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Editorial Staff

The minimum energy hypothesis: A unified model of fixation resolution.

Joseph Evans, PhD, C. Ray Hill, PhD, Robert Leach, DC, and Daniel Collins, DC

Objective: To present a new theoretical construct, the minimum energy hypothesis, which explains structural changes observed in the spine concomitant to spinal joint fixation resolution in initial investigations.

Design: Theoretical analysis.

Hypothesis: A unified theory of manipulative effectiveness is proposed which integrates the fixation and sensory tonus models of manipulation. The theory is based on the fact that the spine will assume a position of minimum internal energy when mechanical equilibrium is achieved. Using a simple mathematical model, it is shown that the fixation model and the sensory tonus models are two different aspects of the same theoretical construct. The minimum energy hypothesis predicts that the spine will seek an optimal minimum energy configuration, if the constraints preventing it from doing so are removed. Constraints are hypothesized to be joint fixations caused by inflammation in and about the spine and its sequella, muscle spasm, fibroadipose and scar tissue, and ultimately degeneration. It is further hypothesized that use of a computerized mechanical manipulative device may resolve such fixations, an example of which is radiographically demonstrable cervical hypolordosis.

Conclusion: A unified theory of manipulative effectiveness based on the concept of minimum energy to attain mechanical equilibrium is brought forward to explain the results of initial investigations.

Key Indexing Terms: chiropractic manipulation; compliance; spine.

Certification examinations for massage therapists: A psychometric analysis.

Claudio Violato, PhD, Lanree Salami, MD, and Sylvia Muiznieks

Objective: To describe the components of the Alberta Registered Massage Therapists Society (ARMTS) examinations and their psychometric properties.

Method: All three components of the ARMTS examinations (knowledge, clinical judgment, clinical skills) were administered to 112 candidates. The examinations consisted of two pencil-and-paper components: 1) a knowledge exam of 140 multiple choice questions on the basic sciences, and clinical judgment - 60 MCQs); and 2) a clinical competency exam assessing practical skills using standardized patients: i) taking a case history, ii) assessing physical conditions, and iii) treatment of the condition. All of these exams were criterion-referenced using the methods of minimum

performance level (MPL).

Results: The internal consistency reliability coefficients (Cronbach's alpha) ranged from .60 to .88 for all test components. The descriptive statistics, performance levels, and reliability estimates indicated that the exams are functioning well. Concurrent, criterion-related validity evidence was provided by correlations between the exam components that ranged from $r = .24$ ($p < .05$) to $r = .78$ ($p < .01$). Factor analysis produced three factors: 1) information processing, 2) clinical treatment, and 3) follow-up management.

Conclusions: The results provide evidence of adequate to good internal consistency reliability and content validity. Empirical validity evidence based on concurrent, criterion-related measures is provided by the correlational analysis. The significant correlations indicate that while performance is related across the exams, the various measures do assess unique and independent domains. This is further supported by the results of the factor analysis that provided evidence for discriminant validity of the measures (i.e., they discriminate between domains of measurement such as information processing, treatment and basic knowledge). Taken together, these results indicate that the ARMTS examinations have evidence for both reliability and validity.

Key Indexing Terms: clinical competency; psychometrics; certification testing.

Effectiveness of a selected bedding system on quality of sleep, low back pain, shoulder pain, and spine stiffness.

Bert Jacobson, EdD, FACSM, Hugh Gemmell, DC, EdD, Brad Hayes, DC, and Thomas Altena, MA

Objective: To determine if clinical and statistically significant changes in back pain, shoulder pain, spine stiffness, and quality of sleep may be documented following use of a prescribed bedding system.

Design: Quasi-experimental field study with single group pre-test/post-test design with subjects serving as their own controls.

Setting: Two chiropractic clinics and University Program of Health and Human Performance.

Subjects: Convenience sample of 22 subjects (women, $n=13$; men, $n=9$) between the ages of 25 and 75 years with documented disturbed sleep, shoulder pain, low back pain, and spine stiffness of a chronic nature.

Outcome Measures: Pre- and post 28-day visual analog scales for pain, spine stiffness, and quality of sleep.

Main Results: The experimental bedding system reduced back pain by 57.21%, $p=.000001$; reduced shoulder pain by 60.83%, $p=.000005$; reduced back stiffness by 59.12%, $p=.000004$; and improved quality of sleep by 60.73%, $p=.000001$.

Conclusion: Results suggest that subjects obtain significant improvement in shoulder and back pain, back stiffness, and quality of sleep when comparing 28 days of personal bedding use to 28 days of the prescribed bedding system. Female subjects and those with less body weight were more likely to significantly improve than heavier and more obese subjects.

Key Indexing Terms: mattress; back pain; shoulder pain; spine stiffness.

Evolution of foot orthotics - Part 1: Coherent theory or coherent practice?

Kevin Arthur Ball, PhD, and Margaret Afheldt

Objective: To present a critical review of the evolution of foot orthotics theory and clinical practice.

Data Sources: Several classic publications were consulted. Given its overwhelming influence, the work of Root and colleagues from the 1970's was carefully examined. Careful evaluations were performed to determine how faithfully Root's central concepts were subsequently followed. Studies attempting to validate this and other orthotic paradigms were also reviewed.

Results: Epidemiological studies provide strong support for the clinical advantages of orthotics, yet explanations of foot orthotic mechanisms remain elusive. Considerable variability has crept into the literature with respect to Root's core theoretical concepts of how and why to determine the neutral position of the subtalar joint (weightbearing vs. nonweightbearing, palpation vs. range-checking). Numerous studies document poor clinical reliability and validity, indeed, this paradigm appears to favor supination (thereby violating its "neutral" premise). Mechanisms other than those of the classic Root theory must be at work. Accordingly, successes have been achieved using alternate paradigms that employ much simpler casting techniques. While less frequently expounded upon, successes have been gained using various viscoelastic materials to enhance shock-absorption/proprioception, and custom-made flexible orthotic designs that emphasize the three natural arches of the foot.

Conclusions: Orthotics use is well documented for the treatment of many maladies, yet clinical successes have been achieved both inside and outside of the classic Root paradigm. Clearly, a more complete theoretical understanding of the mechanisms of orthotics awaits further discovery.

Key Indexing Terms: biomechanics; orthotics; foot; ankle; subtalar joint.

Evolution of foot orthotics - Part 2: Research reshapes long-standing theory.

Kevin Arthur Ball, PhD, and Margaret Afheldt

Objective: To examine understanding of the causal mechanisms of foot orthotics use. While the classic orthotic paradigm of Root and colleagues is often acknowledged, the research attempting to explain and validate these mechanisms is far less clear in its appraisal.

Data Sources: Studies evaluating the relationships between foot type classification (medial arch height) and/or the use of foot orthoses upon the motions of the foot and ankle were compared and contrasted. A search was conducted to evaluate other possible mechanisms of orthotics intervention.

Results: While Root's methods of foot evaluation (subtalar neutral position) and casting (nonweightbearing) are well referenced, these methods suffer from poor reliability, unproven validity, and in fact are seldom strictly followed. We challenge two widely held concepts: that excessive foot eversion leads to excessive pronation, and that orthotics provide beneficial effects by controlling rearfoot inversion/eversion. Numerous studies demonstrate that patterns of rear foot inversion/eversion cannot be characterized either by foot type or by orthotics use. Rather, subtle control of internal/external tibia rotation appears to be the most significant factor in maintaining proper supination/pronation mechanics. Recent evidence also suggests that proprioceptive

influences play a large, and perhaps largely unexplored, role.

Conclusions: Considerable evidence supports the exploration of new theories and paradigms of orthotics use. Investigations of flexible orthotic designs, proprioceptive influences, and the 3-D effects of subtalar joint motion upon the entire kinetic chain are areas of research that show great promise.

Key Indexing Terms: biomechanics; orthotic devices; foot and ankle; subtalar joint.

Incidence of foot rotation, pelvic crest unleveling, and supine leg-length alignment asymmetry, and their relationship to self-reported back pain.

Gary Knutson,DC

Purpose: To determine the incidence of pelvic unleveling, foot rotations and supine leg length alignment asymmetry in a nonclinical population, and examine the validity (sensitivity, specificity, positive and negative predictive values) of these visual tests and their relationship with self-reported back pain.

Design: Volunteers answered a questionnaire regarding back pain and were then examined by a chiropractor unaware of their back pain status.

Participants: Seventy-four unscreened volunteers.

Main Outcome Measures: The association of visual tests with back pain and their validity indices based on visual analogue pain scale ratings.

Results: 51% (n=74) of volunteers examined had supine leg length alignment asymmetry (LLA). Pain intensity on a visual analogue scale of those demonstrating supine LLA was significantly higher ($p<0.001$) than those without LLA. Those with back pain and recurrent back pain were significantly ($p<0.001$) more likely to have supine LLA. The validity indices of the supine leg check showed acceptable levels for sensitivity (87%), specificity (84%), and positive (73%) predictive value in recurrent back pain. Findings also indicate a high incidence of supine LLA in subjects with chronic back pain (85%).

Conclusion: The results indicate that, in this group of subjects, the supine leg length alignment check had clinical validity as a stand-alone test for recurring back pain. Further testing on a larger, statistically defined cross-section of the population is recommended.

Key Indexing Terms: leg length inequality; chiropractic; back pain; incidence; validity.

Crossed ICCs for lateral posterior tangents and AP modified Risser-Ferguson.

Deed Harrison,DC, Burt Holland,PhD, Donald Harrison,PhD, DC,MSE, and Tadeusz Janik,PhD

Objectives: To determine if the newly derived ICCs would overstate or understate two previously published results that had used better known ICCs that assume nested factors, and to determine mean absolute differences of observers' measurements for three previous studies.

Study Design: Retrospective analysis of data from two blind, repeated-measure designed studies. Two newly derived correlation coefficients (ICCs), appropriate to situations with three random

factors (patients, examiners, and occasions) that bear a crossed (as opposed to nested) interrelationship, were applied to data from an experiment with random crossed factors.

Main Outcome Measures: Observer reliability is determined with intra- and interclass correlation coefficients, 95% confidence intervals, and observer error analysis (mean absolute differences of observers' measurements) for angles and distances derived from Harrison's modified Risser-Ferguson line drawing method on AP lumbar and AP cervical radiographic views. Observer error analysis for angles and distances derived from Harrison's posterior tangent method on lateral cervical views was also determined.

Results: The majority of ICCs for reliability of line drawing on both AP cervical and AP lumbar radiographs were in the high range, 13 of 16 ICCs were greater than 0.88. The other three ICC values (0.61, 0.76, 0.78) determined the sacral base on AP lumbar views. The new ICCs underestimated observer reliability compared to previously published results (intraclass ICCs lower by 0.01-0.02 and interclass ICCs lower by 0.03-0.10). For an error analysis on data from both AP views, the mean absolute differences of observers' measurements were 1.1° -1.8° for angles and 1.2mm - 2.3mm for distances. For the lateral cervical analysis, the observer error was in the interval (0.8° -3.2°) for angles and less than 1 mm for distances.

Conclusions: The ICCs assuming random crossed factors understate reliability compared to previously published ICC results assuming nested factors. Reliability of the Harrison modified Risser-Ferguson method of line drawing analysis on AP views is in the high range, with the majority of ICCs > 0.88. For both the Harrison modified Risser-Ferguson method on AP views and posterior tangent method on lateral cervical views, the mean absolute differences of observers' measurements are small.

Key Indexing Terms: lumbar vertebrae; cervical vertebrae; reliability; x-ray.

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