

Characterization of side effects sustained by chiropractic students during their undergraduate training in technique class at a chiropractic college: a preliminary retrospective study

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Introduction: The purpose of this study was to characterize the type, nature and frequency of injuries sustained by chiropractic students during their undergraduate training.

Methods: Chiropractic students in their second, third and fourth year of study at a chiropractic college were asked to complete a questionnaire that chronicled and described the occurrence of any side effects they may have sustained at the hands of their peers during technique class. Students were also asked to record their anthropomorphic characteristic.

Results: Of 450 questionnaires distributed, 292 were completed and returned to the authors. Of the 292 respondents, 127 reported to have experienced an injury, although the total number of injuries was 161. The most common site of injury was the lumbopelvic region. Students reported that it was during their second year of study that they experienced the highest number of injuries. Symptoms occurred the same day as the event in 85% of cases. The most common characteristic of symptoms reported was pain, followed by local stiffness, headache, dizziness, fatigue, diffuse stiffness and cramps. Two thirds of students described the extent of their injuries from 'light' to 'a fair bit'. Three quarters of injuries resolved within the first 72 hours of the event. No treatment was sought by 89 (55%) of the respondents. More than half of students reported that their activities of daily living were either 'not' or 'somewhat' affected. There were three reports of long-term complaints. No statistically significant differences were found between

Introduction : Le but de cette étude était de caractériser le type, la nature et la fréquence des blessures subies par les étudiants en chiropractie durant leur formation élémentaire.

Méthodologie : On a demandé à des étudiants en deuxième, troisième et quatrième année de formation dans un collège de chiropractie de remplir un questionnaire qui rapportait et décrivait l'occurrence de tout effet secondaire qu'ils auraient pu ressentir à la suite d'un traitement prodigué par leurs confrères durant les cours techniques. On a également demandé aux étudiants d'indiquer leurs caractéristiques anthropomorphiques.

Résultats : Sur les 450 questionnaires distribués, 292 ont été remplis et retournés aux auteurs. Des 292 participants, 127 ont indiqué avoir subi une blessure, bien que le nombre total de blessures ait été de 161. Le site de blessure le plus courant était la région lombo-pelvienne. Les étudiants ont rapporté avoir subi le plus grand nombre de blessures pendant leur deuxième année d'étude. Les symptômes apparaissaient la même journée que l'événement dans 85 % des cas. La caractéristique la plus commune des symptômes rapportées était la douleur, suivie d'une raideur localisée, des maux de tête, des étourdissements, de la fatigue, une raideur diffuse et des crampes. Les deux tiers des étudiants ont décrit la gravité de leur blessure comme étant « légère » à « modérée ». Les trois quarts des blessures étaient guéries 72 heures après l'événement. 89 participants (55 %) n'ont demandé aucun traitement. Plus de la moitié des élèves ont indiqué que leurs activités quotidiennes ont été soit « nullement »,

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the group of students reporting to be injured compared to those students not injured with respect to their age, gender, weight or height.

Conclusion: Chiropractic students experience side effects during their undergraduate training that are very similar to those experienced by patients under clinical care.

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KEY WORDS: injuries, chiropractic students.

Introduction

An integral component of chiropractic education is the acquisition of the psychomotor skills needed to successfully deliver the myriad of different forms of therapy chiropractors offer for patient care. Although some programs offer instruction in what has colloquially been described as ‘low’ or ‘minimal’ force techniques [instrument-assisted adjusting, use of padded wedges, drop-table technique and so on (see ¹)], all chiropractic colleges, regardless of their ideology, require students to achieve competency in the delivery of high-velocity, low-amplitude (HVLA) manipulations to the spine and peripheral joints. However, the process during which these skills are obtained require the willing participation of students to practice these procedures on one another, with one student assuming the role of ‘doctor’ and the other assuming the role of ‘patient’. This leads to a struggle (and several different pedagogical approaches) within all chiropractic colleges with respect to a ‘thrust’ or ‘not to thrust’ policy during practice classes on what is essentially healthy spinal joints.^{2–5} That said, at some time during their undergraduate training, students must go beyond simple ‘mock’ thrusts and the poseology positions assumed during practice time in class.^{2–5} Since students possess novice skills, there is legitimate concern (from faculty and other students) that they may be more prone to injuring each other during this training process.

There have been a few studies published in the peer-

soit « quelque peu » affectées par la blessure. Trois problèmes à long terme ont été rapportés. En ce qui concerne l’âge, le sexe, le poids ou la taille, aucune différence significative du point de vue statistique n’a été démontrée entre le groupe d’étudiants qui a rapporté des blessures et le groupe d’étudiants non blessés.

Conclusion : Durant leur formation élémentaire, les étudiants en chiropraxie subissent des effets secondaires qui sont très similaires à ceux subis par les patients en soins cliniques.

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MOTS CLÉS : blessures, étudiants en chiropraxie.

reviewed literature that report chiropractic patients commonly experience adverse reactions to therapy in clinical practice, although the majority of these injuries are minor and self-limiting. The purpose of this study was to characterize the type and nature of side-effects sustained by chiropractic students during their undergraduate training. This study solely focused on those injuries students experienced from procedures performed by their fellow students. In addition, the anthropomorphic characteristics of students were documented in order to determine if any of these factors contribute to, or protect against, such injuries.

Methods

The Institutional Review Board (IRB) of the Canadian Memorial Chiropractic College (CMCC) approved this study. Chiropractic students in their second, third and fourth year of study were asked to complete a questionnaire chronicling the occurrence of *any* injuries they may have sustained at the hands of their peers at CMCC. First year students were excluded from this study because, at the time the questionnaires were distributed, they had not yet been exposed to spinal manipulative therapy (SMT). Students were instructed that the questionnaire was confidential and that they were not to put their name or students numbers on it. The questionnaire, modeled after ones used to obtain similar information from chiropractic patients under clinical care, was distributed during technique class and instructed students to self-report any un-

pleasant reactions they experienced in terms of the following characteristics: time lapsed between event and symptoms; severity of symptoms; nature of symptoms; duration of symptoms; effect the injury had on their activities of daily living; year of study during which the injury occurred; Technique system used at time of injury; where the injury took place (during class or during extra-curricular activity); anatomical site of injury; specific procedure being performed by their peer that resulted in the injury and; type of therapy (if any) sought after injury. In addition, students were requested to record their height, weight, gender and age. Once collected, the data was analyzed using descriptive statistics.

Results

Of 450 questionnaires distributed (150 per year of study), 292 were completed and returned to the authors, 163 from women and 129 from men, representing a response

rate of 64.8%. Of these, 113 respondents were in second year, 69 respondents from third year and 110 respondents were in their fourth year of study. Of the 292 respondents, 127 reported to have experienced an injury, although the total number of injuries was 161 (some students had more than one area injured, or were hurt on more than one occasion). The most common site of injury was the lumbopelvic region (34.8%), followed by the cervical spine (27.5%) and thoracic spine (11.9%), although this percentage climbed to 31.9% if injuries to the thoracic region, costovertebral, cervicothoracic and thoracolumbar junctions were included (Table 1).

Students responded that the procedure most commonly associated with injury was side-posture lumbopelvic manipulation (38.3%), followed by thoracic spine (36.4%) and cervical spine manipulations (23.4%) (Table 2). The adjustment commonly referred to as the 'lumbar roll' was specifically cited as the procedure most commonly asso-

Table 1 Location of injuries reported by CMCC students ($n = 160$)*

Anatomic Location	Count	Percent
Lumbar Spine/pelvis/sacro-iliac	56	35.0
Cervical Spine	44	27.5
Thoracic Spine	19	11.9
Thoracic region/costovertebral joints	19	11.9
Cervicothoracic region	9	5.6
Thoracolumbar region	4	2.5
Wrist	2	1.2
Other (shoulder, face, Elbow, first rib)	7	4.4
*Note: One respondents indicated they were injured but did not specific location		

Table 2 Procedure performed resulting in injury to student ($n = 154$)***

Procedure	Count	Percent
Side-posture lumbar and pelvic manipulation	59	38.3
Thoracic spine manipulations (spinal and costovertebral joints, including cervicothoracic region)	56	36.4
Occipital and cervical manipulations (seated and supine)	36	23.4
'Drop piece' (spinal region unspecified)	3	1.9
***Seven respondents did not specify procedure performed on them that resulted in injury		

ciated with student-derived injury to fellow students. It is of interest that some of the reported injuries were not the result of the student being the recipient of the adjustment; rather, some students injured themselves (i.e. their wrist, elbow, shoulder) during the delivery of the adjustment to their peers (see Table 2).

Not surprisingly, Diversified technique (the only technique system taught in the undergraduate program at CMCC) was used in 93.7% of cases, with 94.4% of injuries occurring during technique class. Students reported that it was during their second year of study that they experienced the highest number of injuries (59%, as compared to 22.9% of injuries occurring during first year and 17.4% of injuries occurring during the third year) (see Table 3).

Table 3 Year of study injury occurred (n = 161)

Year of study	Count	Percent
First year	37	22.9
Second year	95	59.0
Third year	28	17.4
Fourth year	1	0.01

Of all injuries experienced by students, symptoms occurred the same day as the event in 85% of cases. Only 10% of symptoms were experienced by students two days later, less than 2% three days later and less than 1% for each day thereafter (Table 4). The most common characteristic of symptoms reported was pain, followed by local stiffness, headache, dizziness, fatigue, diffuse stiffness and cramps (Table 5). For example, 96.3% of all injured students reported pain, but this represented only 39.3% of all symptoms reported. Similarly, local stiffness was reported in 81.2% of cases, but represented only approximately one-third of all symptoms described by students. Other symptoms, such as falling, vomiting and loss of consciousness were reported in less than one percent of cases (see Table 5). The most unusual case of injury reported was a third-year student who experienced stiffness to the neck, nausea, cramping, fatigue, dizziness, vomiting, headache and vertigo following a side-posture manipulation directed at the thoracolumbar junction.

Students were asked to indicate the extent of discomfort of their injuries. Of the 161 respondents, 12 (7%) de-

Table 4 Onset of discomfort (n = 160)*

Time lapsed between performance of procedure and symptoms	Count	Percent
Same day	136	85
Day 2	16	10
Day 3	3	1.9
Later than 3 days	1	0.6
Cannot recall/ Don't know	4	2.5
*One student did not respond		

scribed their injuries as “light”, 47 (29%) as “moderate”, 42 (26%) as “a fair bit”, 35(22%) as “a lot” and 25 (16%) as “very much” (Table 6).

Students were allowed to record the duration of discomfort in their own words. This generated a large number of different responses. However, 105 of the 161 (66.9%) separate injuries reported by students completely resolved with 72 hours, and 77.6% of injuries resolved with one week of their onset. (Table 7). No treatment was sought by 89 (55%) of the respondents injured. When asked ‘what treatment was sought’, the questionnaire was open-ended, thus also generating a large number of different responses. In general, treatment was typically comprised of soft tissue therapy, spinal manipulation therapy or a combination of the two. There was one report of a student seeking medical care and there were 6 students who reported that their symptoms lasted two years or longer. Of these six students, three reported that their symptoms are now chronic (Table 7).

Respondents were asked to indicate to what extent their activities of daily living (ADLs) were affected by their injuries. Twenty-six respondents (16.3%) indicated their ADLs were not affected, 83 respondents (51.2%) reported their ADLs were “somewhat” affected, 32 respondents (20%) indicated their ADLs were affected “a fair bit” and 18 respondents (11.2%) reported their ADLs were affected “a lot” (see Table 8).

Using MANOVA and Chi Square analysis, no statistically significant differences were found between the group of students reporting to be injured compared to those students not injured with respect to their age, gender, weight or height (see Table 9).

Table 5 Type of symptoms described by injured student**

Symptom	Count	% of all symptoms (n = 394)	% of all injuries (n = 161)
Local pain	155	39.3	96.3
Local stiffness	132	33.5	81.2
Headache	39	9.9	24.2
Dizziness	17	4.3	10.5
Fatigue	16	4.1	9.9
Diffuse stiffness	11	2.8	6.8
Nausea	10	2.5	6.3
Cramps	6	1.5	3.7
Fall	2	0.5	1.2
Vomit	2	0.5	1.2
Loss of consciousness	1	0.3	0.6
Nystagmus	1	0.3	0.6
Ataxia	1	0.3	0.6
Paraesthesia	1	0.3	0.6

**Some respondents reported more than one type of symptom

Table 6 Extent of Injury (n = 161)

Extent of Injury	Count	Percent
'Light'	12	7.4
'Moderate'	47	29.2
'A fair bit'	42	26.0
'A lot'	35	21.8
'Very much'	25	15.5

Table 8 Extent to which Activities of Daily Living (ADLs) were effects among injured Students (n = 160)

Extent of discomfort	Count	Percent
'Not at all'	26	
'Somewhat'	83	
'A fair bit'	32	
'A lot'	18	
'Don't know/recall'	1	

Table 7 Duration of injury (n = 160)*

Duration of injury	Count	Percent
One day or less	17	10.6
Two days or less	26	16.1
Three days or less	64	39.8
3 to 7 days	18	11.2
1 week to 1 month	16	9.9
1 month or less than one year	11	6.9
1 year to 3 years	3	1.9
More than 3 years (ongoing)	3	1.9

*One respondent did not respond to this question

Table 9 Anthropomorphic characteristics of students injured/not injured

Characteristic	Students who were injured	Students not injured
Age (years)	26.6	26.5
Weight (pounds)	152.8	156.3
Height (inches)	67.7	67.6

Discussion

Adverse reactions to patients under care in practice

Three studies conducted among chiropractic practices in Scandinavia reported that as many as one of every two patients experienced an injury during their course of care.⁶⁻⁸ A study from Norway sought to determine whether side effects to SMT can be predicted and, if so, whether they were patient or treatment-related. One hundred and two chiropractors and 12 consecutive patients per chiropractor (totaling 1058 chiropractic patients) attending up to 6 treatments (totaling 4,712 treatments) were investigated.⁶ The researchers found that women were more likely to report injuries than men (65% versus 44%), more reactions occurred during the first treatment session or when more than one region of the spine was treated, and more adverse reactions were reported when the thoracic spine alone was treated.⁶ Senstead et al. also reported that younger patients (aged 27–46 years) were more likely to experience at least one adverse reaction compared to older patients (aged 47–64 years) (60% vs. 47% in the older age group). The type of treatment resulting in injury was also recorded. For the purposes of that study, the type of treatment was divided into SMT only (defined as techniques that employed manual thrusts or pulls such as Diversified or Gonstead), ‘regular’ SMT and soft tissue therapy or ‘miscellaneous’ techniques (defined as techniques not employing a thrust such as Logan Basic or that used a form of instrumentation, such as Activator Methods). Using these descriptors, there was no association found between type of treatment rendered and injuries sustained.⁶

Using the same data set, Senstead et al.⁷ wrote that at least one reaction was reported by 55% of the patients at some time during the course of care. Of reported injuries,

the most common was local discomfort (53%), followed by headache (12%), tiredness (11%) and radiating pain (10%). Nausea and dizziness were uncommon reactions, each reported in less than 5% of cases. Reactions were reported to be either mild or moderate in intensity in 85% of cases. Almost two-thirds (64%) of adverse reactions occurred within 4 hours of treatment, 89% had little or no effect of the patients ADLs and 74% of injuries resolved within 24 hours of their onset. The authors of that study attributed this finding to a possible fear of chiropractic treatment, which may lead to over-reporting of symptoms by patients.⁷ The authors of this study posit that it is also possible that more provocative diagnostic testing was performed during the initial treatment, potentially aggravating pain-sensitive tissues to a greater degree than would be observed in subsequent treatments.

The results of a study (using a self-reporting questionnaire) conducted by Lebouef-Yde *et al.*⁸ tracking 625 patients of 66 chiropractors (1,858 visits) were very similar. For example, on average, 44% of patients reported experiencing an adverse reaction to therapy, two-thirds of patients reported experiencing local discomfort in the treatment area and headache, fatigue and pain in other regions were reported in about 10% of cases. Three quarters of symptoms resolved within 48 hours and two thirds of patients described their symptoms as ‘light’ or ‘moderate’ in intensity.⁸ In this study, women were more likely to report injuries than men (28% as compared to 21%) but there was no association with age as had been observed in the Norwegian study.⁸

A study by Barrett and Breen collected data from 68 chiropractic patients, 53% of who reported to have experienced an adverse side effect to treatment, most commonly additional or radiating pain.⁹ A more recent study by Hurwitz and his colleagues sought to record any adverse reactions resulting from either cervical mobilization or manipulation among patients with neck pain.¹⁰ The investigators reported that 30% of 280 respondents reported to have had at least one adverse symptom from chiropractic therapy in the first 2 weeks of care. Eighty-five patients reported a total of 212 adverse symptoms. Of these, 120 symptoms were reported from the 48 patients in the manipulation group and 92 symptoms were reported from the 37 patients in the mobilization group. Increased pain (27.7%) and headache (15%) were the most commonly reported side effects, followed by fa-

tigue/tiredness (12.1%) and radiating pain/discomfort (6.4%). Dizziness, nausea/vomiting, blurred vision, ringing in ear, arm or leg weakness, confusion/disorientation or depression/anxiety were each reported in less than 5% of cases. In 80% of cases, symptoms began within 24 hours of treatment and disappeared within 24 hours of their onset; the symptoms did not have an appreciable affect on the patient's activities of daily living.¹⁰

Of particular significance, in all of these studies, there were no reports of serious injuries, nor have there been any reports of serious injuries occurring during the several dozen clinical trials investigating the effectiveness of spinal manipulation.¹⁰⁻¹² It should also be mentioned that, based on the very limited number of case studies retrievable from the peer-reviewed literature, the frequency of serious injuries following spinal manipulative therapy such as fracture, disc herniation, cauda equina syndrome, stroke and death is generally agreed to be very low (see 6-8,10,13,14-16).

Thus far, the identifying features of patients likely to be at risk for serious side effects resulting from spinal manipulation have remained elusive. Serious adverse reactions to SMT have been observed in apparently healthy patients who have previously experienced uneventful manipulation and have no obvious risk factors. In cases of cerebrovascular accidents, for example, suspected risk factors include arterial sclerosis, hypertension, heavy smokers and oral contraceptive users. Other proposed risk factors for cerebrovascular accidents include age, gender, diabetes, migraine headaches, and cervical spondylosis.⁸ However, specificity and sensitivity of these predictors is low and it has been found that patients with these risk factors often display normal findings to purportedly provocative tests used to evaluate arterial insufficiency, such as Houle's or George's test.^{11,15} It should be noted that these provocative tests have recently fallen out of favor among teaching faculty at several chiropractic colleges and are taught with several caveats, if taught at all (Gleberzon, personal communication). Haldeman and his colleagues, after an extensive review of the literature, posited that because the event is so rare and the details available from the few documented cases that do exist are often vague or incomplete, it is impossible to advise patients or practitioners about how to avoid the purported risk of stroke following cervical manipulation.^{16,17} These authors were likewise unable to specify

which sport or activity presented the greatest potential risk, having found instances of stroke following such benign activities as yoga, stargazing and prayer. They ultimately concluded that, with regard to cervical manipulation, the risk of serious injury must be considered to be a rare, idiosyncratic and unpredictable occurrence.¹⁷

Adverse reactions among students learning psychomotor skill during undergraduate training: a literature search

One might expect that the incidence of injuries would be high among student populations during their education training of psychomotor skills, possibly even higher than the rate of injuries reported from clinical practice. However, the veracity of this assumption has hitherto gone untested.

A literature search of standard English language medical databases and search engines (PudMed, EBSCO) using key words (spinal manipulative therapy/side effects/risk/ injury/ exposure/ medical/chiropractic/dental/nursing) failed to locate any similar studies. Of the 47 articles found, most dealt with needle stick injuries or concerns of exposure to pathogens (especially the AIDS virus) or occupational chemicals. Some studies discussed allergies to latex, while still other studies discussed eating disorders and stress levels among health care students. A single pilot study by Morse *et al.* investigated musculoskeletal disorders of the hand and arm in dental hygiene students,¹⁸ but this was related to the occupation rather than to injuries sustained from other students. Hand searching of past chiropractic conference proceedings (Association of Chiropractic Colleges-Research Agenda Conference, World Federation of Chiropractic Conference) failed to uncover any studies investigating this topic. To our knowledge, therefore, no studies on this topic have been previously published.

Comparison of characteristics of students injured in class with characteristics of injured patients in practice

Although the overall incidence of injury experienced by students during class was similar to the incidence of injuries reported by chiropractic patients under clinical care, the area of pain was not. In cases where only one area was treated, Senstead *et al.* reported that the thoracic spine was the region of the spine most commonly reported to be injured, followed by the cervical spine and then

the lumbar spine (39%, 32% and 23% respectively).⁶ In this study, however, the most commonly reported region of the spine injured was the lumbopelvic spine. This may reflect the fact that students, while practicing side-posture procedures, often have their student 'patients' lying in a pre-adjustment side posture position for much greater lengths of time than would a chiropractor performing the same procedure for therapeutic purposes. (For example, during a central demonstration or tutor-directed teaching session, a student may be kept in a side-posture position for several minutes). This prolonged rotational effect on the student's body may be in part responsible for the higher number of lumbar spine injuries reported in this study.

The present study found that 55% of participants reported adverse reactions following student performed SMT, which falls within the high range of that reported in general clinical practice (30–55%).^{6–8} However, 36.6% of CMCC students characterized their discomfort as 'light' or 'moderate', while 63.4% of students described their discomfort ranging from 'a fair bit' to 'very much'. This varies somewhat from the trend reported by Senstead *et al.* and Leboeuf-Yde *et al.* that 85% of the side effects resulting from SMT were described as mild to moderate in intensity.^{7,8} The difference in intensity of symptoms may be attributed to the fact that students are novice adjusters (and are thus less competent than field practitioners), tend to adjust in the same region multiple times during one technique class and tend to do so without specific findings or diagnoses.

Of the side effects resulting from student-performed SMT, local pain and stiffness were the most common, followed by headaches, dizziness, fatigue, stiffness in a location other than the site of the adjustment, and nausea. Cramps, falling over, vomiting, loss of consciousness, nystagmas, ataxia, and paresthesias were all reported in less than 2% of respondents. These results are similar to those found in prior studies among patients under care.^{7,8,10}

The majority of adverse reactions induced by student-performed SMT began within 24 hours and typically resolved by the third day following the adjustment, often requiring no treatment or minimal therapy: This suggests that student-induced injuries tend also to be self-limiting and resolve spontaneously. This observation is similar to what been reported by chiropractic patients under clinical care.^{7,8} Interestingly, Senstead *et al.*⁷ reported that less

than 20% of side effects occurred within the first 10 minutes following manipulation: this suggests that the actual act of manipulation is rarely pain producing.

In the literature, 80–90% of the adverse reactions reported by patients had little to no effect on activities of daily living (ADL).^{7,8} Students in this study who suffered from side effects reported little or no effect on their ADLs in 67.5% of cases, with an additional 20% of students reporting their ADLs were affected 'a fair bit'. The small increase in the effect on student's ADLs reported in this study may be due to a number of variables. These include: an increase in physical demands among chiropractic students during technique class (students acting as both 'doctor' and 'patient'); prolonged periods of being sedentary during class time and study time; improperly delivered student-delivered adjustments; lack of necessity for therapeutic intervention or; chiropractic students may be more likely to report higher levels of pain than are chiropractic patients.

In this study 59% of adverse reactions reported occurred during the second year of the curriculum. This is understandable, as it is during the second year of study that the majority of Diversified technique adjustments are initially taught to students (6 thoracic, 5 lumbar, 4 pelvic and 5 cervical, in addition to a number of maneuvers directed to the extremities). By contrast, only 6 adjustments are taught during the first year of the program (4 thoracic and 2 lumbopelvic). Although an even greater number of spinal adjustments are taught during the student's third year of study, students may have acquired sufficient psychomotor-skill competency to avoid serious injury by that time. Another explanation of this discrepancy between the frequency of injuries reported by third year students as compared to less senior students may be that, having been previously injured during technique class, third year students may be more vocal in asking their peers to limit the number of attempts for cavitation, or the student may limit the time spent in one position by themselves.

The vast majority (93.8%) of reported injuries occurred while the student was performing a procedure using the Diversified technique system. This is not surprising since Diversified technique is the only technique system taught during the undergraduate program at CMCC, the majority of students practice it during technique class and it was during technique class where the majority (94.4%) of injuries occurred.

Limitations of this study

There were several limitations to this study. Since this study was retrospective in nature, it relied on student's recollection of events and thus was vulnerable to recall bias.

Feine and his colleagues conducted a 10-week randomized control trial looking at memories of chronic pain and found inaccuracies in the recall of pre-treatment pain and that the subjects made more errors in pain memories with increasing time.¹⁹ In this study subjects were asked to recall incidents from as many as 3 years prior to the present day. They may therefore be a significant degree of recall bias involved in the results. In order to minimize the potential effect of memory bias inherent in this type of study, future studies should be more immediate (with respect to recording injuries) in nature. Lastly, the incidence of more serious symptoms such as loss of consciousness or ataxia, although rare, is of concern and further studies should attempt to characterize these types of injuries in greater detail. Future studies would ideally have chiropractic students start an "injury diary", or similar form of record-keeping device. In this manner, the number, type and severity of adverse side effects to students-performed SMT could be promptly recorded throughout the academic year as they occur.

Response rate for the questionnaire in this study was 64.9%. In the future, there should be an attempt to collaborate with technique instructors and clinical faculty to try to obtain full class participation. As the purpose of this study is to enhance the safety in chiropractic technique classes, co-operation from these stakeholders should not be difficult to obtain.

In this study, some of the response choices, although adopted from the previous studies by Senstad et al.⁷ and Leboeuf-Yde,⁸ were too generalized or open-ended to easily extract quantifiable data from. For example, the questions inquiring about 'time for recovery', 'type of therapy sought' and 'extent of discomfort' generated a number of quantitative responses that were difficult to analyze. Future studies ought to offer few options to be answered (for example, only 'yes' or 'no' for the question "did you seek out care for your injury?") or a more simplified group of options.

This study did not separately analyze the injuries that occurred to students whilst delivering SMT from those injuries students experienced during (or as the result of)

delivering an adjustment. Future studies should be more careful to separate these two types of injuries from each other. In addition, no attempt was made to correlate particular symptoms (i.e. headache) with the region injuries (ie cervical spine).

For reasons of jurisprudence, it is possible that any adverse reactions experienced by students out-of-class (and thus unsupervised), or during 'Technique Clubs' at the college, were under-reported.

This study sought to determine if one technique system resulted in a greater likelihood or incidence of side effects compared to other technique systems. Diversified technique is the only technique system taught during the undergraduate program at CMCC and it is the only technique system permitted for use in the outpatient clinics. The only opportunity where a student may perform a chiropractic procedure under direct supervision would be during an after-hour "Technique Club" session (i.e. Gonstead or Thompson Terminal Point Technique Clubs). However, in this study, the data obtained from respondents was too small to draw any conclusions from with respect to the incidence of injuries sustained at these clubs (see above). Future investigations could be conducted at other chiropractic colleges that teach different chiropractic technique systems in order to determine if any differences exist in the incidence and location of injury sustained during student-performed adjustments of different types.

Conclusion

This study suggests that students experience a similar frequency of injuries as those seen in the chiropractic practice, and that the nature and extent of these injuries are very similar. That said, students might be more prone to injuries of the lumbopelvic spine, especially during instruction of side-posture manipulation, specifically the lumbar roll. Similar to studies involving chiropractic patients, injuries sustained among chiropractic students were most frequently described as being mild and self-limiting, usually resolved within 72 hours and had no or minimal effect on their ADLs. Of interest, most injuries were reported to have occurred during the student's second year of study.

The principle purpose of this study was to characterize the type, nature and frequency of injuries of chiropractic students during their undergraduate training. However, the information gathered from this study may aid those

faculty members involved in the teaching of HVLA psychomotor skills adopt different pedagogical strategies in order to minimize the occurrence and frequency of injuries students sustain in these class. Such strategies may include: suggesting students reduce the number of consecutive attempts at achieving joint cavitation; minimizing the amount of time a student is placed in a rotated pre-tension position prior to such an attempt; reduce the time allocated to the acquisition of any particular set of psychomotor skills each class and; devote more time in selecting an appropriate clinical target. Since this study found the highest incidence of injuries occurred midway through the undergraduate program, it may be prudent for teaching faculty to caution second year students to be more wary of injuring each other and to exercise the type of precautions described above in order to minimize the likelihood of injury.

Based on similar programs at other chiropractic colleges, the authors have suggested that students create a 'clinical file' or 'diary' which records all procedures performed in the technique class. This would also permit better documentation of any injuries sustained by students during class time.

Lastly, a larger, intercollegiate study could be performed to determine if the characteristics of injuries sustained by students during technique class is similar at other chiropractic colleges. In addition, this could permit a determination of which, if any, chiropractic technique system places students at a greater relative risk of injury during their college education.

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