Forces of Expert and Novice Practitioners During Flexion-Distraction Chiropractic Treatment

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ABSTRACT

The objective of this paper was to collect force data while experienced and inexperienced doctor of chiropractic deliver treatment to low back pain. A portable system consists of a three-dimensional force transducer, laptop computer, and custom developed software was used for this study. The system was used to quantify the forces during a flexion-distraction type of treatment delivered by chiropractors. The forces applied in the posterior-to-anterior direction, the forces applied in the inferior-to-superior direction, and the duration of the cycle time in delivering these oscillating forces were quantified. Information on the pre-load and peak forces were gathered while experienced doctors of chiropractic with more than fifteen years of clinical experience were performing the procedure.This information on the forces was compared to the information obtained using doctors of chiropractic who have less than one year of experience. Doctors of chiropractic who have experience applied significantly greater forces than those who had less experience.

Keywords
Spine, Low back pain, Forces, Chiropractic, Real-time

INTRODUCTION

Some of the conservative treatments include physical therapy and back education, chiropractic manipulation, and massage. One set of chiropractic treatment procedures is known as flexion-distraction manipulation procedures administered by chiropractors [1], According to a national survey, flexion-distraction technique developed by James M. Cox, DC, DACBR is used by 58% chiropractors on some percentage of their patients[1-2]. This procedure is done on a specially developed table (Figure 1).

The techniques consist of two biomechanical components. The first is a series of traction procedures directed at a specified joint level. The motion from the traction procedures result in an opening of the posterior joint spaces and a consequent reduction in intradiscal pressure[3-5]. The second is a series of mobilization procedures in a variety of motion directions targeted at a specific joint level. Patient is positioned in a prone position (Figure 1) and the forces are delivered by hand contact on the lumbar spine and by the motion of the table using the other hand.

Figure 1 Patient positioned on a flexion-distraction table

The doctor of chiropractic delivers forces by means of hand contact on the patient during treatments. These forces are complex three-dimensional forces and are delivered to create forces and moments at the joint of interest and create joint movements.
Pioneering work on the measurement of manipulation loads was undertaken by Herzog et al.[6-8,] Triano[9-12].
In summary: 1) the forces in terms of magnitudes, impulse duration and points of application have been quantified for several SM techniques using force plates and pressure mats (e.g., EMED and Tekscan). These techniques may be applicable for other SM procedures. 2) For a given SM technique, the forces delivered seem to vary over a wide range of values. 3) The biomechanical changes that these manipulative forces produce in spinal segments have in some cases been quantified using cadavers. This data is limited in nature and can not be

generalized for other techniques or for living organisms. 4) The effects of SM forces on the motion of 'abnormal' and adjacent spinal segments in-vivo are not known. Thus the biomechanical basis for the effectiveness of any given technique with so much variation in SM forces is not well documented. The optimal force necessary to provide the most effective treatment outcome for various conditions remains to be studied.

Herzog[6], Triano[11], and Gudavalli [13] have identified the need for further research on the biomechanics of spinal manipulation. Van Zoest et al. [14] were the first to report on a measurement method to quantify the three-dimensional forces at the doctor-patient hand contact. This facet of SM measurement has not been thoroughly studied.

The art of chiropractic palpation and adjusting is taught by skilled practitioners and teachers to the students. Students practice on each other under the supervision of a competent teacher. The teacher observes visually how the students are acquiring the skills and gives feedback for the improvement in the performance. Instrumented models could provide specific feedback to the student about their palpatory and adjustment skills. This feedback would allow the student to perfect their method as well as decrease the time needed to learn a technique. Therefore, the development of a bioengineered chiropractic teaching mannequin would pave the way for a new level of improvement in student education.

Young et al.[15] developed a cervical mannequin as a tool for practicing cervical adjustments. These investigators compared the skills of students trained traditionally and the skills of students trained using the mannequin using instructor observed ratings. Triano et al. [12] used a mechanical spring loaded device for teaching the skill of an adjustment to students. These investigators compared the skills of students who were trained traditionally to those that were trained with a mechanical device. Force-time profiles measured using an instrumented table was used for the quantification of the skill. While there is definite interest in the profession in training and assessment using instrumentation and devices

The objective of this investigation was to compare the force profiles delivered by experienced doctors of chiropractic with those delivered by inexperienced doctors of chiropractic.

METHODS

A three-dimensional force transducer as shown in Figure 2 (Model # Mini-45, ATI-Industrial Automation, Greensboro, SC) was used to measure the three-dimensional loads (three forces and three moments).

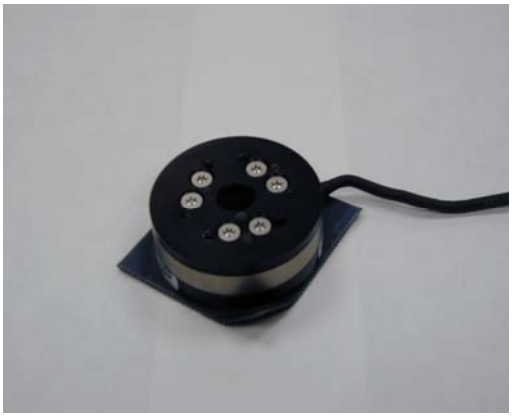

Figure 2 Three-dimensional force transducer used in the study

The transducer was placed between the doctor's hand and the patient. The X-axis of the transducer was pointed inferior-to-superior on the spine, Y-axis was pointing right laterally, and the Z-axis was pointing posterior-to-anteriorly. The load-time histories were recorded at a sampling rate of 100 samples per second using Lab view software and a laptop computer connected to the force transducer by means of Keithly instruments PCMCIA card. The force-time histories were displayed on the computer as a function of time in real time. This real time feed back provides information on the amount of forces applied in all three directions (Fx, Fy, and Fz). The doctor of chiropractic is able to get the information on how much preload force is applied and how much peak force is applied, and the amount of range of the oscillating force.

Five doctors who have more than fifteen years of experience and five doctors who have less than one year of experience performed the procedures on four subjects. Doctors without experience performed a total of 12 adjustments, while the experienced doctors performed a total of 11 adjustments. The major forces observed were posterior-to-anterior stabilization forces, and the inferior to superior traction forces. Both the preloads and peak loads were quantified in both directions. Also the average cycle times were calculated. Differences between the two doctors were analyzed using t-tests for statistical significance.

RESULTS

As part of an initial investigation, we collected the force time profiles of an experienced chiropractor (Figure 3). As evident from the graphs the major forces are inferior to superior force (Fx) and posterior-to-anterior force (Fz). These forces were oscillating from a minimum value to a maximum value in a cyclic way.

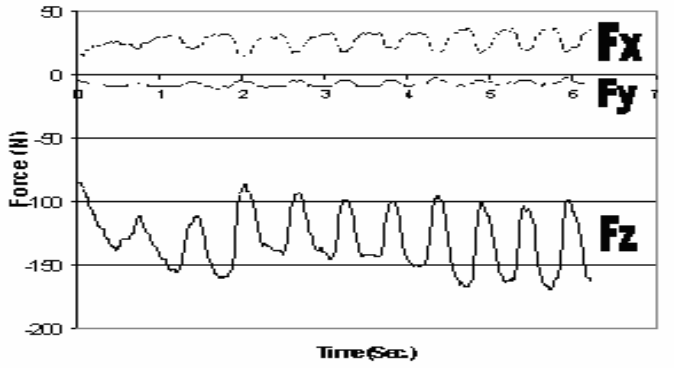

Figure 3. Force-time profiles of an experienced chiropractor

Table 1 lists the mean and standard deviation data of the preload and peak load forces in Fx (inferior-to-superior forces) as well as Fz (posterior to anterior forces), and the average cycle time for the oscillation used by experienced doctors as well as inexperienced doctors. The p values show significant differences between the two groups.

DISCUSSION AND CONCLUSION

This system along with the software is a valuable tool in obtaining real time information of the forces applied by a doctor of chiropractic. The doctors who have experience have applied significantly higher preloads and peak loads compared to doctors having less than one year of experience. This observation was valid for the forces in the posterior-to-anterior direction as well as inferior to superior direction. Doctors who have more experience have a lesser duration cycle compared to the inexperienced doctors.

This system can be used to quantify the skills of experienced chiropractors and this information can be used to train the future doctors of chiropractic. This device can be used to quantify the forces in treating different patient populations presenting different conditions and a research data base can be developed using that information. Future work will be aimed in this direction. This study is a first to report the force characteristics of experienced and inexperienced doctors using a flexion-distraction procedure.

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Table 1. Comparison of forces delivered by doctors with and without experience

Variable	Doctors without Experience (n=12) Average (Std. Dev.)	Experienced Doctors (n=11) Average (Std. dev.)	p value
Inferior-to-superior force Fx (N)			
Pre-load	20.42 (4.86)	35.64 (16.97)	0.007
Peak-load	42.48 (10.57)	54.89 (14.57)	0.028
Posterior-to-anterior force Fz (N)			
Pre-load	45.84 (22.51)	87.54 (46.92)	0.012
Peak-load	82.28 (38.62)	132.67 (44.62)	0.008
Cycle Duration (Seconds)	2.67 (0.56)	2.28 (0.28)	0.047