Consistency and Malleability of Manipulation Performance in Experienced Clinicians: A Pre-Post Experimental Design

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Abstract

Objective: The purpose of this study was to sample the stability of spinal manipulation performance in peak impulse force development over time and the ability of clinicians to adapt to arbitrary target levels with short-duration training.
Methods: A pre-post experimental design was used. Human analog mannequins provided standardized simulation for performance measures. A convenience sample was recruited consisting of 41 local doctors of chiropractic with 5 years of active clinical practice experience. Thoracic impulse force was measured among clinicians at baseline, after 4 months at pretraining, and again posttraining. Intraclass correlation coefficient values and within-subject variability defined consistency. Malleability was measured by reduction of error (paired *t* tests) in achieving arbitrary targeted levels of force development normalized to the individual's typical performance.
Results: No difference was observed in subgroup vs baseline group characteristics. Good consistency was observed in force-time profiles ($0.55 \leq$ intraclass correlation coefficient ≤ 0.75) for force parameters over the 4-month interval. With short intervals of focused training, error rates in force delivery were reduced by 23% to 45%, depending on target. Within-subject variability was 1/3 to 1/2 that of between-subject variability. Load increases were directly related to rate of loading.
Conclusion: The findings of this study show that recalibration of spinal manipulation performance of experienced clinicians toward arbitrary target values in the thoracic spine is feasible. This study found that experienced clinicians are internally consistent in performance of procedures under standardized conditions and that focused training may help clinicians learn to modulate procedure characteristics. (J Manipulative Physiol Ther 2015;38:407-415)
Key Indexing Terms: *Manipulation; Chiropractic; Skills, Clinical; Reliability of Results*

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Experience and skill proficiency, although generally considered to be related, are not synonymous. In both longitudinal[1] and cross-sectional[2] studies of the characteristics of spinal manipulation (SM) among samples of learners and experienced clinicians, there is an association with experienced practice and the maturation in characteristic parameters of SM. Both peak amplitude of force and rate of rise in force increase with experience to mature at approximately the 5-year mark. In clinical practice, therapeutic parameter dosages are varied pragmatically. Clinical heuristics, for example, suggest that patients with large stature, in respect to the clinician, and those with clinically persistent muscle tension are commonly assumed to require higher forces applied. Smaller stature, frail patients, and those with comorbid conditions that may alter tissue properties receive lower force.[3] Yet, there remains a wide variation in the individual values of force application reported across tested samples of

clinicians.[4-6] To date, there is no clear understanding of the optimum dosage related to clinical outcomes for the parameters that comprise a specific SM maneuver administered for any given condition. Emerging evidence suggests that there may be a stronger foundation for clinical dosage decisions than clinical wisdom. Animal work shows that systematic variation of procedure components (eg, preload,[7] peak force,[8,9] rate of rise in force,[10,11] and applied force direction[12]) can translate into differing biomechanical, neurophysiologic, and metabolic biomarker responses. Analogous results, although fewer in number, are present in human studies[13-21] but are not yet linked to clinical outcomes.

Given the uncertainty of procedure performance, it is difficult to determine a clinically relevant biomechanical threshold or an optimum dosage of component parameters. There are 2 main strategies available. An epidemiological approach would involve the acquisition of performance measures from a wide variety of clinicians treating a spectrum of patients. Clinical outcomes might then be used to parse related characteristics of the manipulation procedures. Such a method is sufficiently a challenge both technologically and logistically as to be infeasible. A more pragmatic method would be to train clinicians to provide different dosages of the characteristic components on demand. Then an experimental protocol could randomly allocate patients with differing conditions to treatment groups with defined parameters.

Earlier studies have shown that voluntary control of SM parameters is feasible,[22,23] and training has been used to a limited extent in an attempt to bound therapeutic procedures[24-26] within narrower ranges. It can be argued that, in each of these cases, the clinicians involved in training were strongly motivated participants in highly controlled experimental environments. Little is known about how consistent in performance experienced clinicians are in general or how malleable their skills may be. Consistency, in the intended context, implies a pairwise similarity of performance within narrow tolerances by the same operator given the same clinical/patient circumstances. In like manner, malleability implies the capacity of an operator to achieve directed change in performance to a targeted level under a given set of conditions. The purpose of this project was to sample the stability of SM performance in peak impulse force development over time and the ability of clinicians to adapt to arbitrary target levels with short-duration training.

Methods

A pre-post experimental design was used to evaluate the stability of performance of a common thoracic spine high-velocity low-amplitude (HVLA) procedure at baseline and again immediately before and after a 2-hour training intervention. The baseline preceded the pretest measure by approximately 4 months as determined by scheduling availability of the participant at times in which the laboratory was available.

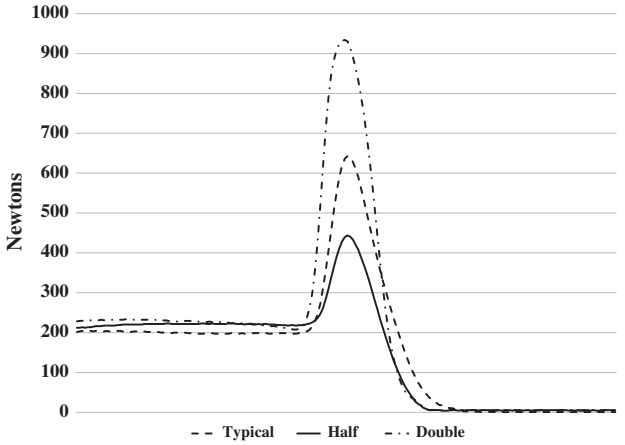

Fig 1. *Force-time profiles demonstrating the performance of instructions to administer a typical, half-typical, or double-typical peak impulse force. The horizontal (abscissa) extends over a 1-second interval.*

A convenience sample of 41 local clinicians was recruited. Each was required to have a minimum of 5 years of active clinical practice experience to allow sufficient time for SM skill maturation and to asymptotically reach maximum performance[1,2] for commonly measured characteristic parameters as reported within the literature. Candidates were excluded if they had prior training with technology-assisted means to provide knowledge of results from force-time profiles and mannequins or had previous or current injuries that would interfere in delivery of their typical treatment procedures.

Participants were scheduled for testing at the Simulation Laboratory located at the Canadian Memorial Chiropractic College (CMCC) where they signed informed consent approved by the institutional research ethics board (REB#1411X04). Participant descriptive characteristics included weight, height, and age. Clinical experience was quantified both in terms of the number of years in active practice and the recall history on the current average number of patient encounters per week.

A custom foam human analog mannequin (HAM) with anthropometrically consistent soft tissue compliance[27] and anatomical landmarks served as a stand-in for live subjects. The HAM also permitted standardized sensory feedback as simulation for the participants as they applied treatment procedures. The mannequin was part of a high-fidelity[28,29] force-sensing treatment table system (FSTT; CMCC, Toronto, Ontario, Canada) instrumented with an AMTI (Advanced Mechanical Technology Inc, Watertown, MA) force plate providing quantification of force-time profiles transmitted through the torso support section. The location