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Review

The basis for spinal manipulation: Chiropractic perspective of indications and theory

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ABSTRACT

It is reasonable to think that patients responding to spinal manipulation (SM), a mechanically based therapy, would have mechanical derangement of the spine as a critical causal component in the mechanism of their condition. Consequently, SM practitioners routinely assess intervertebral motion, and treat patients on the basis of those assessments.

In chiropractic practice, the *vertebral subluxation* has been the historical raison d'etre for SM. Vertebral subluxation is a biomechanical spine derangement thought to produce clinically significant effects by disturbing neurological function. This paper reviews the putative mechanical features of the subluxation and three theories that form the foundation for much of chiropractic practice. It concludes with discussion of subluxation as an indicator for SM therapy, particularly from the perspective that subluxation may be one contributory cause of ill-health within a "web of causation".

1. Introduction

It is reasonable to think that patients responding to spinal manipulation (SM), a mechanically based therapy, would have mechanical derangement of the spine as a critical causal component. Consequently, SM practitioners routinely assess intervertebral motion, and treat patients on the basis of those assessments (Abbott et al., 2009; Hengeveld et al., 2005; van Trijffel et al., 2010; Leach, 2004).

In chiropractic practice, the *vertebral subluxation* has been the historical raison d'etre for SM. Vertebral subluxation (or simply "subluxation") is a biomechanical spine derangement thought to produce clinically significant effects by disturbing neurological function (Henderson, 2005b; Triano, 2005). Joint misalignment may be determined by palpation or radiographic examination, but it is substantially less than that seen with a luxation (dislocation). This minimal joint misalignment was the first reported characteristic of subluxation, and hence the origin of the term. Given the semantic link to the term luxation, it is sometimes confusing to clinicians that subluxations are mechanically characterized by hypomobility, rather than the hyper-mobility observed with luxations. In addition, the biomechanical features characterizing the subluxation are subtle, lacking the gross mechanical disruption and manifest microanatomical ligamentous and capsular discontinuities that are common to luxation.

Chiropractic perspective is an evolving synthesis of historical chiropractic thought, clinical observations, and research. In this paper, I introduce the historical origins of chiropractic, review putative mechanical features of subluxation as it relates to three foundational theories of chiropractic practice, and present related research. I conclude with a discussion of subluxation as an indicator for spinal manipulation.

2. Biomechanical features of the vertebral subluxation

D.D. Palmer, the originator of chiropractic, considered vertebral misalignment to be the hallmark feature of subluxation (Palmer and Palmer, 1906). However, Smith et al., early chiropractic practitioners, educators, and publishers of the first chiropractic textbook, asserted that intervertebral hypomobility, not misalignment, was subluxation's cardinal feature (Smith et al., 1906). This contrasting mechanistic emphasis, intervertebral misalignment vs. hypomobility, formed the basis for a heated polemic. It was maintained by B.J. Palmer, the son of D.D. Palmer, a contemporary of Smith et al., and the most widely acknowledged pioneer developer of chiropractic. B.J. vigorously supported D.D. Palmer's original assertion that vertebral misalignment was the critical feature of subluxation (Palmer, 1934). Although both misalignment and hypomobility are currently recognized as biomechanical features of subluxation, hypomobility has garnered much more attention in recent years. In addition, chiropractors appreciate that vertebrae may be hyper-mobile. Intervertebral hyper-mobility may result from frank

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trauma, advanced connective tissue pathology, or as a mechanical compensation to intervertebral hypomobility.

2.1. Intervertebral hypomobility

Patients reporting headache, neck, back, or limb pain often have demonstrable altered spine mobility (Fernandez-de-las-Penas, 2009; Langevin and Sherman, 2007; Ssavedra-Hernandez et al., 2011; Triano, 2005; Zito et al., 2006). And, intervertebral hypomobility has been identified as a key prognostic factor in studies developing clinical prediction rules for neck pain (Puentedura et al., 2011; Raney et al., 2009; Ssavedra-Hernandez et al., 2011), headache (Fernandez-de-las-Penas et al., 2011), and low back pain (Childs et al., 2004; Cleland et al., 2009; Fritz et al., 2011). In early studies, intervertebral hypomobility was implicated as a clinically important factor in neck pain. For example, Norlander and Nordgren (1998) conducted a cross-sectional study of 142 male and 139 female workers to evaluate the influence of segmental mobility in neck-shoulder pain (Norlander and Nordgren, 1998). They observed reduced relative mobility at levels C7–T1 and T1–T2 and reported that it was a significant predictor of neck-shoulder pain. In their study, reduced mobility explained 14% of neck-shoulder pain ($r^2 = 0.14$, $p < 0.001$) and 15% of weakness in the hands ($r^2 = 0.15$, $p < 0.001$).

In a recent randomized clinical trial examining the predictive validity of manual, posterior–anterior mobility testing in 131 low back pain patients, Fritz et al. reported finding both hypomobile and hyper-mobile lumbar segments, with a prevalence of 71% and 12% respectively (Fritz et al., 2005). And, in a study of 607 women working as homecare personnel, it was reported that a combination of positive pain provocation tests and reduced lumbar sagittal mobility was associated with particularly high disability levels (Lundberg and Gerdle, 2000). Finally, in 30 human spine specimens, investigators examined the effect of degenerative changes in lumbar discs on intervertebral mobility (Thompson et al., 2000). They reported that degenerative spine changes are associated with intersegmental hypomobility, even when the individuals have no history of low back pain complaints.

This conclusion highlights a well known clinical paradox; the severity and disability of neck and back pain do not correspond to the degree of spinal degeneration observed with plain film radiography (Gore et al., 1986; van Tulder et al., 1997; Witt et al., 1984) or the presence and magnitude of disc herniations demonstrated with discograms (Holt, 1968; Walsh et al., 1990), myelograms (Hitselberger and Witten, 1968), computerized tomography scans (Wiesel et al., 1984), or magnetic resonance images (Boden et al., 1990; Borenstein et al., 2001). Researchers have observed a high incidence (24–37%) of abnormal findings on advanced imaging studies in patients that have never had low back pain or sciatica (Boden et al., 1990). Boden et al. found that 57% of individuals sixty years old or older had degenerative spine problems (21% had intervertebral foramen stenosis and 36% had one or more herniated discs) (Boden et al., 1990). Similarly, a 7-year follow-up study on a group of 67 individuals who were asymptomatic with no history of back pain at an initial MRI, demonstrated that MRI had no predictive value in forecasting the development or duration of low back pain. This finding was underscored by the observation that 21 (31%) of these individuals had an identifiable disc or spinal canal abnormality in the initial MRI (Borenstein et al., 2001). The effect of this clinical paradox on current research efforts is discussed in the final section of this paper.

2.2. Intervertebral hyper-mobility

Hyper-mobile spine segments are not primary therapeutic targets for chiropractic SM (Peterson and Gatterman, 2005). But, compensatory (secondary) intervertebral hyper-mobility may occur as a mechanical response to hypomobility in other spine segments. In the spine literature, this is often described as a component of "adjacent segment disease," which may be observed after spine fusion or with rigid and semirigid spine instrumentation (Cakir et al., 2009; Panjabi et al., 2007; Shono et al., 1998). This mechanism has been directly observed in intervertebral hypomobility studies with the External Link Model in my lab (Fig. 1, unpublished observation). Similarly, it may occur as a compensatory response to physiologically developed intervertebral hypomobility (DeStefano and Greenman, 2011; Lewit, 2010). Chiropractors treat compensatory intervertebral hyper-mobility with SM directed to hypomobile spine segments, often with adjunctive active stabilization exercise programs (Hicks et al., 2005; Peterson and Gatterman, 2005).

2.3. Intervertebral dyskinesia

Intervertebral mobility is often discussed as if the articulation between two vertebrae comprised a single normally mobile, hypomobile, or hyper-mobile joint. This is the simple mechanistic approach presented above. In actuality, intervertebral articulations are quite complex, being composed of synovial joints, a symphysis (with the notable exception of C1–C2), and a compound syndesmosis (Cramer and Darby, 2005). Consequently, clinicians and spine researchers observe that a given intervertebral articulation may be hypomobile on one side and normally mobile, or hyper-mobile on the contralateral side.

Some chiropractic scholars suggest that features other than misalignment or hypomobility characterize a subluxation. Perhaps the quality, rather than the quantity, of intervertebral motion is modified with a resulting loss of load bearing efficiency (Enebo and Gatterman, 2005). Triano notes that the spine tissues are dependent on regular movement to retain their integrity (Triano, 2005). Immobility, sustained or excessive loading, and repetitive loads may all lead to tissue changes and failure under subsequent loads. Prolonged static postures, even without additional loads, become uncomfortable because of tissue deformation (creep) with concentration of local tissue stresses. Concomitant muscle fatigue is thought to aggravate this situation by altering muscle recruitment patterns and redistributing loads to auxiliary muscles and ligaments. Consequently, load bearing efficiency is lost with an increase in the magnitude of coupled motions and an increased likelihood of injury.

It is increasingly suggested by SM therapists that a synovial joint may demonstrate normal range of motion but have aberrant motion within the joint's motion-path and distorted coupled motion patterns (Abbott et al., 2009; Enebo and Gatterman, 2005; Lund et al., 2002). As a result of the complex intervertebral articulation, as well as paraspinal muscle activity, coupled motions are known to occur throughout the spine (Cholewicki et al., 1996; Panjabi et al., 2001; Steffen et al., 1997). Many SM therapists incorporate the concept of coupled motion into their therapeutic rationale. However, the clinical implications of coupled intersegmental motions is presently unclear. A recent critical review of the literature examined 24 articles on coupled motion in the lumbar spine, but found little agreement concerning its specific characteristics or correlation with back pain (Legaspi and Edmond, 2007).

Lastly, two new kinematic phenomena have garnered increasing interest in the manual therapy community. These are "spine buckling" and the notion of a dynamically changing "neutral zone" existing within the range of motion of any given synovial joint. Buckling is the rapidly developing spine instability characterized by sudden bending under loads that are far lower than those required to disrupt the connective tissues of the multijoint, multimuscle spinal column. It is thought to result from a failure to