in the United States. A number of authors have suggested this variation in the chiropractic lexicon, especially with respect to term subluxation, may impede both intraprofessional and interprofessional communications.[2, 15,17, 25-27] That is, chiropractors from different chiropractic programs may

find it difficult to find a common lexicon to share ideas and perceptions, especially since operational definition of terms such as subluxation are so varied.[28] Some authors go even further, opining chiropractic's cultural authority can only be achieved by jettisoning conservative chiropractic terms, particularly the word subluxation.[15,25-27]

That said, we continue to be mindful of the findings by Biggs *et al*.[11] that reported that, in a survey conducted of Canadian chiropractors, 14.9% were found to be 'rationalists' (chiropractors who adopt scientific validation and champion a narrow scope of practice), 26.4% were found to be 'empiricists' (chiropractors who adopted the Palmer postulates, including subluxation theory) and the vast majority – over 56% – were 'moderates', sitting somewhere in-between these two groups. We opine that the findings of that study, along with the study by Gliedt *et al*.[8] may better reflect the attitudes of the majority of chiropractors who may exist on a continuum between liberal and conservative perspectives.

Limitations

This study had several limitations. There was a relatively low and unequal response rate among students from both chiropractic programs, but especially noted for Year 2 of the CMCC program, which may have skewed our results because of non-response bias. This response rate may have been caused by the different distribution mechanism used at each institution, which should be carefully reviewed in future evaluations. Additionally, since the psychometric properties of the survey were not assessed we cannot be certain we measured what we intended to measure.

The options used to define the profession's cultural authority, the role of chiropractic in the healthcare delivery and the eight terms thought to be unique to chiropractic were generated by consensus opinion in an early study.[10] Since this was a somewhat unilateral and unformal decision-making process it is possible some options and terms that should have been provided were not. Alternatively, since definitions of all terms and options were not included in the survey's instruction they may have been misunderstood by the respondents.

Conclusions

We found that while there were some similarities, there were several statistically significant differences between two North American chiropractic teaching institutions with respect to their perception of the profession's cultural authority, role in healthcare and likelihood to use various terms unique to the chiropractic lexicon. The influencers of these differences were not reviewed, but adds to the emerging need in the literature to evaluate the impact of curriculum and co-curriculum within chiropractic training programs on professional identity. Future studies ought to address the limitations identified and be conducted at other chiropractic programs longitudinally with a curriculum / co-curriculum assessment.

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Clinical management of an adult with erythema infectiosum: a retrospective case report

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Objective: *To review the epidemiology, etiology, diagnosis and typical management of erythema infectiosum and to illustrate the clinical management of an adult with erythema infectiosum.*

Clinical features: *A 38-year-old male complaining of severe global pain, swelling, weakness and stiffness in his shoulders, elbows, knees, and fingers of seven weeks duration.*

Intervention and outcome: *The patient was treated with a combination of 1) pharmacological treatment of naprosyn, prednisone, methotrexate, hydroquinone and sulfasalazine, 2) conservative treatment consisting of spinal manipulation, peripheral joint mobilization, acupuncture and low-tech Qi Gong and Tai Chi exercises, and 3) an active physiotherapy program consisting of strengthening exercises, and stationary bike. The patient reported marked improvement in pain, mobility, strength, and function with the addition of conservative physical treatment.*

Objectif : *Examiner l'épidémiologie, l'étiologie, le diagnostic et la gestiontypique de l'érythème infectieux, et illustrer la gestion clinique d'un adulte présentant un érythème infectieux.*

Caractéristiques cliniques : *Un homme âgé de 38 ans, se plaignant d'une douleur intense, de tuméfaction, d'une faiblesse et d'une raideur intense dans les épaules, les coudes, les genoux et les doigts depuis sept semaines.*

Intervention et résultats : *Le patient a été traité avec l'association suivante : 1) traitement pharmacologique aux naprosyne, prednisone, méthotrexate, hydroquinone et sulfasalazine, 2) traitement conservateur consistant en une manipulation vertébrale, une mobilisation articulaire périphérique, en de l'acupuncture et des exercices de Qi Gong et Tai Chi à faible technologie, et 3) un programme de physiothérapie active comprenant la pratique d'exercices de renforcement et de vélo stationnaire. Avec l'ajout d'un traitement physique conservateur, le patient a rapporté une nette amélioration de la douleur, de sa mobilité, de sa force et de sa condition.*

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The involved patient provided consent for case publication.

Summary: *Erythema infectiosum is associated with a wide spectrum of clinical manifestations, where arthropathy is the most common clinical manifestation in adults. Erythema infectiosum should be suspected as a potential differential diagnosis when a patient presents with red or purplish skin rashes, especially when accompanied by fever and joint pain. Conservative management could be considered as an adjunctive therapy option for this condition. However, further validation and research is warranted.*

(JCCA. 2019;63(1):44-50)

KEY WORDS: erythema infectiosum, Parvovirus B19, arthropathy, chiropractic, physiotherapy

Résumé : *L'érythème infectieux s'accompagne d'un large éventail de manifestations cliniques, l'arthropathie étant la plus courante chez l'adulte. L'érythème infectieux doit être considéré comme un diagnostic différentiel potentiel lorsqu'un patient présente des éruptions cutanées rouges ou violacées, surtout s'il est accompagné de fièvre et de douleurs articulaires. Un traitement conservateur pourrait être envisagé comme une option thérapeutique complémentaire pour cette affection. Toutefois, une validation et des recherches poussées s'imposent.*

(JCCA. 2019;63(1):44-50)

MOTS CLÉS : érythème infectieux, Parvovirus B19, arthropathie, chiropratique, physiothérapie

Introduction

In healthy, immunocompetent individuals, parvovirus B19 (B19V) is the cause of Erythema infections (EI), also called "fifth disease" or "slapped cheek" disease.[1] EI is referred to as fifth disease because it was fifth of the common rash-associated diseases of childhood to be identified, which includes measles, scarlet fever, rubella, and varicella.[1] Fifth disease is also most common in children ages five to fifteen.[1] EI commonly affects children but can also continue at lower rates throughout adulthood.[2] EI symptoms are characterized by low-grade fever, malaise, a red "slapped cheek" facial rash, and later by the spread of a lacy or reticular maculopapular rash involving the trunk and limbs.[2] Arthropathy is the most common clinical manifestation in adults with EI and is usually of a brief duration, although some individuals do experience prolonged symptoms that last weeks to years.[2]

EI in adults is rare and poorly described in the literature.[3] We report the case of a 38-year-old male presenting with severe global joint pain, swelling, stiffness and weakness of seven weeks duration due to EI. EI does not typically require treatment, but some patients with arthropathy may require symptomatic management such as anti-inflammatory medication.[4]

To our knowledge, there is no published literature regarding conservative care for arthropathy in adults with EI. In our case study, the patient elected to access conservative care for his condition and received a variety of interventions consisting of chiropractic spinal and peripheral joint manipulation and mobilization, acupuncture, and range of motion and strengthening exercises. The conservative interventions were well tolerated, and the patient considered it to be a useful adjunct to the usual and customary pharmacological treatment.

The purpose of this case report is to review the etiology, epidemiology, clinical manifestations and typical medical management of this condition. It is important for primary healthcare providers to be aware of this condition as a potential differential diagnosis and should be suspected in individuals who present with maculopapular skin lesions, especially if accompanied by fever and arthropathy.

Case presentation

A 38-year-old male airport authority service worker presented with severe global pain, swelling, weakness and stiffness of seven weeks duration. He had been previously diagnosed with EI by an infectious disease specialist.

The patient had previously been tested for a wide variety of infectious diseases including syphilis, HIV, and Lyme disease, before it was concluded that he was suffering from severe reactive arthritis induced by Parvovirus B19. The patient's daughter, who had recently recovered from the illness, was suspected to have passed the infection to her father. He tested positive for a resolved

Figure 1.
Typical "Slapped Cheek" rash associated with Erythema Infectiosum.[26]

Parvovirus B19 infection. Initial rheumatology investigations revealed elevated ESR (73mm/hr) and CRP (5.4mg/dL) levels. Low hemoglobin level was also noted.

Prior to presenting to our office, the patient had reported having the typical "slapped cheek rash" (Figure 1). A course of prednisone (5mg daily prescribed by a rheumatologist) had begun three weeks prior to initial presentation at our office. The patient reported that the prednisone had improved his ability to move noting a reduction from 23 to twenty hours per day spent in bed. He described the most severe stiffness in his shoulders, elbows, knees, and fingers with little swelling in his knees and severe swelling of all fingers.

Initially the patient self-medicated with Advil for two weeks. Subsequently a two-week prescription of Naprosyn (500mg bid) was attempted without any improvement. Prednisone (5mg daily) was prescribed for seven weeks then concurrent with a three-drug cocktail of methotrexate (20 mg weekly), hydroquinone (200 mg daily) and sulfasalazine (1000 mg bid). Folic acid supplementation was recommended to reduce side effects of methotrexate. The patient used non-prescription supplements as follows: 2000mg omega-3 fatty acids, 1000mg magnesium, high potency B-complex, 2000 mg Vitamin C, and 1000 IU vitamin D3. The combined prescription drug regimen was stopped after six weeks and the patient resumed a short course of Naprosyn.

When the patient presented to our office, he was seven weeks into his post-viral reactive arthritis and was experiencing progressive musculoskeletal disability and impairment of daily function. He was spending twenty hours a day in bed despite the pharmacological regimen he was following. He had not been prescribed nor attempted any physical rehabilitation. Frustrated by the slow rate of his recovery the patient self-referred to our office.

The patient was measured at 178 cm in height, 82 kg in weight with an average build. On examination, he was normotensive with a resting pulse of 72 beats per minute. The patient ambulated very slowly and cautiously, becoming fatigued after walking 10 steps. He had difficulty lowering himself into a sitting position and did so deliberately and with determination, not demonstrating any signs of amplified pain behaviour. Passive range of motion (ROM) of all large joints was painfully limited with soft end feel. His fingers were markedly swollen and he was unable to make a fist with either hand. His grip strength was measured at five kilograms bilaterally with a handgrip dynamometer.

Chiropractic care was initiated at a frequency of one visit per week for the first eight weeks. During this time

emphasis was placed on restoring mobility and encouraging active movement within the patient's tolerance. High velocity, low amplitude chiropractic spinal manipulation and mobilization primarily targeted to the thoracic spine as it was the area of greatest stiffness and tender joint dysfunction; peripheral joint mobilization attending to each phalangeal joint of all ten digits as well as shoulders, elbows, wrists, knees, and ankles; traditional Chinese acupuncture for reducing pain, swelling and inflammation including points Large Intestine-4 (LI-4), Liver-3 (LV3), Spleen-6 (Sp-6), Spleen-9 (SP-9), and Stomach-36 (ST-36) and low tech Qi Gong and Tai Chi exercises involving slow, mindful, continuous movements were employed in treatment. Subjectively, the patient reported feeling significant pain relief and improvement in mobility with each treatment. After the eighth week, the patient noted improved ROM and energy and of his own volition had discontinued pharmacological treatment.

At 20 weeks into the episode, 11 weeks after the commencement of chiropractic care, the patient was able to begin attending an active physiotherapy program three times a week. At this point he was spending 15 hours a day in bed, reduced from 20 hours at the beginning of care. He discontinued chiropractic care at that time as his insurance benefits had run out.

Upon the resumption of insurance benefits, he followed up at our office approximately seven months later having continued with physiotherapy during the intervening time. He had not yet returned to work and noted residual deficits in grip and the ability to form a fist, he was slow to warm up and slow to recover from exertion and fatigue. His grip strength was measured at 43.5 kg on the right and 45 kg on the left.

He resumed monthly chiropractic visits concurrent with twice a week physiotherapy consisting of active rehabilitation (ROM exercises, strengthening exercises, stationary bike). Spinal manipulation and joint mobilization were employed to improve mobility and function as indicated.

Over the next four months, the patient continued to demonstrate improvement in function. His grip strength was measured at 60 kg in each hand and complete finger flexion and fist closing was possible. There was residual limitation of horizontal abduction of both shoulders with pain at the plane of the anterior chest wall. The patient had gained 11 kg since initial consultation and had begun a program to reduce some weight with aerobic exercise, swimming and portion control. The patient had discontinued all medication citing that he perceived they were not helpful in his ongoing recovery. Overall, the patient reported a subjective improvement of 75% better in pain relief, mobility, and strength.

During the final month, at almost one year from initial onset of symptoms, the patient reported a safe and sustainable return to work. The swelling in his large and small joints had resolved and that his endurance was back to normal. He continued to experience limitations in shoulder range of motion.

Discussion

Transmission of infection occurs via the respiratory route and can be transmitted from mother to foetus, through transfusion of blood products, bone marrow transplants, and solid-organ transplants.[2,5]

EI is widespread and acquisition is often during childhood and continues at lower rates throughout adulthood, such that between 70% and 85% of adults show serologic evidence of past infection.[2] The peak incidence of parvovirus infection shows seasonal variation and occurs more commonly in winter and spring.[2]

Erythema infectiosum (EI) in adults is rare and poorly described in the literature.[3] The condition is caused by Parvovirus B19 (B19V), the only known human pathogenic parvovirus.[5] Erythema Infectiosum symptoms are characterized by low-grade fever, malaise, a red "slapped cheek" facial rash, and later by the spread of a maculopapular rash involving the trunk and limbs.[2] The rash normally disappears within one week, although intensity and remission of symptoms can occur for several months after emotional or physical stress or exposure to sunlight or heat.[2] To date, the largest retrospective analysis of 49 cases of adult onset EI was published by Bandera and colleagues in 2015, where they found that the maculopapular rash was a major diagnostic indicator of EI and was seen in over half the cases.[3]

Immunologically, detection of antibodies is the standard method of laboratory diagnosis of B19V infection, as they are the hallmark of the adaptive immune response to B19V infection.[4] Immunoglobulin M (IgM) are first produced approximately 12 days post-infection and can usually last about three to six months following infection, soon followed by production of Immunoglobulin G (IgG)

that is assumed to be long-lasting.[4,9] Immunoglobulin A (IgA) can also be detected in body fluids.[4] Polymerase chain reaction (PCR) assays are also sometimes used to detect B19V DNA in the serum of infected individuals.[9] B19V infections can also be accompanied by the induction of various auto antibodies such as anti-nuclear antibody (ANA), rheumatoid factor (RF), and anticardiolipin (ACL).[10]

Dobec and colleagues reported a case of a 37-year-old woman with persistent parvovirus B19 infection and arthralgia that was mistakenly treated for Lyme disease.[11] Medical treatment consisted of only Ponstan (mefenamic acid) 500 mg tables that were taken as required to combat pain.[11] This particular case suggested that before making a final diagnosis of Lyme arthritis in an endemic region, other causative agents of arthritis such as B19V should be excluded to avoid unnecessary treatment or to add appropriate therapy in the case of co-infections.[11] Since parvovirus B19 is often associated with arthralgia and can mimic rheumatoid arthritis and autoimmune diseases, it should be included in the differential diagnosis of arthralgia.[11]

In children with EI, the incidence of arthropathy is approximately 10% or less. While in adults, arthropathy is the most common clinical manifestation, occurring in 60% of female patients and 30% of male patients.[6] Joint symptoms typically present as acute and moderately severe non-erosive polyarthritis involving the metacarpophalangeal joints, knees, wrists, and ankles.[6] Although the joint symptoms are usually of brief duration, some do have prolonged symptoms that last weeks to years.[2]

There is currently no specific antiviral therapy to treat B19V infection.[2] The treatment approach of infection depends on host factors such as immune status, underlying conditions, and manifestations of infection.[2] Most cases of infection in immunocompetent hosts do not need treatment, while some patients with B19V-induced arthralgia may need symptomatic pharmacological treatment such as NSAIDs/anti-inflammatory drugs.[2] Few case studies have documented the management of arthropathies induced by B19V.

In 2005, Lowry and colleagues reported a case of a 48-year-old female physician with persistent B19V infection that was complicated by prolonged fatigue and arthritis associated with cartilaginous and ligamentous damage in both wrists.[6] Nineteen months after presentation, intravenous immunoglobulin therapy resulted in clearance of parvovirus B19 viremia and a significant improvement in the symptoms of fatigue and arthritis.[6] In 2008, Ogawa and colleagues reported a case of an immune-competent Japanese adult woman with persistent B19V who developed chronic severe B19V associated arthritis without PRCA or chronic anemia.[5] The patient was initially treated with NSAIDs but the NSAID treatment was unable to control her arthralgia.[5] She then received high-dose intravenous immunoglobulin (IVIg) at a dosage of 0.4g/kg per day for five successive days and experienced remission from the disease two weeks following the IVIg treatment.[5]

Based on previous case studies and current literature, the emphasis of medical management on B19V-induced arthropathy is on mitigation of inflammatory process through pharmacological intervention such as anti-inflammatory drugs.[2,4,5,6,11] To our knowledge, there are currently no case reports or literature regarding conservative management of arthralgia in adults with EI. In our case study, the patient elected to try conservative care for his condition and received a variety of interventions consisting of chiropractic spinal and peripheral joint manipulation and mobilization, acupuncture, and range of motion and strengthening exercises.

Spinal manipulation is a commonly used intervention for the management of musculoskeletal conditions.[12] In 2009, Walser and colleagues conducted a systematic review and meta-analysis on the effectiveness of thoracic spine manipulation and found that there was significant evidence to support the use of thoracic spine manipulation for non-specific neck and thoracic pain.[12] In our case study, high velocity, low amplitude manipulation was used and directed to the thoracic spine, which had the greatest joint dysfunction and restriction.

Joint mobilizations are also commonly used in the treatment of musculoskeletal conditions to decrease pain and restore joint arthrokinematics, which often involve passively moving the joint or rhythmically oscillating a joint through an accessory range of motion.[13] The treatment effects of joint mobilizations are thought to increase the extensibility of non-contractile tissues surrounding a joint and activate the neurophysiological mechanisms that alter the transmission of nociceptive afferent impulses[13] likely via enhancement of descending pain mechanisms[14]. In 2016, Courtney and colleagues found that conditioned

pain modulation in individuals with knee osteoarthritis was significantly enhanced by joint mobilizations, which was demonstrated by a global decrease in deep tissue pressure sensitivity.[14]

Acupuncture is considered a simple, cost effective and convenient treatment intervention and could "serve as a valuable alternative treatment for many conditions in which modern conventional treatments are unsuccessful"[15]. The analgesic and anti-inflammatory efficacy of acupuncture is well documented within controlled clinical trials.[15-19] Studies have shown that acupuncture may exert its anti-inflammatory and analgesic effects via elevating anti-inflammatory cytokines level and reducing pro-inflammatory cytokine level and regulating Th 1/Th 2 balance[18] or via the release of endogenous opiates, which desensitize peripheral nociceptors and reduce proinflammatory cytokines[19]. In our study, traditional Chinese acupuncture was used at acupuncture points Large Intestine-4 (LI-4), Liver-3 (LV3), Spleen-6 (Sp-6), Spleen-9 (SP-9), and Stomach-36 (ST-36) to reduce pain, swelling and inflammation.

Qigong and Tai Chi are traditional Chinese wellness practices that focus on "three regulations" including body focus (posture and movement), breath focus, and mind focus (meditative, mindful components).[20] Both Qigong and Tai Chi sessions incorporate a wide range of physical movements and a series of orchestrated practices, including slow, meditative, flowing, dance-like motions.[20] According to a comprehensive literature review by Jahnke and colleagues[20] and a systematic review by Li and colleagues[21], Qigong and Tai Chi appears to be safe and has positive effects on health related quality of life in patients with various chronic conditions, bone health, cardiopulmonary fitness, and factors related to falls prevention[20,21]. In our current case report, traditional Tai Chi and Qigong warm up movements were prescribed to encourage general motion at the shoulders, elbows, knees, and fingers while some exercises were extracted specifically from the Yang style Tai Chi form and isolated to encourage shoulder movement.

To our knowledge, there is no literature regarding rehabilitation exercises for arthropathies in individuals with EI. However, there is research regarding physiotherapy exercise programs for arthropathies induced by other viral infections. Previous research has found that physiotherapy treatment was effective in decreasing pain and edema and improving muscle strength, range of motion, and functional capacity in patients with post chikungunya arthralgia.[22,23] Rehabilitation exercise and strength training has also been shown to improve joint range of motion, decrease pain perception and increase muscle strength in patients with osteoarthritis[24] and rheumatoid arthritis[25]. However, the optimal content of exercise therapy programs remains inconsistent.[24] Physiotherapy consisting of active rehabilitation (ROM exercises, strengthening exercises, stationary bike) was added to reduce pain, increase strength and endurance while in conjunction with chiropractic care in order to improve and maintain mobility and function.

Although EI is primarily a pediatric condition, it can also occur in adults and primary healthcare providers should be aware of this condition, especially when adults present with acute polyarthritis.

Summary

Erythema Infectiosum is a viral illness that is associated with a wide spectrum of clinical manifestations, where arthropathy is the most common clinical manifestation in adults. EI should be suspected as a potential differential diagnosis when a patient presents with red or purplish skin rashes, especially when accompanied by fever and joint pain. Specific antiviral therapy is not available to treat EI and the current treatment approach for immunocompetent patients with arthropathy associated with EI is to decrease symptoms through pharmacological treatment. The ideal treatment intervention should aim to minimize symptoms and recurrence while limiting associated risks. Conservative management could be considered as an adjunctive therapy option for providing symptomatic relief from EI induced arthropathy.

In our case report, the patient elected to try conservative treatment and subjectively reported that the conservative treatment provided symptomatic relief and considered it to be a useful adjunct to the usual and customary pharmacological treatment.

We acknowledge that the current report consists of only one individual and thus is not representative of the entire population of individuals with EI induced arthropathy. Thus, future research is needed to explore the value of conservative treatment for adults presenting with EI.

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Pulse pressure findings following upper cervical care: a practice-based observational study

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Introduction: *Pulse pressure is an indicator of cardiovascular health and is the difference between systolic and diastolic blood pressures. An important etiologic consideration is autonomic nervous system balance. The purpose of this study is to observe pulse pressure changes following a six-week course of care utilizing an upper cervical technique.*

Methods: *One hundred and thirty patients presenting in five different clinics were separated into three groups based on initial pulse pressure groups with 40 mmHg considered as normal: low (< 40 mmHg), medium (40-49 mmHg), and high (> 49 mmHg).*

Results: *Pulse pressure reduced by 8.9 mmHg in the high group which was statistically significant ($p < 0.01$) with a large effects size of 0.8. Changes in the low and*

Introduction : *La tension différentielle est un indicateur de la santé cardiovasculaire et représente la différence entre la tension artérielle systolique et diastolique. L'équilibre du système nerveux autonome est une considération éthologique importante. L'objectif de cette étude est d'observer les changements de la tension différentielle à la suite d'un traitement utilisant une technique des hautes cervicales d'une durée de six semaines.*

Méthodologie : *Cent trente patients se sont présentés dans cinq cliniques différentes et ont été répartis par groupes de trois en fonction des groupes de tension différentielle initiaux avec une pression de 40 mmHg considérée comme normale : faible (< 40 mmHg), moyenne (40-49 mmHg) et élevée (> 49 mmHg).*

Résultats : *La tension différentielle réduite de 8,9 mmHg dans le groupe élevé, ce qui était statistiquement important ($p < 0,01$) avec une ampleur des effets observés de 0,8. Les changements dans les*

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medium groups were not statistically significant ($p < 0.05$).

Conclusion: *In this observational study the group displaying the highest pulse pressure demonstrated statistically significant reduction in pulse pressure.*

(JCCA. 2019;63(1):51-58)

KEY WORDS: chiropractic, pulse pressure, cervical spine, autonomic nervous system

groupes faibles et moyens n'étaient pas statistiquement importants ($p < 0,05$).

Conclusion : *Dans cette étude par observation, le groupe présentant la tension différentielle la plus élevée a démontré une réduction statistiquement importante de la tension différentielle.*

(JCCA. 2019;63(1):51-58)

MOTS CLÉS : chiropratique, tension différentielle, colonne cervicale, système nerveux autonome

Introduction

Pulse pressure is an established clinical measurement that may be useful for health professionals that seek to monitor cardiovascular health. Autonomic dysfunction can lead to essential hypertension and arterial stiffness reflected in elevated pulse pressure.[1,2] Pulse pressure is the difference between systolic and diastolic blood pressures. Elevated pulse pressure is a recognized cardiovascular risk factor and some studies have suggested it to be a marker for pre-clinical cardiovascular disease.[3-5] A meta-analysis involving 8000 patients found that a modest increase of 10 mm Hg in pulse pressure increased the risk of cardiovascular events and mortality by almost 20%.[6] This study also found that pulse pressure was a better predictor of cardiovascular endpoints than systolic pressure alone.

Pulse pressure is an interplay between the cardiac stroke volume and arterial wall compliance. Compliance is predominantly determined by the arterial wall behavior of the aorta and its large vessels. Increased stiffness of the large vessels decreases their compliance and increases pulse pressure.[5] In the case of arteriosclerosis a vicious cycle ensues: stiff arteries increase pulse pressure and an increase in pulse pressure causes mechanical damage to the endothelial lining promoting arteriosclerosis. It can be difficult to determine which is the cause and which is the effect. Regardless, once the cycle begins it can create havoc on the circulatory system.[5]

The literature indicates a pulse pressure of 40 mm Hg is normal. According to Sherazi S, *et al*.,[7] a pulse pressure of >40 mm Hg has a greater magnitude of left ventricular remodeling due to reduction in left ventricular end-systolic volume. The main variable of interest in the current study was the pulse pressure difference in pre- versus post (at six weeks, following the initial upper cervical adjustment). Low pulse pressure has been defined as a pulse pressure lower than 25% of the systolic pressure.[8] Others have defined low pulse pressure as <35 mm Hg.[9] Additionally, increased mortality has been attributed to low pulse pressure in patients with advanced heart failure.[9] With low pulse pressure it is the loss of stroke volume in an already compromised patient that is detrimental.

Elevated pulse pressure is a measure of arterial stiffness.[10-12] It has been linked to cardiovascular end-points[4-7], left ventricular hypertrophy[13], cognitive decline[14-17], diabetes[18], and brain atrophy[15].

There is some evidence that patients with cardiovascular problems such as hypertension sometimes improve following chiropractic adjustments.[19-23] The present study explores the potential usefulness of pulse pressure for monitoring cardiovascular progress (or lack thereof) in a chiropractic setting. The purpose of the study was to observe pulse pressure changes following application of an upper cervical chiropractic technique. Improved pulse pressure is defined as a decrease in pulse pressure following care in these cases with previously elevated pulse pressure. It was theorized that pulse pressure changes may depend on initial values, e.g., normal pulse pressure may not change while lower and higher pulse pressures would show a change toward normal.

Methods

The practice-based study design was approved by the Institutional Review Board at Sherman College of Chiro-

practic. All participants signed informed consent forms prior to participation.

The study included all new patients entering into any of the five participating clinics and who fit the criteria of consenting to the participation within the dates of March 15, 2014 to December 31, 2014. The five attending chiropractors (one per office) were trained in the knee chest upper cervical specific (KCUCS) chiropractic technique. The technique utilizes the Tytron infra-red scanning technology to assess upper cervical subluxation status on a visit to visit basis along with prone leg check analysis. A three view cervical x-ray series was performed on each case consisting of Anterior-Posterior open mouth full cervical, neutral lateral and base posterior views for the purpose of assessing alignment of the cranio-cervical junction. A knee chest solid head-piece table set at 14-degree angle was employed for the adjusting technique. All of these procedures were consistent with training through KCUCS chiropractic technique.

Prior to the administration of KCUCS chiropractic technique each participant had their brachial blood pressure measured in the supine position using an automatic Omron model BP760. This instrument has been accepted as valid by the European Society of Hypertension International Protocol and Association for the Advancement of Medical Instrumentation.[24-26] The patient was instructed to rest in the supine position in a quiet rest area for 10 minutes prior to blood pressure examination. Following the initial blood pressure examination, the patient's initial upper cervical chiropractic adjustment was administered. Following the post adjustment rest period of between 20 to 60 minutes, the blood pressure was measured again in the same position. Knee chest upper cervical care was provided for a six-week period of time.

The knee chest upper cervical care provided for each subject followed the same protocol in each of the five clinics regarding Tytron infra-red scanning, prone leg check analysis, x-ray analysis and the knee chest adjustments administered. The exception in patient care between the five clinics was in the rest time of between 20 to 60 minutes immediately following each upper cervical adjustment. Early pioneering researchers studying upper cervical chiropractic technique were of the opinion that a rest period immediately following an upper cervical adjustment was essential for improved outcomes.[27] It is thought longer rest periods facilitate stability of the cranio-cervical junction. There are no current data to support the preference of rest period length other than clinical experience.

The specific vectors of adjustment were assessed via x-ray analysis of the upper cervical misalignment. Frequency of upper cervical chiropractic adjustments administered was determined by analysis of Tytron infra-red thermography as well as leg length equality examination. On the six-week follow-up office visit, blood pressure measurements were obtained prior to any care on those visits utilizing the procedure for blood pressure assessment used in the initial blood pressure reading.

Statistical Methods

Data were sorted into three groups, according to initial pulse pressure, based on the assumption that a pressure of 40 is normal[7]: low (< 40), medium (40-49), and high (> 49). The range of 10 mmHg was arbitrarily selected as it was thought to be wide enough to be clinically significant. Paired testing for differences were used in each category, comparing pulse pressures for pre-adjustment versus at six weeks (three tests; one per each of three pulse pressure categories). Probability plots indicated acceptable normality for all six variables (pre versus six week pulse pressure for low, medium, and high categories). Thus, the paired t-test was used, in Stata 12.1 (StataCorp, College Station, TX). Two-tailed p-values less than or equal to the conventional alpha level of 0.05 were considered statistically significant. Effect size, using a pooled standard deviation, was also used to determine the magnitude of pre-post differences that were statistically significant.

Results

There were 130 participants (81 females and 49 males) included in the study. The mean age for the patients was 46.7 years old (standard deviation = 17.2) ranging from eight to 81 years of age. Most patients (n = 97 of the 130) were younger than 60 years of age. Through the course of six weeks care the average number of office visits was 11.5 (SD = 3.4) and the average number of upper cervical chiropractic adjustments was 2.8 (SD = 2.5). Out of 130 patients, 128 cases were adjusted with an atlas listing while two cases were adjusted using an axis listing.

Mean pulse pressure changes (from pre- to six-weeks) were slight and statistically insignificant for the low

Table 1.

Summary data, by pre pulse pressure group, reported as mean (SD). ES = effect size, reported for the main variable of interest in the study, pulse pressure. Initial post is on same visit as initial adjustment. Initial post systolic and diastolic missing for one patient in low pulse pressure group.

Variable	Low (< 40)	Medium (40-49)	High (> 49)
n	54	29	47
Mean age	38.7 (15.6)	48.8 (16.6)	54.5 (15.4)
Female	40	19	22
Male	14	10	25
Pre systolic	107.6 (11.8)	121.2 (10.8)	144.7 (19.9)
Initial post systolic	112.4 (14.7)	121.0 (13.0)	137.1 (15.4)
6w post systolic	108.7 (12.2)	118.1 (14.0)	132.5 (12.6)
6w – pre difference	1.1	-3.1	-12.2
Pre diastolic	76.5 (10.7)	76.4 (10.0)	82.9 (12.2)
Initial post diastolic	77.9 (10.6)	77.7 (9.4)	82.0 (12.8)
6w post diastolic	76.0 (10.4)	75.7 (9.3)	79.4 (10.3)
6w – pre difference	-0.5	-0.7	-3.5
Pre pulse pressure	31.1 (5.8)	44.8 (2.4)	61.9 (12.1)
Initial post pulse pressure	34.5 (7.8)	43.2 (8.2)	55.1 (8.3)
6w post pulse pressure	32.7 (7.1)	42.4 (8.8)	53.0 (9.6)
6w – pre difference	1.6	-1.4	-8.9
p-value for 6w-pre diff	0.13	0.14	< 0.01
Effect size	0.3	0.4	0.8

Legend: n= number, w = week, diff = difference

and medium pulse pressure groups (Table 1). The mean change for the high pulse pressure group was relatively large, where a reduction by 8.9 points was observed, and this change was statistically significant ($p < 0.01$) with a large effect size of 0.8. In the high pulse pressure group similar treatment numbers were observed: the average number of visits were 11.9 and the average number of adjustments was 2.6.

Discussion

Pulse pressure represents the relationship between left ventricle ejection and the properties of the arterial wall. Attributes of the arterial wall determine arterial compliance and the transmission characteristics of the arterial system.[5] The Windkessel model of circulation describes the relationship between stroke volume and arterial compliance of the aorta and large vessels.[28] Windkessel is loosely translated from German to English as 'air chamber'.[29] In regard to circulation it is generally accepted as 'elastic reservoir'. The aorta has remaining blood volume at the end-point of diastole. Upon systole, the left ventricular ejection pumps more blood into the aorta. Compliance is determined by the aorta's ability to accommodate further increases in volume. Although compliance occurs throughout the vascular tree, total systemic arterial compliance is primarily determined by the aorta and its large

vessels. Aortic compliance is largely dependent upon the vessels elasticity. As the vessel becomes less elastic, it loses ability to adequately take on more volume upon systole and pulse pressure increases.

There are transmission characteristics of the arterial tree, beyond the Windkessel model, to be considered when evaluating pulse pressure. Circulation depends on a pulse wave initiated by cardiac contraction. Pulse waves travel from the heart to the capillary bed. The forward wave (systolic P1) runs into multiple branch junctions as arteries split into smaller vessels. Each time a wave hits a branch junction there is a wave reflection. A small amount of the wave bounces back toward the heart. The waves reflecting back and having impact on pulse pressure are predominantly from the major branches of the aorta. The reflected wave going back toward the heart can increase aortic systolic pressure, thus pulse pressure, above what is generated via left ventricle ejection. The reflected wave (systolic P2) has an amplifying effect on central pulse pressure. Pulse pressure can be clinically assessed via brachial measurements. Izzo found that brachial systolic blood pressure closely related to centrally measured pressure.[30]

According to Dart and Kingwell [5], there is a common thread between arterial compliance described by the Windkessel model and wave reflection. Both are similarly affected by arterial wall properties. Arteries with compromised elasticity are less compliant and magnify the wave reflection, increasing pulse pressure.

Pulse pressure has a bidirectional effect on cardiovascular disease.[31] Elevated pulse pressure increases mechanical pressure upon the endothelial lining and increases the risk of a CVD event. Mechanical pressure, over time, has a damaging effect on the endothelial lining creating a vicious cycle of further increased arterial stiffness.

Pulse pressure is subject to any factor that affects aortic elasticity. Aging[12] is associated with loss of elasticity in the aorta as is atherosclerosis [32-33]. High homocysteine [34-35] and insulin resistance [36-38] have been found to increase pulse pressure. Pulse pressure improvements have been reported with exercise [39-40] as well as diet modifications [41-42] including n-3 fatty acids.

Vascular smooth muscle tone has a direct impact on arterial elasticity. Vascular smooth muscle is largely determined by the sympathetic nervous system and is subject to autonomic balance. The sympathetic nervous system has significant influence on mean arterial pressure and systemic vascular resistance as it modulates the mechanical properties of muscular arteries.[43] Increased smooth muscle tone can be an explanation for the arterial wall effects seen in elevated pulse pressure.[44]

A number of studies on upper cervical chiropractic techniques have reported improvements in hypertensive patients' systolic pressures following care.[19-23,45-46] One study that included 42 subjects found that hypertensive subjects' blood pressure lowered and hypotensive patients' blood pressure elevated following care indicated a broader normotensive effect.[47]

Other studies have suggested upper cervical chiropractic care as being beneficial for autonomic balance. These studies[19, 48-51] have focused on heart rate variability (HRV) as an indicator of autonomic modulation.[52-53] HRV has been found low in survivors of myocardial infarction (MI) and abnormal HRV patterns precede episodes of life-threatening arrhythmias. Furthermore, HRV is a strong predictor of mortality in patients with MI.[54] Our study adds to the body of literature on a possible association between upper cervical chiropractic care and cardiovascular assessments.

Various studies have confirmed positive post changes with the application of an upper cervical technique.[55-56] One study also reported on positive subjective outcomes and safety of several upper cervical techniques.[57]

Further research (e.g., a randomized clinical trial) seems warranted as a next step toward possibly introducing a novel approach for a safe, natural approach to cardiovascular health. The present study is limited in its generalizability to other patients since it had an observational study design (case series). In addition, the high pulse pressure group's readings may simply be temporary outliers. As this is the first study of its kind, further research is needed before more definite conclusions can be drawn. In further research, our sample size calculations indicate that 20 patients would be needed in a high pulse pressure group such as ours, based on our data in Table 1 for that group (using 80% power and a two-tailed alpha level of 0.05).

Conclusion

In this study we observed, through the application of an upper cervical chiropractic technique, lowered pulse pres-

sure in patients determined to previously have had elevated pulse pressure. It is plausible that these observations are related to improved autonomic function. Further research with improved designs is a reasonable next step in this line of investigation.

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