

Lessons learned from cases of rib fractures after manual therapy: a case series to increase patient safety

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Objective: To identify commonalities among cases of rib fractures after spinal manipulative therapy (SMT); discuss chiropractors' case management perspectives; and propose strategies for prevention and/or management of future cases.

Methods: Semi-structured interviews were conducted with chiropractors who identified cases of rib fractures after SMT at a chiropractic institution's teaching clinics. Patient characteristics, incident characteristics, and chiropractors' perspectives were collected and analysed.

Results: Three chiropractors were interviewed, each identifying one case. Patient ages ranged from 57-77; two were female; two had osteopenia; two cases involved thoracic SMT; and one involved lumbar SMT. Chiropractors agreed that verifying and updating potential contributing factors for rib fractures,

Objectif : Établir les points communs entre des cas de fractures des côtes après des manipulations vertébrales (MV); examiner des points de vue de chiropraticiens sur la prise en charge de cas; proposer des stratégies de prévention et/ou de prise en charge des cas à venir.

Méthodologie : On a fait des entrevues semi-structurées avec des chiropraticiens travaillant à la clinique d'un établissement d'enseignement de la chiropratique et ayant identifié des cas de fractures de côtes après des MV. Les caractéristiques des patients, les caractéristiques des incidents et les points de vue des chiropraticiens ont été recueillis et analysés.

Résultats : Trois chiropraticiens ont été interrogés, chacun ayant identifié un cas. Les patients étaient âgés de 57 à 77 ans; deux étaient de sexe féminin; deux souffraient d'ostéopénie; deux cas avaient été traités par manipulations thoraciques et un cas par manipulations lombaires. Les chiropraticiens ont convenu qu'il était important de vérifier et de mettre à jour les facteurs contributifs potentiels de fractures des côtes, d'informer le patient, en toute transparence, avant

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transparent communication prior to SMT and/or after the adverse event (AE) occurrence, and enhancing student education on AE management were important.

Conclusion: Important lessons can be learned from AEs, despite their infrequent occurrences. A more open and constructive patient safety environment is needed within the chiropractic profession.

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KEY WORDS: adverse events, chiropractic, patient safety, quality improvement, spinal manipulative therapy

Introduction

Patient safety continues to be a leading global health care challenge.^{1,2} The World Health Organization (WHO) defines patient safety as the absence of preventable harm to a patient during the process of health care³ and prioritises the safety of every patient in order to provide high quality health services².

The Institute of Medicine's report "To Err is Human: Building a Safer Health System"⁴ and the Government of Canada's "Building a Safer System: A National Integrated Strategy for Improving Patient Safety in Canadian Health Care"⁵ have emphasised the importance of creating an open and constructive patient safety environment in order to develop strategies to reduce preventable adverse events (AEs). It promotes shifting from a blaming culture to a safety culture that learns from AEs, in order to maximise the potential to avoid future AEs.⁶ While strategies for prevention and improving the quality and safety of health care delivery have been shown to improve patient safety in hospital settings⁷ and in family physician practices^{8,9}, little has been reported within the chiropractic profession.

Manual therapy, which includes spinal manipulative therapy (SMT), is used by various health care providers, including chiropractors. Spinal manipulative therapy is commonly used to treat several musculoskeletal conditions and has been recommended by clinical practice guidelines for the management of spinal pain.¹⁰⁻¹⁴ It is estimated that up to 50% of patients who receive manual

d'effectuer des MV et après la survenue d'un événement (ÉI) et d'améliorer la formation des étudiants sur la prise en charge des ÉI.

Conclusion : Les ÉI, bien qu'ils soient rares, peuvent nous permettre de tirer d'importantes leçons. Une attitude plus ouverte et plus constructive envers la sécurité du patient s'impose chez les chiropraticiens.

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MOTS CLÉS : événements indésirables, chiropratique, sécurité du patient, amélioration de la qualité, manipulation vertébrale

therapy experience some form of AE.¹⁵⁻¹⁷ Although most AEs experienced after manual therapy are mild and transient¹⁶, some AEs may have a greater impact on a patient's well-being, function, and quality of life¹⁸.

Rib fractures are often identified as a risk to SMT treatment on clinical consent forms¹⁹; however, to our knowledge, there are limited reports of rib fractures following SMT within the scientific literature. Although most rib fractures are generally benign, heal on their own, and can be managed with conservative therapy, there is the potential risk of serious complications, such as hemothorax or pneumothorax, that can have a substantial impact on patients' morbidity and mortality.²⁰ Since SMT has been clinically perceived as a risk for rib fractures, it is important to explore the occurrences of rib fractures after SMT in more detail. By better understanding the characteristics of the rib fractures after SMT, prevention and mitigation strategies can potentially be developed to increase the safety of this popular intervention.

Therefore, the objectives of this study were to: (1) identify commonalities among cases of rib fractures after SMT; (2) discuss chiropractors' perspectives in case management; and (3) propose strategies for prevention and/or mitigation of future cases. Specifically, our case series will provide an overview of cases of rib fractures after SMT and propose prevention and mitigation strategies. This can contribute to the development of strategies to reduce the occurrences of rib fractures after SMT, contributing to enhancing SMT safety.

Methods

This study was a case series involving supervising chiropractors at the teaching clinics of a chiropractic institution, exploring their experiences and perspectives gained from cases of rib fractures observed after SMT.

Participants

All chiropractors involved in a supervisory role at the Canadian Memorial Chiropractic College (CMCC) teaching clinics were invited to identify eligible cases and to participate in this study. Supervising chiropractors at clinics located within the institution as well as those located at externally hosted institutions were invited to participate. Cases were eligible for this study if the following inclusion criteria were met: the supervising chiropractor volunteered to participate in the study; SMT was provided at the teaching clinic at the time of the rib fracture diagnosis; diagnostic imaging (based on a radiologist's report) was used to confirm the diagnosis of a rib fracture; and cases occurred within the last seven years. All participating chiropractors signed a written informed consent. All patients of CMCC's teaching clinics provided written informed consent for the use of their information for research purposes. This study was approved by the research ethics board at CMCC (1905B01).

Data collection

Participating chiropractors who volunteered to participate in the study were asked to review the electronic medical record (EMR) (IndiviCare, Indivica Inc., Toronto, Canada) of the patient they identified as having experienced a diagnosed rib fracture following SMT. A pre-defined standardised data collection form was used to collect data on patient characteristics and incident characteristics. Variables included in the data collection form were consistent with variables used in a previous study investigating AEs following SMT (SafetyNET)²¹ and variables used in fracture risk prediction tools²². Specifically, variables related to patient characteristics included: patient demographics (including age, sex, weight, body mass index, bone mineral density, physical activity level, co-morbidities, use of medications and supplements, and potential red flags for fractures), and the diagnosis for which the patient was receiving chiropractic treatment for. Variables on incident characteristics included: 1) plan of management (including type and location of SMT, frequency and duration of

care, other treatment modalities); 2) details of the rib fracture (including imaging modality and results, level and location of fracture, time to onset of symptoms, time to diagnosis on imaging, and patient description of event); and 3) rib fracture resolution (including healing time, complications, and return to treatment).

After case review and completion of the standardised data collection form, semi-structured interviews were then conducted with the participating chiropractors. The principal investigator followed a list of pre-determined open-ended questions which included questions on the chiropractors' perceptions of potential contributing factors, their suggestions for prevention of future cases, recommendation/advice to their colleagues, and how the event may have changed their practice. Data on patient and incident characteristics that were previously identified through the data collection form were used to enhance the interview and allow for further details and discussion. The semi-structured interviews were conducted in person by the principal investigator in a quiet room at the chiropractors' offices and lasted approximately 30 to 60 minutes. Details of the interviews were recorded with written notes.

Data analysis

Information from the standardised data collection forms and semi-structured interviews were transferred to a spreadsheet on Microsoft Excel (Microsoft, Redmond, USA). Commonalities between the three cases were identified through visual inspection and interpretation of the data in the spreadsheet by the principal investigator. The data were reviewed by a second investigator and any disagreements were resolved through discussion. This case series followed the CARE Guidelines for clinical case reporting where possible.²³

Results

A total of four chiropractors, with an average of 23.5 years of practice, identified rib fracture cases and volunteered to participate in this study: three of them identified one patient case meeting the inclusion criteria and one chiropractor identified two cases. Due to differences in institutional policies for research use of clinical data at an externally hosted institution, two cases were excluded. Patient characteristics of the three cases are described in Table 1. Incident characteristics of the three cases are described in Table 2.

Table 1.
Patient characteristics. BMI (body mass index); BMD (bone mineral density);
N/A (not applicable, due to unavailable data)

	Age (years)	Sex	BMI (kg/m ²)	Activity level	Smoking	Alcohol	BMD (T-score)	
							Lumbar spine	Femoral neck
Case 1	77	Female	N/A	Low	No	No	-2.1	-2.3
Case 2	60	Female	21.2	Low	Yes	No	-1.5	-2.4
Case 3	57	Male	25.1	Moderate	No	No	N/A	N/A

Case 1:

Case one is of a 77-year-old female with a sedentary lifestyle. Bone mineral density (BMD) T-scores in the lumbar spine and femoral neck were indicative of low BMD (osteopenia).^{24,25} She did not smoke or consume alcohol. She was on medications for the management of hypertension, hyperlipidemia, and hypothyroidism. She had a history of a motor vehicle collision with multiple fractures. She was being treated with chiropractic care, including SMT, for non-specific spinal pain in the cervical, thoracic, and lumbar spines for several years with no previous reports of AEs.

Her treatment plan included multimodal therapy including SMT, spinal mobilisations, and soft tissue therapy to the cervical, thoracic, and lumbar spines. She received SMT targeted at T3-T6 in the supine position with a bilateral posterior contact.²⁶ She reported hearing a loud

“pop” and felt immediate pain on her left side. She did not return to chiropractic treatment for the following three weeks due to scheduling conflicts; however, she reported constant pain at the left lateral chest wall over that three-week period, as well as pain with breathing and sleeping on her left side.

When she returned to the chiropractic clinic after three weeks, a physical examination was conducted, including rib springing and sternal compression, which reproduced mild pain. Vibration testing over the ribs was inconclusive. The patient was referred for an x-ray, which demonstrated a recent rib fracture at the left 5th and 6th ribs in the axillary region. Treatment was modified to exclude SMT to the thoracic and lumbar spines. No complications from the rib fractures were reported. The patient reported symptom resolution in seven weeks and continued to re-

Table 2.
Incident characteristics. SMT (spinal manipulative therapy); N/A (not applicable, due to unavailable data)

	SMT			Symptom onset	Fracture location	Complications	Time to symptom resolution
	Type	Side	Level				
Case 1	Supine; posterior contact	Bilateral	T3-T6	Immediate	Ribs 5 and 6; left side, axillary region	None	7 weeks
Case 2	Prone; hypothenar transverse contact	Left	C7-T1	Immediate	Ribs 4 and 5; left side, anterolateral region	None	12 weeks
Case 3	Side posture; lumbar roll	Left	L3-L5	Immediate	Rib 9; left side, anterior region	None	N/A

ceive chiropractic care. She perceived the experience of the rib fracture as mild.

Case 2

The second case is of a 60-year-old female with a sedentary lifestyle. Bone mineral density T-scores in the lumbar spine and femoral neck were indicative of low BMD (osteopenia).^{24,25} She was a daily smoker and did not consume alcohol. She was on medications for the management of hypertension, depression, pain, and osteopenia (including anti-resorptive therapy, calcium, and vitamin D). She had a history of previous falls with fractures. She was being treated with chiropractic care for non-specific spinal pain in the cervical, thoracic, and lumbar spines for several years with no previous reports of AEs.

Her treatment plan included multimodal therapy including mobilisations and soft tissue therapy to the cervical, thoracic, and lumbar spines. On the day of the rib fracture incident, she was not treated by her usual chiropractic intern and an unintentional error was made where she received SMT targeted at C7-T1 in a prone position using a left unilateral hypothelar transverse contact.²⁶ She reported immediate pain on her left side over the ribs around the axillary region.

A physical examination was conducted immediately after she reported the described pain. Percussion, vibration, and palpation over the left 6th, 7th, and 8th ribs reproduced the chief complaint. Rib springing and thoracic spine ranges of motion produced vague pain over the lower left ribs. She was referred for an x-ray of the ribs, which was taken one week later. The x-ray demonstrated a healing rib fracture at the left 4th and 5th ribs in the anterolateral aspect of the ribs. She reported pain with coughing, sleeping on her left side, and moving from a supine or side-lying position to an upright position.

Treatment was modified to include soft tissue therapy to the intercostal muscles and low-level laser therapy over the affected ribs. As SMT was not part of the patient's original treatment plan, the supervising chiropractor reinforced the importance of easily accessing this information in the patient's file to potentially prevent future unintentional errors. No complications from the rib fractures were reported. The patient reported symptom resolution in 12 weeks and continued to receive chiropractic care. She perceived the experience of the rib fracture as mild.

Case 3:

The third case is of a 57-year-old male who was regularly engaged in moderate level physical activity. Bone-mineral density scores were not available. He did not smoke or consume alcohol. He was not taking any medications for the management of any health conditions. He had a history of a traumatic fall with multiple fractures. He was being treated with chiropractic care for non-specific low back pain; he had received five treatments according to the current treatment plan with no previous reports of AEs.

His treatment plan included multimodal therapy including SMT and soft tissue therapy to the lumbar spine. He received SMT targeted at L3-L5 on the left in the side posture position.²⁶ He reported feeling immediate sharp pain over his left ribs and pain with breathing.

The patient was immediately referred for x-ray, which demonstrated a non-displaced anterior rib fracture of the left 9th rib. He was advised to apply ice by the chiropractor. He was contacted over the phone nine days later and reported improvement in pain. No complications from the rib fracture were reported. The patient was lost to follow-up; therefore, data on symptom resolution and patient perception of the rib fracture could not be recorded.

Chiropractors' perspectives on lessons learned

Three main themes emerged from the semi-structured interviews with the chiropractors who participated in the study: 1) verifying and updating potential contributing factors associated with rib fractures; 2) transparent communication prior to SMT and/or after the occurrence of an AE; and 3) the opportunity for enhancing student education on AE management.

Verifying and updating potential contributing factors associated with rib fractures

In patients with identified risk factors for osteopenia or osteoporosis who may be at an increased risk of fracture (e.g. sex, age, sedentary lifestyle, smoking, alcohol intake, prolonged use of glucocorticoid medication), the chiropractors in this study thought that it was not only important to identify those risk factors at the initial assessment, but also to continuously verify and update them in order to continually choose treatment options to mitigate risk to the patient. Additionally, some chiropractors in this study emphasised that osteopenia and osteoporosis are

relative, not absolute, contraindications to SMT.²⁷ Lastly, the chiropractors in this study suggested that modifications to SMT, such as using non-thrust interventions, may be appropriate in patients who may be at risk for or who have been diagnosed with osteopenia or osteoporosis.

Transparent patient communication

Open and transparent communication with the patient, both prior to providing SMT and/or after the occurrence of an AE, was also identified as an important strategy by the participating chiropractors. Prior to SMT, the chiropractors in this study emphasised the importance of informed consent as a process where the treatment's benefits, risks, and alternatives should be discussed with the patient so that the patient can have an active and informed involvement in the decision-making process. After the occurrence of an AE, participating chiropractors believed that it was important to understand the patient's perception of the event, as the patient's perception may not be the same as the chiropractor's perception.

Opportunity to enhance student education on AE management

As all of the participating chiropractors in this study are involved in a supervisory role at a teaching clinic, they perceived these experiences as an opportunity to enhance students' education on patient safety and AEs. Some of the chiropractors in this study believed that it is important to introduce the concept of patient safety and AEs early in the chiropractic curriculum in order to expose students to an environment where they feel comfortable and supported to talk about safety concerns and AEs, thus promoting an open and trusting patient safety culture focused on learning from AEs instead of blaming.

Discussion

This case series provided an overview of three cases of rib fractures after SMT. In two of the cases, the patients were over 60 years of age, female, had BMD T-scores in the osteopenic range, and were sedentary. In one case, the patient was under the age of 60, male, had unknown BMD T-scores, and was moderately active. In all three cases, the patients were treated with SMT, however the type and location of SMT were different in all cases. In all three cases, the patient felt immediate pain and continued to report aggravation of symptoms with sleeping on the

affected side and with breathing. There were no known complications in any of the cases.

The limited availability of scientific evidence regarding rib fractures following SMT precludes the comparison of our findings to those previously reported in the literature. Two of the cases in this study, however, described characteristics that are similar to the risk factors included in fracture risk prediction tools commonly used to evaluate fracture risk of patients.²⁸ These factors include age, previous fracture, smoking, and low BMD.

Verifying and updating potential contributing factors associated with rib fractures

In 2000, osteoporosis resulted in more than 9.0 million fractures annually worldwide, contributing to the growing global health burden associated with low BMD.^{29,30} Fracture risk assessment tools for low BMD patients have been developed to include risk factors such as sex, age, history of fracture, prolonged glucocorticoid use, rheumatoid arthritis, cigarette smoking, and alcohol intake.²² As patients presenting to chiropractors may return over time for the management of their condition, it is important to always have the most updated information about a patient's overall health, including information on the patient's most recent BMD examination results. For patients with diagnosed osteopenia or osteoporosis, some chiropractors in this study emphasised the importance of making this diagnosis clearly visible and accessible in the patient's file. In doing so, any provider providing care to the patient can easily identify the presence of osteopenia or osteoporosis, which may affect the patient's treatment plan.

According to the WHO, osteopenia and osteoporosis are relative contraindications to SMT.²⁷ The WHO defines a relative contraindication as "one where the treatment may place the patient at undue risk unless the presence of the relative contraindication is understood and treatment is modified so that the patient is not at undue risk".²⁷ The chiropractors in this study felt that students training in SMT should understand what a relative contraindication means for the management of their patient. Students should be able to effectively communicate and discuss relative risks to their patients during the informed consent process by presenting the treatment's potential benefits, risks, and alternatives, allowing them to actively engage in a process of informed and shared decision making.

Although previous studies described that during SMT^{31,32}, forces are applied and transmitted through the patient, no studies have quantified forces applied to the thoracic or lumbar spines in a clinical setting. Additionally, there are no studies quantifying the SMT force-time characteristics required to fracture ribs of varying bone mineral densities. Regardless of the applied SMT force-time characteristics, however, evidence suggests that both thrust (SMT) and non-thrust (spinal mobilisation) interventions may lead to reductions in pain and improvements in function outcomes in individuals with chronic neck and low back pain.^{33,34} As such, treatment modifications including non-thrust interventions instead of thrust interventions was suggested by participating chiropractors for patients with identified osteopenia or osteoporosis, or in those who may be at risk, in order to reduce the occurrences of rib fractures.

Transparent patient communication

Chiropractors in this study also emphasised the importance of the informed consent process prior to SMT. Specifically, it has been described that informed consent should be an ongoing process, and that it is perceived by patients as such.³⁵ Similar to what was suggested in the previous theme (*Verifying and updating potential contributing factors associated with rib fractures*), patients who present with potential contributing factors associated with any AE should receive all relevant information in order to make an informed decision by weighing the risks of the treatment to its potential benefits. Nevertheless, participating chiropractors thought that all patients, even those without apparent contributing factors, should be appropriately informed about treatment risks. Additionally, as part of the informed consent process, alternative treatment options should also be explained to the patient. Treatment options could include not only alternative manual therapy techniques (e.g. spinal mobilisation instead of SMT), but also referrals for collaborative, interdisciplinary approaches to management based on the needs of the patient (e.g. co-management with physicians or pharmacists for management with medication; with other rehabilitative professionals for fall prevention; and/or with nutritionists for management of diet). Lastly, based on the case in which a rib fracture occurred after lumbar SMT, the chiropractor emphasised the importance of including rib fracture as a potential risk in the informed consent process

when providing manual therapy to both the thoracic and lumbar spines.

Patient perception of the event after the occurrence of an AE was highlighted as an important consideration. While some patients may perceive the event as very serious, others may perceive it as mild. In this study, patients involved in two of the three cases were very understanding of the situation, were not upset or angry, perceived the rib fracture as a mild AE, and subsequently returned to chiropractic care. In the third case, data on the patient perception was not available. After an AE, the chiropractors in the study stressed the importance of communicating with the patient about the events that occurred, what the patient should expect to feel, and potential complications, as this communication demonstrates accountability and professionalism.

Opportunity to enhance student education on AE management

In order to create a culture of learning from AEs when they occur (as opposed to a blaming/shaming culture), curricular changes may be needed. Specifically in the chiropractic curriculum, general concepts around patient safety and AEs (e.g. epidemiology, use of safety checklists) could potentially be implemented early in the curriculum. This could then be followed by practising cases and using simulation training, which would allow for students to identify potential contributing factors associated with particular AEs, practise different manual therapy techniques in addition to SMT, and practise the informed consent process in order to facilitate shared decision making. Indeed, structured educational programs including didactic and practice-based learning have been used in medical residency programs to educate medical residents on patient safety and quality of care.³⁶ Furthermore, simulation training for acute care nurses has been demonstrated to achieve improved patient safety outcomes.³⁷ By enhancing education on AEs and patient safety, chiropractic institutions have the potential to teach the next generation of chiropractors to be comfortable with talking about patient safety, which would significantly advance patient safety within the chiropractic profession.

Limitations

Not all cases of rib fractures that occurred after SMT may have been included in this study, as participating chiro-

practitioners had to actively volunteer for this study. In addition, details surrounding the patient and incident characteristics were based on previously documented clinical notes and memory recall. Therefore, there is the potential for unclear documentation, missing data, and memory decay, with no method for verifying the information. It is important to note that this study was not designed to establish risk factors associated with rib fractures or AEs, nor was it designed to establish causality of observed AEs. Lastly, no standardised qualitative technique was used for inquiry or to analyse the data and the perspectives of interns and patients were not collected. Future studies should use a systematic qualitative technique to identify themes or develop a taxonomy on lessons learned and risk mitigation strategies.

Future research

Future studies are needed to establish the SMT force-time characteristics necessary to cause a rib fracture in patients with varying characteristics, including varying BMD levels. A standardised method for systematically collecting AE data is also needed so that potential risk factors can be identified, significantly contributing to advancing patient safety related to SMT. Patients' and providers' expectations and perceptions towards AEs should also be further explored to expand on risk prevention and mitigation strategies.

Conclusion

This case series reviewed chiropractors' perspectives on cases of rib fractures after SMT, including their thoughts on potential contributing factors based on patient and incident characteristics, as well as their suggestions on enhancing patient safety and developing prevention and mitigation strategies. The chiropractors in this study stressed the importance of verifying and updating potential contributing factors that may be associated with rib fractures over the course of treatments, as well as open and honest communication with the patient as suggested prevention and mitigation strategies. They also viewed their experience in managing AEs as an opportunity to enhance student education in order to improve the overall patient safety culture. Our study indicates that important lessons can be learned from AEs, despite their infrequent occurrences. As patient safety is a global healthcare challenge, chiropractors need to be leaders in creating an open

and constructive patient safety environment within their profession.

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