Critical Skills for Manual Therapy Competency

Controlled Practice Methods

- **Fine Sensorimotor Skills**

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Triano et al (2003)[1]	5/11 (PEDro scale)	1b	RCT	"To quantify elements of performance of spinal manipulation and to test the strategy of combined rehearsal and quantitative feedback as a means of enhancing skill development in the cervical and thoracic spine."	"It is now possible to determine quantitative thresh- olds for proficiency in the domain of spinal manipulation/ adjusting."
Triano et al (2002)[2]	6/11 (PEDro scale)	1b	RCT	"To quantify elements of performance of spinal manipulation and to test the strategy of combined rehearsal and quantitative feedback as a means of enhancing skill development in the lumbar spine."	"Results demonstrated significant changes in performance of spinal manipulation by students using the training aid instrument versus those who did not." This was determined by the measurement of amplitude, cycles, direction, duration, preload, and slope of force through the use of a force plate.
Downie et al (2010)[3]	6/11 (AMSTAR)	1a	Systematic Review	"To systematically review studies that quantify the HVLA spinal thrust, to qualitatively compare the apparatus used and the force-time profiles generated, and to critically appraise studies involving the quantification of thrust as an augmented feedback tool in psychomotor learning."	"Quantifiable parameters (preload, peak force, and thrust duration) of the HVLA spinal thrust exist and have been described. There is variation between studies which is why a standard has not been established."
Graham et al (2010)[4]	18/29 (Downs and Black)	2a	Prospective Cohort Study	"To determine the inter- and intra-practitioner variability of the thrust parameters resulting from a toggle-recoil adjustment thrust using a patient simulation device capable of recording the thrust force and displacement."	"This study has demonstrated that considerable variability (intrarater and interrater) exists in the force and displacement generated by practitioners using the toggle recoil high velocity SMT procedure. Furthermore, this variability is apparent when an individual practitioner performs the procedure over multiple occasions."

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
DeVocht et al (2013)[5]	15/29 (Downs and Black)	2a	Prospective Cohort Study	"To examine the force-time profiles of toggle recoil using an instrumented simulator as a way to objectively measure and evaluate students' skill to determine if they become quicker and use less force during the course of their training and to compare them to course instructors and to field DCs who use this specific technique in their practices."	"As students progressed through the class, velocity reduced as they increased control to lower peak loads. In the group studies, field DCs applied higher forces and were faster than both students and instructors."
Descarreaux et al (2006)[6]	7/11 (PEDro Scale)	1b	RCT	"To compare the performance of two groups of chiropractic students, one receiving traditional training from experienced instructors, and the other, augmented feedback on specific biomechanical aspects of SMT (spinal manipulation therapy) using an instrumented manikin."	"The instrumented manikin providing augmented feedback is certainly as valuable as standard training and even more efficient for specific biomechanical parameters of spinal manipulation." Efficiency was measured by using peak force, preload force, peak force variability, downward incisural point, time to peak force, and hand-body delay.
Pringle et al (2004)[7]	7/11 (PEDro Scale)	1b	RCT	"To determine the effects of various amounts of knowledge of results (KR) on learning a novel skill that is frequently taught in chiropractic for the assessment of vertebral motor unit dysfunction."	"This study demonstrates the utility of motor learning theory in the development of critical motor skills in chiropractic. Simple novel skills are retained better when feedback is intermittent." Each group was given different amounts of verbal feedback (ex. once, twice, four times, or during every one of the twelve trials). Twice and four times were considered intermittent.
Chang et al (2007)[8]	7/11 (PEDro scale)	1b	RCT	"Investigate whether quantitatively augmented feedback could enhance the learning of joint mobilization and more specifically, to compare the effects of training with concurrent or terminal feedback by using a joint translation simulator (JTS)."	"Practice conditions with both concurrent and terminal feedback were more effective for learning joint mobilization tasks, as measured during skill acquisition and retention tests, than the condition without augmented feedback."

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Enebo et al (2005)[9]	18/29 (Downs and Black)	2a	Prospective Cohort Study	"To address some of the current limitations present in teaching HVLA spinal manipulation, specifically evaluating experience level, practice variability, feedback, and force variability."	"(Practical) Familiarity and practice with HVLA spinal manipulation were associated with greater accuracy of peak force production compared with less experienced participants." "Practicing a manipulative procedure with different force magnitudes may assist performance and retention through the creation of contextual interference." "The acquisition of HVLA spinal manipulation was enhanced with blocked variable practice compared with random variable practice." But, random practice also had its benefits including better short-term retention.
Harvey et al (2011)[10]	18/29 (Downs and Black)	2a	Prospective Cohort Study	"To quantify the HVLA spinal manipulation biomechanical parameters of two cohorts of students in two different teaching institutions."	"Overall, the results of the present study suggest that a specific and constant regimen of spinal manipulation skill practice seems to promote a refined motor execution." This regimen involves exposing students early on to spinal manipulation with thrust and having them practice on their colleagues.

Best Evidence

- Downie AS, Vemulpad S, Bull PW. Quantifying the high-velocity, low-amplitude spinal manipulative thrust: A systematic review. *J Manipulative Physiol Ther*. 2010;33(7):542-553. doi:10.1016/j.jmpt.2010.08.001.
- Chang J-Y, Chang G-L, Chang Chien C-J, Chung K-C, Hsu A-T. Effectiveness of two forms of feedback on training of a joint mobilization skill by using a joint translation simulator. *Phys Ther*. 2007;87(4):418-430. doi:10.2522/ptj.20060154.
- Descarreaux M, Dugas C, Lalanne K, Vincellete M, Normand MC. Learning spinal manipulation: The importance of augmented feedback relating to various kinetic parameters. *Spine J*. 2006;6(2):138-145. doi:10.1016/j.spinee.2005.07.001.

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5. DeVocht JW, Owens EF, Gudavalli MR, Strazewski J, Bhogal R, Xia T. Force-time profile differences in the delivery of simulated toggle-recoil spinal manipulation by students, instructors, and field doctors of chiropractic. *J Manipulative Physiol Ther*. 2013;36(6):342-348. doi:10.1016/j.jmpt.2013.05.027.
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Repetition and Body Control

- **Clinician's Control of Self and Patient Movement**

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Summers et al (1993)[11]	16/29 (Downs and Black)	2a	Prospective Cohort Study	"To propose a model for how subjects could perform specified polyrhythms with a hierarchical timing system."	"When the two hands are required to move in a clearly defined metric structure, cognitive strategies can override lower level oscillatory mechanisms. The fact that musically trained subjects did not exhibit such a strong tendency toward an antiphase (180° difference in movement phase) relation for between-hand responses as nonmusicians is consistent with the view that central control may be exerted over lower level mechanisms." These findings suggest training/practice help to control coordinated movements.
Swinnen et al (1993)[12]	12/29 (Downs and Black)	2a	Prospective Cohort Study	"To gain information (a) about the way learners cope with preexisting co- ordination tendencies that give rise to persistent errors in performance; (b) about the extent to which these tendencies can be overcome with practice; and (c) about the way the learning environment needs to be organized to accomplish these goals, in particular the role of various sources of augmented information feedback in acquiring new patterns of interlimb coordination."	"The findings of all three experiments suggest that mutual interactions were evident between the limbs, despite the de- tailed information feedback that was provided to the subjects." "The present study underscores the viewpoint that motor learning requires overcoming the limitations imposed by preexisting (preferred) patterns. In other words, abandoning preferred coordination modes is often a prerequisite for acquiring new coordination patterns."

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Carson et al (1995)[13]	14/29 (Downs and Black)	2a	Prospective Cohort Study	"To examine in greater detail the system introduced by Baldissera et al. in an attempt to identify candidate order and control parameters and determine whether instabilities, and signature features of nonequilibrium phase transitions, such as critical fluctuations, would be exhibited as oscillation frequency was systematically manipulated."	"The stability of the movement patterns was determined by spatial (dependent on the direction of movement) rather than anatomical (dependent on the coupling of specific muscle groups) constraints."
Serrien et al (2001)[14]	13/29 (Downs and Black)	2a	Prospective Cohort Study	"The present study addressed the question to what extent grip-load force coupling diverges in a bimanual action with two hand-held objects vertically moved according to the in-phase versus anti-phase mode."	"During bimanual activities, in-phase patterns involving activation of homologous muscles are generally performed more successfully than anti-phase patterns (180° difference in movement phase) which require activation of non-homologous muscles."
Salesse et al (2005)[15]	13/29 (Downs and Black)	2a	Prospective Cohort Study	"To investigate the role of muscle-dependent constraints on hand–foot coordination in more detail by comparing, for the first time to our knowledge, coordination modes involving different patterns of muscle activation with a focus on the nature of the neuro-muscular coupling."	"Directional constraints play a principal role in the stability of coordination between the upper and lower limbs." "The present study also shows that visual information of the moving limbs modulates pattern stability and accuracy."
Smethurst et al (2003)[16]	6/11 (PEDro scale)	1b	RCT	"To compare the stability characteristics of bimanual coordination under two different instructional sets (i.e., do not intervene and stay). Specifically, we sought to determine how different instructional sets, representing distinct intentional states, influence the time at which transitions occur."	The intention to persist with an antiphase pattern of coordination as movement frequency was scaled did not influence the time at which a phase transition occurred but did influence the nature of the posttransition behavior. Generally, when participants were instructed to stay with the antiphase pattern, transition from antiphase to phase wandering occurred.

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Smethurst et al (2001)[17]	19/29 (Downs and Black)	2a	Prospective Cohort Study	"We examined how learning affected the production and dynamic stability of two bimanual coordination tasks corresponding to a 90° out-of-phase pattern (the to-be-learned task) and a 270° out-of-phase pattern (transfer task). The performance of these patterns was paced using an auditory signal that increased in frequency."	"Practice increases the stability of a to-be-learned coordination pattern. This is reflected in an increased tolerance to frequency induced transitions. The changes are also reflected in a transfer task that is symmetrically opposite of the to-be-learned task."
Temprado et al (2007)[18]	16/29 (Downs and Black)	2a	Prospective Cohort Study	"The present work investigated the effects of spatial and neuromuscular constraints on the mean states and variability of bimanual coordination patterns performed in the para-sagittal plane of motion during a hand-held pendulum oscillation task."	"Results showed that forearm posture changed the expression of muscular coupling on pattern stability. Indeed, patterns involving non-homologous muscular coupling were less stable than patterns involving homologous muscular coupling in the dissimilar forearm posture condition. These results are consistent with those observed in previous studies on bimanual coordination."
Kovacs et al (2003)[19]	17/29 (Downs and Black)	2a	Prospective Cohort Study	"To determine if participants … could effectively tune in (produce) a continuous 5:3 bimanual coordination pattern after 10 min of practice, and then without additional practice transfer the acquired skill to a 4:3 bimanual pattern."	"Remarkably, participants effectively tuned in the continuous 5:3 coordination pattern after 10 min of practice, and then on the first attempt re-tuned to the unpracticed 4:3 coordination pattern."
Boyles et al (2012)[20]	18/29 (Downs and Black)	2a	Prospective Cohort Study	"To determine whether multi-frequency continuous bimanual circling movements of varying difficulty (1:2. 2:3, 3:4, and 4:5) could be effectively performed following relatively little practice when on-line continuous relative velocity feedback is provided."	"Salient perceptual information can override some aspects of the system's intrinsic dynamics, which have typically linked to motor output control. Given integrated visual information and a clear goal participants can with little practice essentially tune-in complex multi-

					frequency bimanual coordination patterns.”

Best Evidence

- Smethurst CJ, Carson RG. The effect of volition on the stability of bimanual coordination. *J Mot Behav*. 2003;35(3):309-319. doi:10.1080/00222890309602143.
- Temprado JJ, Salesse R, Summers JJ. Neuromuscular and spatial constraints on bimanual hand-held pendulum oscillations: Dissociation or combination? *Hum Mov Sci*. 2007;26(2):235-246. doi:10.1016/j.humov.2007.01.012.
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20. Boyles J, Panzer S, Shea CH. Increasingly complex bimanual multi-frequency coordination patterns are equally easy to perform with on-line relative velocity feedback. *Exp Brain Res*. 2012;216(4):515-525. doi:10.1007/s00221-011-2955-x.

Expertise and Discriminate Touch

- **Discriminate Touch**

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Abbott et al (2009)[21]	16/29 (Downs and Black)	5	Descriptive Study/Survey	"To (1) establish what manual physical therapists are intending to assess while applying passive intervertebral motion tests; and (2) examine the face validity and content validity for manual physical assessment of the spine."	"Manual physical therapists attribute moderate to strong face validity to manual passive assessment techniques, both for assessing spinal segmental motion and as a basis for determining what type of intervention is indicated."
Billis et al (2003)[22]	20/29 (Downs and Black)	2a	Prospective Cohort Study	"To investigate reproducibility and repeatability of physiotherapists in locating three spinal levels (one cervical, one thoracic and one lumbar) by palpation"	"The research indicated that physiotherapists have fairly poor reproducibility and good repeatability in locating C5, T6 and L5 spinous processes by palpation. The reproducibility data demonstrated that students were less consistent than clinicians and MTs in palpation, whereas there were no differences between clinicians and MTs."
Chiradejnant et al (2003)[23]	19/29 (Downs and Black)	2a	Prospective Cohort Study	"To evaluate a revised version of the reference-based protocol that standardized more of the factors known to affect measured and perceived stiffness."	"Therapists can accurately judge asymptomatic subjects' spinal stiffness using a matching task. We believe that this method may allow objective assessment of PA spinal stiffness in clinical practice."
Harlick et al (2007)[24]	19/29 (Downs and Black)	2b	Quasi-Experimental, Cross-Sectional Study	"To use standard two-dimensional (2-D) X-ray investigation of radiologically opaque, palpated surface points to determine the lumbar SP palpation accuracy of a sample of manipulative physiotherapists."	"It appears that between therapist variability has a greater effect on accuracy than any patient defined factor." "The manipulative physiotherapists used in this study appear to be moderately successful in either palpating a nominated SP or being no more than one spinal level in error."

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Kasparian et al (2015)[25]	19/29 (Downs and Black)	2a	Prospective Cohort Study	"We tested the ability of foreign-trained osteopaths and nonosteopaths to detect controlled motions of 10 to 1000 μm amplitude using a mechanical setup. We hypothesized that motions in the range of tens of micrometers can effectively be detected by passive palpation, with or without osteopathic training."	"The data show human passive palpatory sensitivity to be in the range of several tens of micrometers. This range is comparable to that reported for calvarial motion (10-50 μm). One-third of our sample was able to detect a movement smaller than 50 μm."
Nicholson et al (2003)[26]	20/29 (Downs and Black)	2a	Prospective Cohort Study	"To determine the discrimination threshold for viscous stiffness using a posteroanterior pressure technique, such as that used by manual therapists when assessing the stiffness of the lumbar spine, and with viscosity test values like those estimated to characterize the human spine."	"Poor reliability of manual judgments of spinal stiffness may be due to the difficulty in judging the viscous stiffness component."
Maher et al (1998)[27]	19/29 (Downs and Black)	2a	Prospective Cohort Study	"To evaluate the interrater reliability of measurements obtained with 2 new PA spinal stiffness rating methods and (2) to evaluate the criterion-related validity of these ratings."	"The results of this study show that physical therapists can judge the magnitude of stiffness stimuli (provided by metal springs). Their judgments are reliable and correlate with the measured stiffness magnitude."
Karadogan et al (2010)[28]	18/29 (Downs and Black)	2a	Prospective Cohort Study	"To design and perform an experiment to test the ability of individuals to discriminate stiffness differences; (2) to analyze the palpation forces during palpation; and (3) to analyze palpation speed during haptic exploration."	"Higher speed is related to lower sensitivity in discrimination of stiffness differences for these two standard stiffness values. Our results are applicable to tasks involving stiffness discrimination between multiple objects."

Author (Year)	Study Quality Score	Level of Evidence	Study Design	Purpose of the Study	Key Findings/Conclusions
Van Trijffel et al (2010)[29]	13/29 (Downs and Black)	5	Qualitative Interview Study	"To explore why and how MPTs use PIVM assessment within their clinical reasoning and decision-making. We hypothesized that its results could help guide the design and conduct of future studies into manual diagnostics leading to improved external validity of research results."	"This study has identified the specific role and position of PIVM assessment as related to other clinical findings within clinical reasoning and decision- making in manual physical therapy in The Netherlands."
Povoa et al (2015)[30]	9/11 (AMSTAR)	1a	Systematic Review	"The aim of this study was to perform a systematic review of the validity of palpatory procedures for evaluation of anatomical bone landmarks of the cervical spine."	"The 5 studies that were found showed fair to good methodological quality." There were many confounding variables in the studies researched.

Best Evidence

- Povoa LC, Ferreira APA, Silva JG. Validation of palpatory methods for evaluating anatomical bone landmarks of the cervical spine: A systematic review. *J Manipulative Physiol Ther*. 2015;38(4):302-310. doi:10.1016/j.jmpt.2015.04.002.
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