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ORIGINAL ARTICLE

Training and certification of doctors of chiropractic in delivering manual cervical traction forces:
Results of a longitudinal observational study

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Objective: Doctors of chiropractic (DCs) use manual cervical distraction to treat patients with neck pain. Previous research demonstrates variability in traction forces generated by different DCs. This article reports on a training protocol and monthly certification process using bioengineering technology to standardize cervical traction force delivery among clinicians.
Methods: This longitudinal observational study evaluated a training and certification process for DCs who provided force-based manual cervical distraction during a randomized clinical trial. The DCs completed a 7-week initial training that included instructional lectures, observation, and guided practice by a clinical expert, followed by 3 hours of weekly practice sessions delivering the technique to asymptomatic volunteers who served as simulated patients. An instrument-modified table and computer software provided the DCs with real-time audible and visual feedback on the traction forces they generated and graphical displays of the magnitude of traction forces as a function of time immediately after the delivery of the treatment. The DCs completed monthly certifications on traction force delivery throughout the trial. Descriptive accounts of certification attempts are provided.
Results: Two DCs achieved certification in traction force delivery over 10 consecutive months. No certification required more than 3 attempts at C5 and occiput contacts for 3 force ranges (0–20 N, 21–50 N, and 51–100 N).
Conclusions: This study demonstrates the feasibility of a training protocol and certification process using bioengineering technology for training DCs to deliver manual cervical distraction within specified traction force ranges over a 10-month period.

Key Indexing Terms: Chiropractic; Education; Manipulation, Cervical; Manipulations, Musculoskeletal; Traction

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INTRODUCTION

Neck pain represents a substantial burden to the health and quality of life of individuals and societies.[1–7] Other complaints such as stiffness, headaches, and upper extremity symptoms of impaired coordination, decreased muscle strength, and paresthesia can also accompany neck pain.[8] Estimates of the 12-month prevalence of neck pain in the adult population range from 15% to 50%.[6,9,10] Untreated neck symptoms can lead to severe pain, long-term disability, work absences, and increased health care costs.[2,11] Conservative care, including manual therapy, can be an effective and lower cost treatment for neck pain.[12–14] Doctors of chiropractic (DCs) treat patients with neck symptoms using many conservative care modalities; among them are several types of manually delivered high-velocity spinal manipulation and low-velocity spinal mobilization procedures.[15,16]

Manual cervical distraction (MCD), or the Cox flexion distraction procedure, is a cervical spine mobilization technique commonly used by DCs. MCD consists of manually controlled, low-velocity variable amplitude movements.[17–21] MCD procedures are performed using variable distraction forces based on therapeutic intent and individual patient tolerance. Traction force application is the key input thought to produce therapeutic benefit by stretching spinal ligamentous and paraspinal muscular tissues and reducing hydrostatic pressure in intervertebral discs.[22] Questions remain whether a specific force range has optimal therapeutic value for patients with neck symptoms. However, some evidence suggests that cervical mobilization force magnitude can influence clinical outcomes.[23] A recent systematic review reported high variability between providers delivering manual treatments.[24] Our cadaveric research discovered that MCD traction decreased intradiscal pressure relative to the force

magnitude and that forces among experienced DCs vary substantially.[22] These variances point to the need for technologies that measure traction forces and training protocols to ensure accurate delivery of this procedure. In order to conduct clinical studies to determine optimal force delivery, we need technologies to train DCs to measure and confirm the delivery of standardized forces.

Clinician delivery of MCD and other chiropractic treatments requires the mastery of complex psychomotor skills, including a thorough understanding of patient and table positioning, implementation of coordinated movements during treatment, and simultaneous assessment of joint and tissue tension/stiffness and patient tolerance. Students and clinicians typically master the delivery of manual therapies through a progression of lecture, laboratory sessions, and delivery to patients in clinical settings.[25–35] In educational settings, students often observe a teacher demonstrating a procedure, practice the technique on fellow student volunteers, and sometimes receive hands-on guidance and/or verbal feedback on their performance.[36–38]

Researchers and educators have developed innovative bioengineering technologies, such as instrumented mannequins or treatment tables and other measurement devices, to provide objective feedback on forces, durations, and loading rates generated during SMT.[26–30,32,33,39–41] However, few studies have evaluated these new technologies for training students or clinicians in the delivery of mobilization procedures.[42–46] Gudavalli and colleagues recently described the development of an audible/visual and graphical feedback technology to measure cervical traction force delivery.[47] Here, we report on a training protocol and monthly certification process that used this technology to standardize the cervical traction forces delivered by 2 experienced DCs over a period of 10 months during a randomized controlled trial (RCT) of MCD.

METHODS

This longitudinal observational study assessed the feasibility of a training and monthly certification process to assure standardized delivery of cervical traction forces between 2 research clinicians providing force-based MCD in a RCT conducted from January to October 2013. The Palmer College of Chiropractic institutional review board provided ethics approval. Volunteer participants and the DCs who served as research clinicians signed written informed consent to participate in the study.

Participants

Nineteen asymptomatic participants recruited from collegiate employees and research fellows served as simulated patients (12 males, 7 females; mean age 43 years, SD 13 years). Volunteers were screened for any safety considerations and contraindications to receiving MCD before inclusion in the study.

Two DCs served as research clinicians, participated in the training and certification process, and delivered the study treatments. The clinicians (1 male and 1 female) had extensive clinical experience (31 years and 28 years, respectively) in chiropractic private practice, research, and technique instruction. One clinician had over 5 years of experience treating patients with MCD, whereas the other clinician had not used the technique in clinical settings before this study.

Training Intervention

The training procedures were developed for an RCT that assessed MCD involving 3 force-based intervention groups: a low-force group requiring traction measured at $\leq$20 newtons (N), a medium-force group requiring traction measured between 21 and 50 N, and a high-force group requiring traction measured between 51 and 100 N. The 2 DCs completed an initial training and monthly certification process over the 10 months of the trial. The clinicians underwent 7-weeks of training in the clinical trial protocol, which included certification in the delivery of force-based MCD before trial launch.[47] This training program included a 1-day lecture and demonstration by Dr. James Cox, the expert clinician who developed this chiropractic technique. Topics covered during this didactic training included the theoretical basis of how the MCD procedure is thought to influence the mechanics of the spine, proper doctor and patient positioning and the DC's hand placement, procedures for testing patient tolerance, treatment protocols for patients with and without radiating symptoms of varying intensity, and clinical insights from years of experience both treating patients and teaching the technique. Training included individualized practice with asymptomatic volunteers accompanied by feedback.

The DCs then practiced MCD delivery on volunteer simulated patients during one 2-hour and one 1-hour training session scheduled on 2 different days of the week for 7 weeks. The MCD procedure was performed with the DC standing beside a participant lying prone on an instrumented table (Fig. 1a and b) with a moveable headpiece that allowed for guided head movement in the cephalic, lateral, and flexion directions; however, only neutral distraction, the most common MCD procedure, was used in this study. To deliver treatment, the DC gently held the posterior and lateral aspect of the participant's neck at a specific vertebral level (cervical vertebra 5 [C5] and occiput) with a broad manual contact between the thumb and index finger (Fig. 1c and d). With the opposing hand, the DC held the control handle of the headpiece. The hand on the control handle manually dampens motion and ensures slow, gentle headpiece movement. Because the control handle is connected to the headpiece, both hands move simultaneously during the procedure; therefore, the DC's hand on the control handle aids the generation of coordinated upper body movements. With the contact hand, the DC exhibited superior traction while maintaining the manual cervical contact. The goal was to generate a slow and somewhat rhythmic (1- to 3-second cycles) localized cervical distraction. The DC elicited verbal feedback from the participant regularly throughout the procedure to assess tolerance.

DCs were trained to deliver MCD within prescribed force ranges using bioengineering technology that provid-

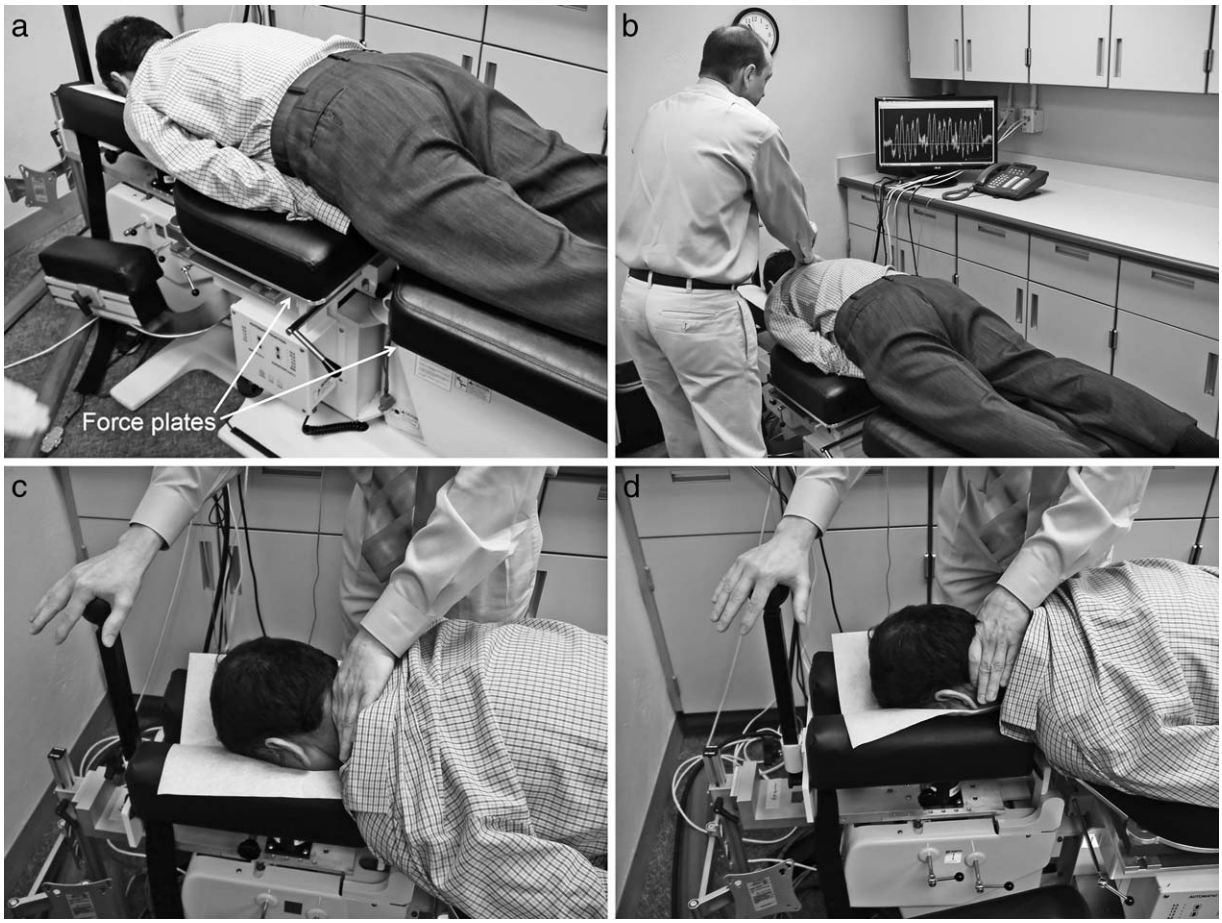

Figure 1 - (a) Positioning of patient on the instrumented treatment table. (b) Chiropractor viewing graphical force feedback. (c) Hand contact positioning at C5. (d) Hand contact positioning at occiput.

ed real-time audible feedback and postintervention graphical feedback on the applied traction forces (Fig. 1b). This audible and graphical feedback was enhanced with real-time visual feedback midway through the clinical trial to enhance accuracy in force delivery.[47] For this study, we modified a Cox flexion-distraction chiropractic table (Model 7, Haven Innovation, Grand Haven, MI) with three-dimensional force transducers (Models 2850-06 and Py6-100, Bertec Inc, Columbus, OH) and used Motion Monitor software (version 8, Innovative Sports Training Inc, Chicago, IL) to measure manually applied traction forces. During training, we set the software to produce a steady audible feedback tone when measuring traction forces at $\leq$20 N, to become silent when forces ranged between 21 and 50 N, and to produce an audible tone again when traction forces exceed 50 N. Software was configured to display real-time visual feedback in the form of a cursor on a computer screen moving through force ranges. The audible and visual feedback was reinforced through graphic force-time display as shown in Figure 2.

Simulated patient participants received the MCD procedure from 2 DCs with manual contacts over C5 and the occiput for a maximum of 3 sets of 5 cycles within a given force range. Three sets of 5 distraction cycles lasted 1–2 minutes. The DCs assessed participant tolerance with a single distraction cycle before beginning treatment delivery and during a scripted pause between each of the 3 sets. Participants could discontinue treatment at any time. Because neck stiffness and cervical spine anatomy differed between simulated patients, the force-feedback training provided clinicians with objective measures of manually applied forces delivered to patients of different body types, genders, and ages. Posttreatment peer debriefing by the simulated patients, most of whom were DCs or health care professionals themselves, further sensitized the clinicians to delivery of the MCD procedure.[48] Weekly evaluation of clinician proficiency in force delivery indicated that the DCs were sufficiently trained and confident to complete certification at the end of 7 weeks. The DCs received certification (described below) to treat RCT participants after completing this training protocol.

Certification Process

The DCs were required to certify in traction force delivery on a monthly basis to enhance implementation fidelity throughout the RCT, a period of 10 months.[49] The initial certification and recertification included performing MCD within the measured range on 80% or more of 15 repetitions at each contact on 2 consecutive participants

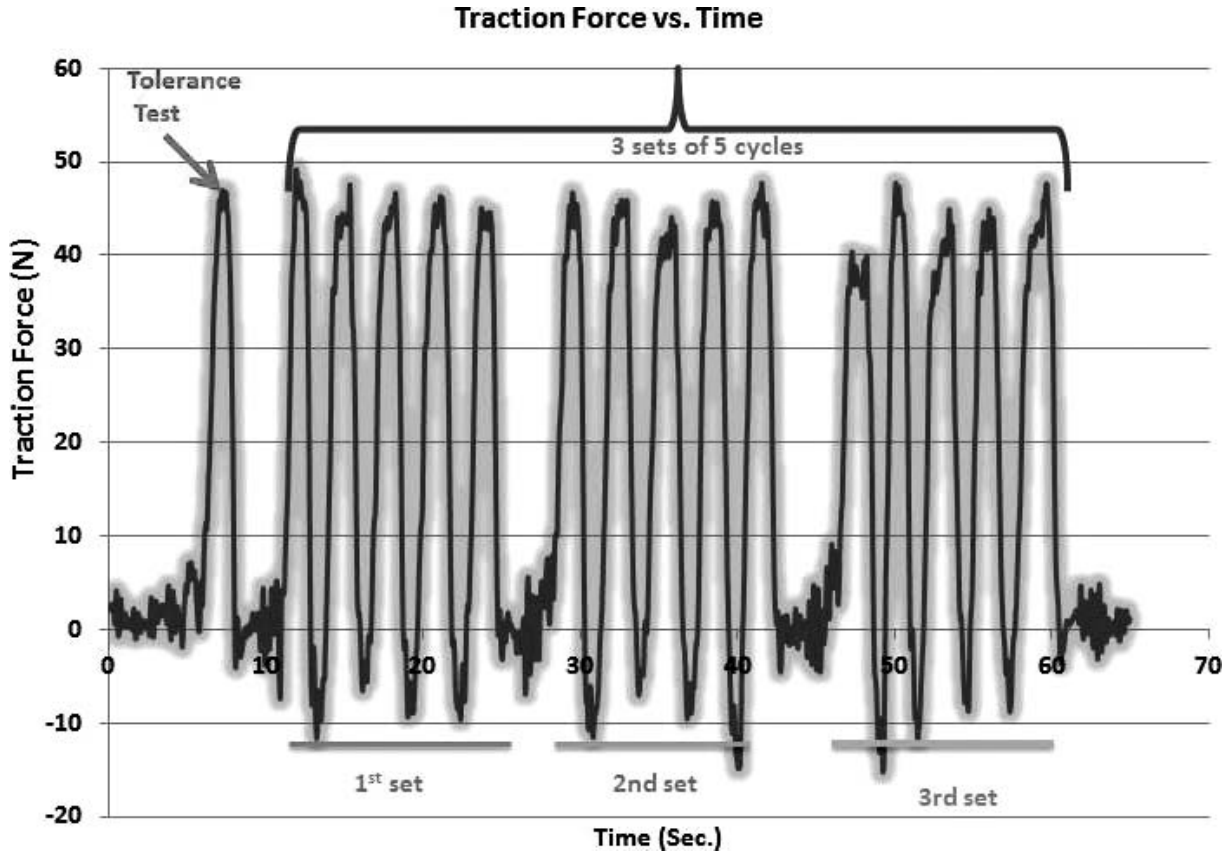

Figure 2 - Cervical traction forces graphically displayed after manual cervical distraction procedure.

for each force range. The DCs did not receive audible or visual force feedback during the certification or monthly recertification process as one objective of this research was to replicate field settings where force feedback is not available. Once a participant received treatments from both DCs, a different participant served as the simulated patient for the next force range or anatomical position.

Outcomes

Delivery of the prescribed traction force is the quantitative outcome measure. We set a priori criteria for DCs to obtain certification to deliver traction forces during the clinical trial in 3 ranges (0–20 N, 21–50 N, and 51–100 N) on 2 consecutive participants for each force range at each hand contact point (C5, occiput). Successful completion of a single test occurred when traction forces generated during the procedure stayed within the force range at least 80% of the 15 cycles (minimum of 12 cycles). A biomechanics researcher saved the traction force data into an Excel spreadsheet (Microsoft, Redmond, WA) and entered certification attempt data into a study log book for subsequent data analysis.

Statistical Analysis

We completed descriptive statistics on the pass/fail rate of certification using the criterion of an 80% pass rate when 12 of 15 cycles of peak forces were achieved in the prescribed force range. Certification attempts were depicted graphically by clinician, certification month, and contact point.

RESULTS

The number of attempts each clinician made to obtain certification in traction force delivery for each force range and contact location is depicted in Figure 3 (occiput) and Figure 4 (C5). The DCs made 1–3 attempts to certify in traction force delivery at each given force and contact level. DC1 made 10 repeated certification attempts (5 attempts at occiput; 5 attempts at C5), and DC2 made 9 repeated certification attempts (6 attempts at occiput; 3 attempts at C5). The DCs required repeated attempts to certify in traction force delivery only twice over a 10-month period for each of the contact levels when delivering MCD in the high-force range (51–100 N). The DCs required more than 1 attempt to certify on 6 occasions for occiput contact and 7 occasions for C5 contact when delivering MCD in the medium-force range (21–50 N). The DCs required multiple certification attempts on 6 occasions to certify at the occiput contact compared to single certification attempts in traction force delivery at the C5 contact when in the low-force range (0–20 N). In total, the DCs required repeated certification attempts more often at the occiput contact ($n = 15$) compared with the C5 contact ($n = 9$). Both DCs certified in traction force delivery in a single attempt at C5 for the last 4 months of certification,

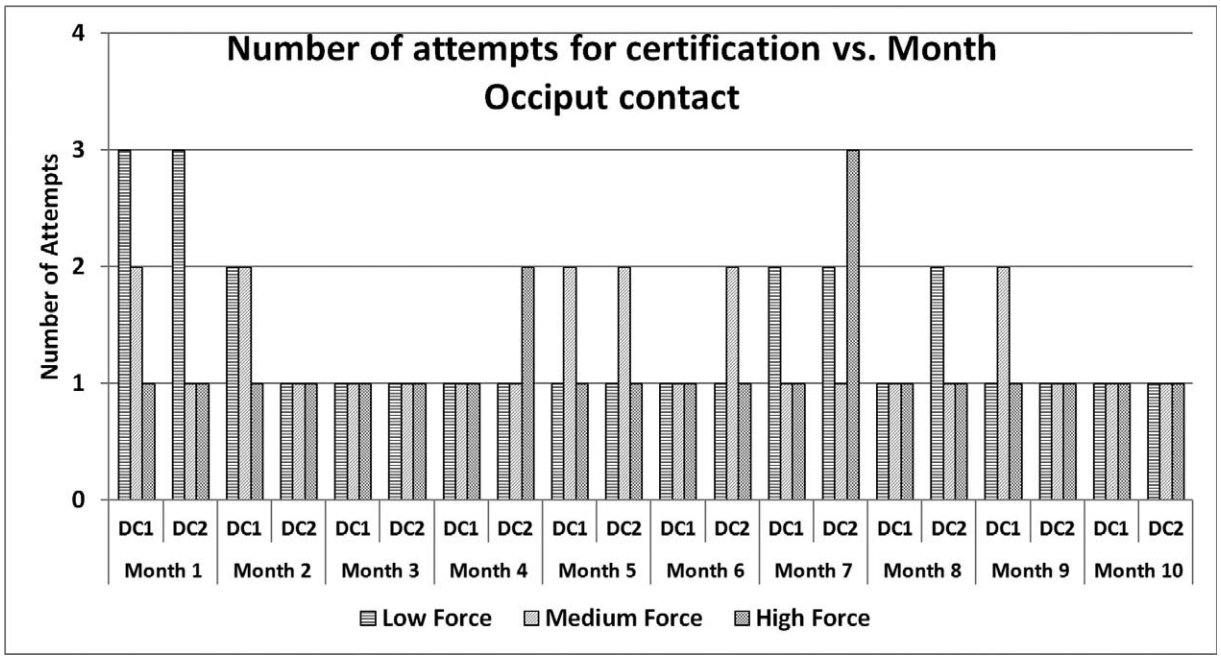

Figure 3 - Number of attempts for certification at occiput contact.

as well as at the occiput contact point during the 10th month.

Two participants reported unexpected adverse events of mild severity during the training and certification process. These adverse events were rated as probably due to the intervention. One participant reported transient right pupillary dilation and unclear vision lasting approximately 4 hours, beginning approximately 30 minutes after receiving the MCD procedure. A second participant reported a transient episode of vertigo experienced within 24 hours of receiving treatment. These symptoms resolved without recurrence in both participants.

DISCUSSION

This novel investigation demonstrates the feasibility of a training protocol and certification process for DCs to deliver manual cervical distraction within prescribed traction force ranges. We utilized a combination of audible, visual, and graphical feedback technology to train and certify 2 DCs over a 10-month period in 3 force ranges at 2 contact points. The training and monthly certification of DCs was an instrumental component of a randomized force-based dose-response clinical trial as it standardized treatment delivery between clinicians.

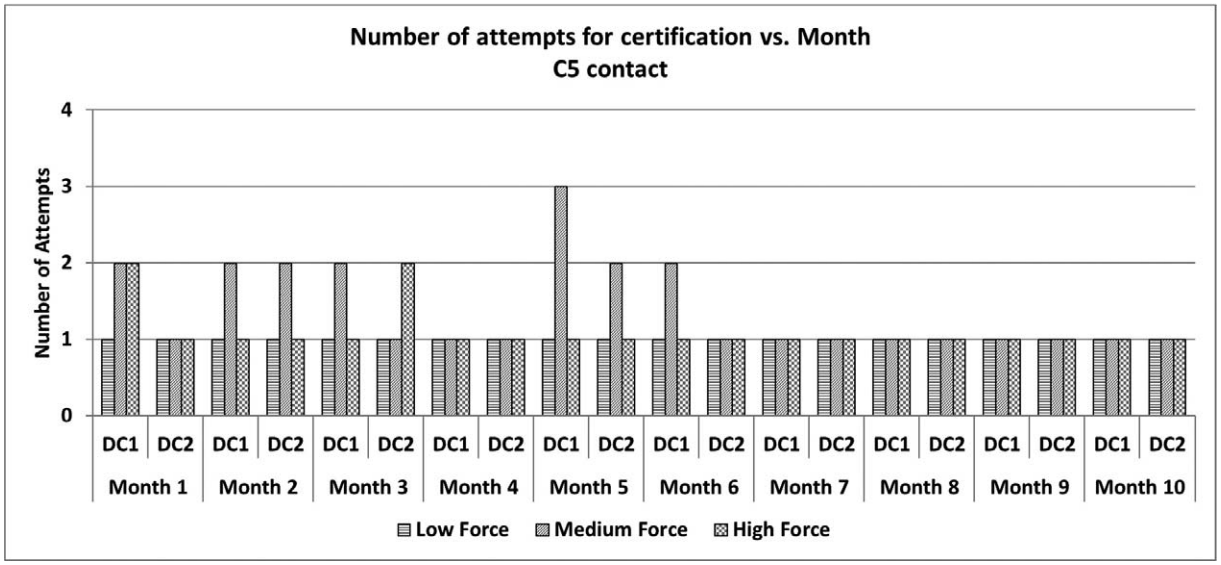

Figure 4 - Number of attempts for certification at C5 contact.

Traditional approaches for training in spinal manipulation and mobilization techniques have included demonstration, observation, and verbal feedback by an instructor. This method is based primarily on the subjective evaluation of distraction technique as a complex psychomotor skill. This study used objective measures with quantitative traction force data to measure the delivery of MCD. Simulated patient participants also provided feedback to DCs regarding their experience of receiving MCD at different force ranges, which enhanced the DCs' perceptions of force delivery, patient comfort, and safety concerns.

Two participants experienced mild adverse events that were probably related to the study treatment. Participants in previous studies also have reported visual changes and vertigo or dizziness following spinal manipulation or mobilization to the neck.[50–53] DCs in clinical and educational settings should monitor their patients for adverse events and document their occurrence. Dose-related studies of spinal mobilization and manipulation should assess whether participants receiving varied doses report differences in adverse events.

DCs required a different number of certification attempts with manual contacts at C5 and occiput, suggesting that traction forces delivered to these areas may be perceived differently, a finding that was consistent with reports during peer debriefing. That is, cervical traction delivered at the occiput often registered higher peak forces on the graphical feedback report than was expected by DCs. The quantified force feedback proved helpful in distinguishing this difference and suggests that local tissue features under the manual contact may affect perceived force.

Several investigators have used instrumented mannequins, tables, or other devices to obtain force feedback during high-velocity, low-amplitude spinal manipulation (HVLA-SM) and posterior-to-anterior mobilizations.[26–30,32,33,39,40,42–46] The present study differs in 3 substantive ways. First, our study is based on combined real-time audible/visual and immediate graphical feedback for a traction-type procedure used by chiropractors. Real-time feedback allowed the DC to match his or her observed sensory perceptions to objectively measured traction forces, thereby facilitating alteration of treatment delivery. Secondly, monthly recertifications supported implementation fidelity of the MCD procedure over 10 months of an RCT, potentially enhancing study findings. Finally, we trained and certified experienced DCs within 3 prescribed force ranges, allowing for future force-based, dose-response studies of MCD. This finding suggests the usefulness of this training protocol and certification process for educating chiropractic students and practicing clinicians in variable delivery of this procedure. Training clinicians to accurately calibrate force in treatment delivery is important so that MCD can be provided within the tolerance range of individual patients and to ensure consistent care within and between providers. The importance of calibrated force delivery will increase if subsequent clinical research determines that traction force delivery is a key component of treatment effectiveness.

Training was time and personnel intensive, requiring a minimum of a DC, simulated patients, and technical operator. Training and certification of DCs for this study were designed for clinicians delivering MCD in a clinical trial within very specific traction force ranges and incorporated the development of a new technology. In educational and practice settings, the precision and training time we required is likely not as crucial. The benefit of real-time visual force feedback, which was added midway through the trial, also indicates that the same amount of training time we encountered would not be necessary in educational and clinical settings. The equipment used to develop the technology in this study is costly and requires technical expertise to operate and maintain. However, cost-effective technologies are available and can be incorporated into treatment table design and used by educational institutions to train students during technique classes taught within the curriculum and in continuing education programs.

Because this study trained and certified only 2 DCs, the generalizability of results is limited, and future studies should incorporate a larger number of DCs and possibly chiropractic students. We did not include a control group to determine if the DCs trained without the aid of this technology could perform equally as well as the DCs in this study. Our training protocol was tested only on traction forces. However, this technology can support training in other aspects of the MCD procedure, and future studies are planned to incorporate additional measures used in field settings.

CONCLUSIONS

This study demonstrates the feasibility of a training protocol and monthly certification process using real-time audible/visual and graphical feedback in delivering manual cervical distraction within prescribed force ranges. The study also demonstrated that experienced DCs could improve their treatment delivery skills using this type of training and certification process and retain this learning over a 10-month time period. Future studies might assess the usefulness of this technology and training protocol with chiropractic students and practicing DCs.

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