Imaging Technology and Somatic Dysfunction Theory

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Somatic dysfunction theory and related palpatory findings have not changed meaningfully since the founding of the osteopathic medical profession. However, as imaging technology evolves, prevailing assertions concerning the validity of somatic dysfunction theory and palpatory findings will no doubt be under increased scrutiny, resulting in substantial changes. In the current article, I present and discuss imaging data derived from studies using various imaging modalities and explain how these data predict the changes to osteopathic physicians' understanding of somatic dysfunction.

Somatic Dysfunction Theory

The presence of somatic dysfunction (formerly called an *osteopathic lesion*) is the main indication for manipulative treatment.[1] By using palpation or joint motion testing, practitioners can determine the appropriate manipulative forces for treating somatic dysfunction. Somatic dysfunction of an intervertebral joint is expressed as an abnormal motion pattern or abnormal positioning of the joint constituents. The position and motion aspects of somatic dysfunction have the following 3 components: forward or backward bending, sidebending (left or right), and rotation (left or right). With little exception, the motion aspect is one of loss rather than excess. The appropriate manipulative procedure would reverse the positional abnormalities or restore lost motion.

Validity of Palpatory Data

The relative positions and mobility of the spinous and transverse processes of the vertebrae in question are important cues to determine whether somatic dysfunction is present. Although varying importance may be attributed to palpating bony vs soft tissue structures among different practitioners (ie, osteopathic physicians, foreign-trained osteopaths, and others who practice manipulative therapy), it is not possible to bypass soft tissue to reach bony processes. Because these structures may be several inches below skin level (in my practice, I have commonly observed 4 inches below skin level in muscular adult men during back surgery, and sometimes more in cases of obesity), the question of the reliability of palpatory information, motion testing, and interexaminer reliability logically arises. Practitioners who have a high regard for their sensory prowess may not question their palpatory abilities. Anecdotes abound in which certain practitioners have been able to localize a hair lying on a table through a thick telephone directory. Practitioners who have some doubt concerning their sensory abilities may be more comfortable if their impressions are confirmed by a colleague. Still others remain doubtful despite confirmation by 1 or more colleagues—they all could be wrong in a given case. With more recent advances in imaging technology, it is possible to clarify some of these issues.

Regarding assessment of the linear and angular range of motion for each of the 3 components of a given case of somatic dysfunction, the distance of an examiner's palpating finger or thumb from the center of intervertebral movement would be a crucial factor. The question of the validity of palpatory assessment was partly addressed by a 1962 study[2] that measured the distance between the spinous process and the approximate center of the corresponding vertebra at every level of 13 adult spines. The study revealed the level of magnitude of the linear excursions (given the angular excursions) with which a manipulator would be dealing. Answers to the question of the validity of palpatory examination for somatic dysfunction would be relevant in determining whether somatic dysfunction does or can occur in the manner conventionally declared. Such answers would also have a bearing on the validity of the examinations used and on the validity of interexaminer reliability.

Data From Imaging Studies

Three-Dimensional Computed Tomography and Magnetic Resonance Imaging

In a kinematic study[3] of the thoracic spine in 13 healthy volunteers using 3-dimensional computed tomography (CT), axial rotation at the T5 and T6 vertebrae was found to be 1.6° plus or minus 0.8°. If a patient was found to have somatic dysfunction at this level, and if the rotational component of the 3-component complex was less than 1.6° (because the conventional theory is that most dysfunctions involve deficient rather than excessive movement), would an experienced practitioner be able to detect a deficit this small? And, assuming that appropriate manipulation for all 3 components of the dysfunction were administered, could the correction of the deficit be confirmed objectively? The current mode of confirmation, if any, is 2 or more examiners agreeing on the findings before and after manipulation.

A kinematic study[4] of the cervical spine used videofluoroscopy to examine 56 healthy volunteers. The intervertebral angular and translational movements in forward and backward bending were recorded, producing 1120 image sequences (*Table 1*). Although ordinary rocking or angular movements of intervertebral joints are characterized in the osteopathic context, can experienced practitioners detect the presence of translatory movement and distinguish it from ordinary rocking movement?

In a study[5] of 20 healthy volunteers using 3-dimensional magnetic resonance (MR) imaging, coupled movements were noted in which rotation to 1 side was combined with sidebending to the opposite side (*Table 2*).[5] In the subaxial cervical spine, various combinations of rotation coupled with forward bending, backward bending, or sidebending were quantitatively identified, ranging from a maximum of 5.4° of sidebending coupled with axial rotation at the C3 and C4 vertebrae to a minimum of 0.9° forward bending coupled with axial rotation at C5 and C6. The authors did not report on the 3 motion parameters of somatic dysfunction.

At this point, some osteopathic physicians might question whether the imaging data are unassailable. In a scientific context, exactitude is always a matter of degree—nothing is unassailable. Decades of spinal and sacroiliac mechanics have been settled simply by the declarations of Fryette[6] and Mitchell.[1(p590)]

MR Imaging and Diskography

A study[7] examining the relationship between concordant pain on diskography and lumbar rotation included 10 female and 6 male patients, aged 26 to 53 years. Sixty-eight normal disks were detected by MR imaging and diskography. Nonconcordant pain occurred in 6 disks and concordant pain in 20. Rotation averaged 0.6° for normal disks, 1.4° for disks with nonconcordant pain, and 1.8° for disks with concordant pain ($P<.001$). It is notable that disks with pain (especially concordant) exhibited more rotation than normal, nonpainful disks. This finding is in contrast to the usual presumption that somatic dysfunction involves a limitation or decrease in movement. Furthermore, the observation that rotation in normal, nonpainful disks averaged 0.6° again raises the question concerning the reliability of standard investigation procedures for somatic dysfunction: if a lumbar intervertebral joint's rotation was 0.4° (reduced from 0.6° because of dysfunction), would this deficit be detectable and recognizable as an abnormality through palpation? The normal average of 0.6° rotation also fits the anticipated engagement of opposing facet joint surfaces, which may be observed directly during surgical procedures when facet joint capsulectomy is performed in conjunction with certain spinal fusion procedures. Although this study[7] assessed candidates for surgical intervention, the fact that normal, asymptomatic disks could be identified is of importance to those interested in normal spinal kinematics.

Table 1.
Angular and Translatory Movements of the Cervical Spine[4]

	Forward Bending		Backward Bending	
Vertebrae	Degrees	mm	Degrees	mm
C2-3	5.8	0.7	7.7	0.7
C3-4	7.3	1.0	10.0	1
C4-5	10.0	1.2	12.6	1.3

Table 2.
Coupled Movements of the Spine: Rotation Combined With Sidebending to the Opposite Side[5]

	Degree, Mean (SD)	
Spinal Level	Rotation	Sidebending
Atlantooccipital	1.7 (1.5)	4.1 (1.4)
Atlantoaxial (C1-2)	36.2 (4.5)	3.8 (3.0)

A comparison of the quantity of joint gapping in lumbar facet joints in participants in the side-lying position with and without manipulation was studied in 16 healthy volunteers[8] (8 men and 8 women, aged 22 to 29 years) with no history of lumbar pain. Four groups, each consisting of 2 men and 2 women, were assigned to side-posture positioning alone or side-posture manipulation. Anterior-posterior MR imaging was performed before and after the interventions for all participants. Three blinded radiologists took 2 measurements of the interfacet intervals on the MR images of all participants before and after the interventions. In the manipulation group, joint gapping increased by 0.7 mm and 0° in the control group. Again, these observations coincide with what may be seen directly during operation. The spatial limitations within the zygapophyseal (facet) joints contradict the abnormal 3-parameter joint movement theory of plausibility. These spatial limitations are readily confirmed by direct observation of intervertebral joint dissection on cadavers and during spinal operations.

Radiographic Stereophotogrammetry

A study[9] of 25 patients with sacroiliac disorders (21 female and 4 male patients) in physiologic and extreme physiologic positions revealed a constant pattern of motion around the transverse axis: mean (range) rotation between extreme positions, 0.8° (2.5°-3.9°); mean (range) translation, 0.7 mm (0.1-1.6 mm). No difference was noted between symptomatic and asymptomatic joints. In osteopathic dysfunction theory, multiple axes, around which multiple abnormal movements are thought to occur, are said to be detectable by palpation. However, to my knowledge, no experimental or imaging data are extant in this regard.

Another study[10] involved 10 participants with presumed sacroiliac discomfort who underwent radiographic stereophotogrammetry before and after manipulative treatment. No positional change was noted at the joints after manipulation—even in those who experienced relief of symptoms.

Conventional Radiography

The effect of spinal manipulation on lumbar subluxation was studied using conventional radiographic methods.[11] Participants underwent radiographic imaging of the lumbar spine before and after manipulation. Subluxation before manipulation remained unchanged after manipulation even when symptoms were relieved. The authors did not state whether or not subluxation was detected by physical examination before manipulation.

Translatory movements in the cervical spine were identified often enough in one study[4] to question the "normal limits" for this movement because the participants were healthy volunteers. Owing to the frequency of the phenomenon in this study,[4] one might question whether translatory movements are normal. This question was answered in principle by a study[8] in which the participants were symptomatic, but lumbar diskography enabled the distinction between asymptomatic and symptomatic disks. Asymptomatic disks exhibited less angular excursion than symptomatic disks with structural abnormalities. Symptomatic disks usually exhibit structural damage associated with increased mobility. The normal turgidity of an intact disk permits rocking movements, but translatory movement would suggest possible loss of disk integrity. Further studies will probably clarify this issue.

Using Dynamic 3-Dimensional Imaging to Test Somatic Dysfunction Theory

The imaging studies discussed in the current article, many of which included a 3-dimensional component, revealed intervertebral behavior in vivo. Such studies have large implications for the prevailing conceptions of somatic dysfunction. It is notable that most of the studies cited in the current article were performed by investigators who did not express any particular interest in manipulation as an objective and presumably had no particular doctrinal "axe to grind."

The technology makes possible a more direct way of testing the postulates of somatic dysfunction, for which I propose the following protocol:

1. A study sample of individuals with and without spinal discomfort is assembled.
2. All participants undergo a form of dynamic 3-dimensional imaging of their intervertebral positioning and movements.
3. All participants are examined for somatic dysfunction by both experienced and inexperienced practitioners.
4. The findings of the practitioners are compared with the imaging data.
5. The practitioners administer the manipulative treatment thought to be appropriate for each participant.
6. Steps 2 through 4 are repeated.

The radiologist(s) should be blinded to the examination and intervention procedures throughout the study, and the examiners should be blinded to the imaging data throughout the experiment. Such a study should help clarify the validity of somatic dysfunction theory and the reliability of traditional procedures for and assumptions about somatic dysfunction, and perhaps generate a new paradigm. Freedom from doctrinaire preconceptions should be enough to motivate investigators in this arena.

Osteopathic Distinction

Painful limitation of movement, painful movement when not limited, tender myofascial tissue with or without spasm, painful movement against resistance with or without yielded effort, and *certain musculoskeletal asymmetries*[12(pp29-30)] are terms representing findings familiar to all physicians—osteopathic and allopathic—in an orthopedic context. An osteopathic physician may additionally be attentive to the texture of myofascial tissue, the presence of moisture on the skin, the timing of red streaking and blanching of the skin in response to digital pressure, and other subtleties,[12(pp84-88)] because osteopathic theory emphasizes that the musculoskeletal and cutaneous structures reflect the status of the milieu interior by way of the nervous system—in particular, the sympathetic nervous system.

The artistic, subjective, interpersonal nature of manipulative treatment is part of its importance and effectiveness in medical practice. Those qualities are also limiting factors in further understanding and improving its efficacy from a scientific standpoint. It is my expectation that the consequences of further imaging studies of spinal kinematics will ultimately shift the focus from joint mechanics to soft tissue behavior and physiology for those interested in promoting the use of manipulative treatment. (doi:10.7556/jaoa.2015.059)

(*continued*)

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