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TOOL ASSISTED CLINICAL METHODS

Dynamic fascial release and the role of mechanical/vibrational assist devices in manual therapies

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Summary Machine-assisted vibrational devices have a following in current and historical approaches to bodywork. This article reviews several such devices, including the percussion vibrator, vibrational platforms, and deep tissue oscillation. The percussion vibrator, reintroduced by Robert Fulford, reflecting the author's practice style and is addressed in more detail. Usage, conceptualization of goals as well as possible mechanisms of effect on the fascial and neuromuscular system are discussed. Special attention is given to the physiologic phenomenon of tonic vibratory reflex.

Introduction

The term fascia is often reserved for the thicker portions of connective tissue which are easily identified and cleared away to examine more important structures. In doing so, the role of connective tissue is underappreciated. Given its proper significance, fascia, and connective tissue more generally, represents a continuum of mesodermally derived connective tissue (van der Wal, 2009). As such, it serves a role in creating form and transmitting the force of intended action. But equally important, fascia plays a key role in the maintenance of readiness for further action, as well as in coordination of motion itself.

Combined with the neural system, fascia participates in a functional neuromyofascial syncytium in which the connective tissue component serves the role of form integrity, force distribution, and reactivity (van der Wal, 2009). The continuously connected universal distribution of connective tissue from the intracellular microtubules to the epidermis has been described elsewhere (Chen and Ingber, 2007). Since form is commonly coupled to function, this structural hierarchy suggests a corresponding functional hierarchy.

The classical view of fascia ascribes it the role of passive transmission force, as an element in engineering design (Huijing, 2007). However fascia has more recently been described as an integral part of the self-regulatory coordination of muscle movement (van der Wal, 2009). Spindles and other mechanoreceptors found in the aponeurotic arrangement of fibrin at myotendinous junctions in a parallel, not series arrangement imply a role in regulation

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(van der Wal, 2009). Additionally, the recent identification of alpha smooth muscle actin in fascia (Schleip et al., 2005) reinforces the concept of fascial reactivity.

Historically, some practitioners have intuited the importance of fascia and the relevance of mechanical vibration in correcting restrictions (Comeaux, 2002). This functional relationship of vibration and oscillation to physiology will be reviewed below. Empirically, externally applied oscillation has been shown to interact with the neuro-coordinative process of proprioception and its relationship to locomotor function (Hagbarth and Eklund, 1966). This article explores that relationship and its relevance to the historical and current usage of mechanical vibration. The data is not conclusive in supporting a translational application to clinical practice however the hope is that this discussion will stimulate further research. Furthermore, although vibration had been used historically in light therapy, music and tone therapies, homeopathy, radionics as well as conventional radiation therapy (Abrams, 1922; Vithoulkas, 1980; Kruser, 1937), this chapter focuses on therapies using vibration in the range of 1—100 Hz.

Historic use of vibration in neuro/fascial regulation

The literature of early American manual medicine, notably osteopathy, cites the primacy of motion is assessing the quality of life and the importance of fascial function in this regard (Still, 1892). Wernham, a student of J.M. Littlejohn (who introduced osteopathic education to England), attests that rhythm has been part of osteopathy since its inception in the late nineteenth century (Wernham, 2003). In the US, in this era, the introduction of machine assist devices in manual therapy sparked debate regarding the use of manually applied techniques versus mechanically applied vibration, and its relevance to physiologic wellness. A perspective from that time can be obtained by comparing the work of Snow (1912) and articles in the Journal of Osteopathy from the same period contesting this approach (Bower, 1904; Sullivan, 1904) (Figure 1).

Robert Fulford reintroduced mechanical vibration into the context of osteopathic bodywork in the 1950s using a percussion vibrator treatment (Comeaux, 2002). Simultaneous to these developments, oscillation evolved in purely manual techniques as in Wernham's General Osteopathic Treatment (GOT) and in the derived Harmonic Technique (Hartman, 2001; Lederman, 1997). In America, T.J. Ruddy used patient activated rhythmic motions to induce localized relaxation (Comeaux, 2000). This became the basis for Mitchell's neuro-coordinative techniques termed Muscle Energy Technique and Vibratory Isolytic Technique (Mitchell, 1998).

Current use of vibration in neuro/fascial regulation

Osteopathic manipulation

Some osteopaths, in treating somatic dysfunction in the fascial component, continue to use the percussion vibrator

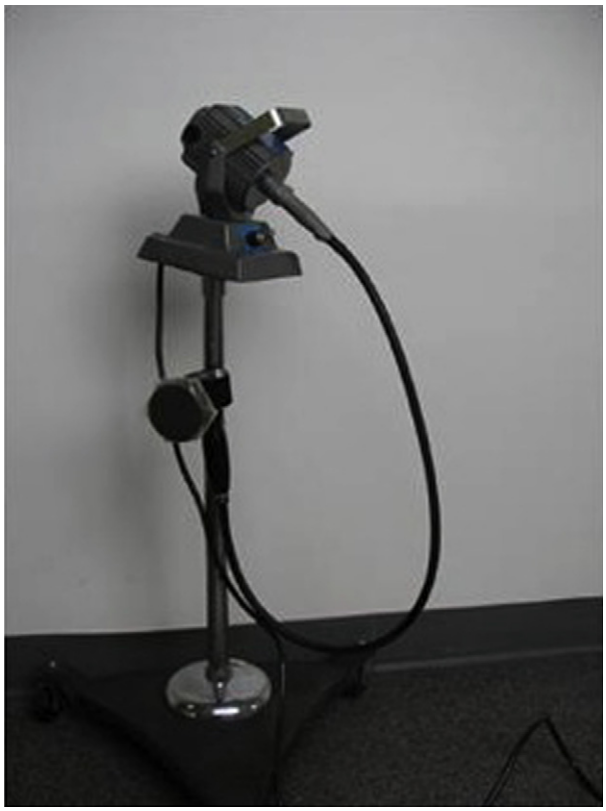

Figure 1 Contemporary version of Foredom percussor used by Dr. Fulford.

(or percussion hammer), as introduced by Fulford. The technique is cited in the Glossary of Osteopathic Terminology (American Association of Colleges of Osteopathic Medicine, 2009). Fulford's use of the device relied heavily on the practitioner's perception and intention. This rationale will be discussed later in this article under explanatory mechanisms since his approach presumed a redefinition of the patient, the practitioner and their interaction. After multiple trials of available devices, Fulford used a Foredom model percussor (Comeaux, 2002).

This device consists of a standard induction motor with a variable running speed from 0 to 4000 rpm or 66 Hz. The motor's rotational force is conveyed by means of a shielded flexible cable to a hand piece. Within the hand piece the rotary force is converted by a cam to reciprocal motion, driving a piston at the end of which is a padded applicator head. The applicator conveys the therapeutic force to the patient as it is applied over a bony prominence to disseminate force optimally through the fascial matrix.

More recently the author has used a device introduced in the chiropractic community namely, the VibraCussor® to be an improvement. The motor of the Vibracussor is in the hand piece which is connected only by a flexible coiled wire to the transformer which allows more freedom of movement. Additionally, the direct proximity of the motor to the point of application creates a more forceful, though gentle, corrective force (Figure 2).

The percussor may be been used in general treatment or for specifically targeted local effects. In the general technique, vibration is applied over bony prominences (to

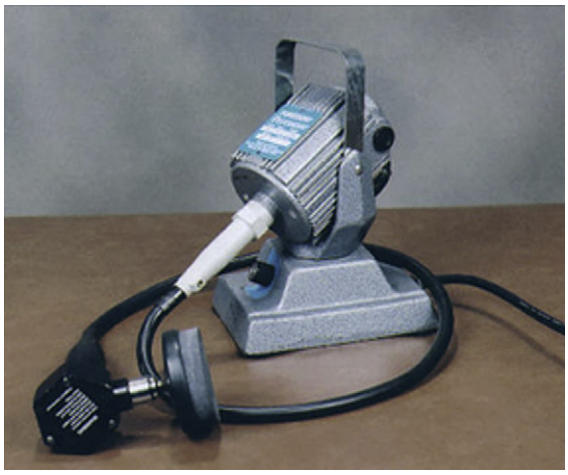

Figure 2 Vibracussor, a contemporary alternative preferred by the author.

maximally disseminate vibratory force through the fascial matrix) in a pattern from feet to shoulders. The organization was derived according to a conception of the distribution of the body's energy field, as described by Stone, as well as from experience working with residual birth trauma, even in adult patients (Stone, 1986; Comeaux, 2002) (Figures 3 and 4).

Specific, focal treatment may be applied anywhere that a decrease in vital resonance is detected. This lack of resonance relies on refined palpation to complement the more conventional parameters for defining dysfunction. Considering matter, including the body, as fundamentally an expression of vibrating energy, Fulford saw somatic dysfunction, the result of trauma and strain underlying complaints of pain, as a dysrhythmia. He referred to the residual tension in fascia as an ''energy sink'', or drain, by which the natural vibratory capacity of tissue was restrained from healthy resonance (Comeaux, 2002).

Chiropractic

Within the chiropractic field, vibration has been introduced in the current generation of computer assisted thrust

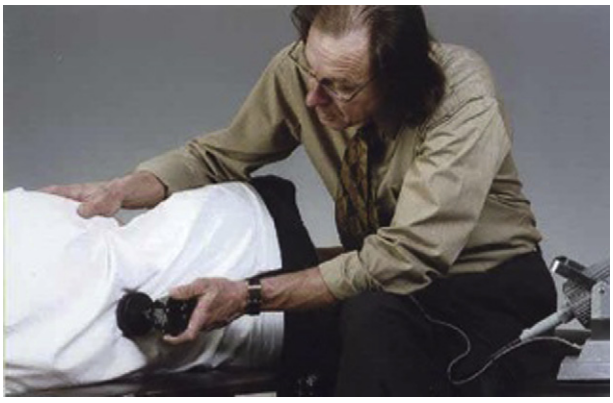

Figure 3 Percussion vibrator, spinal application. Applicator may be advanced over each segment both to diagnoses and treat.

Figure 4 Percussion vibrator, application in a limb. May be applied over bony prominence or directly over tissue you intend to release.

devices which use frequency modulated repetitive thrusts. This is a succession to the spring loaded devices for controlling force in spinal manipulation. They function within the range of 6—12 Hz based on empiric testing of spinal compliance in animal models (Keller et al., 2007; Colloca and Keller, 2001). Two well advertised formats include Arthro stim and Impulse IQ referenced below. Although the stated focus in validation and effectiveness research is on the role of non-osseous components of the spine (Colloca, 2001), implications for connective tissue involvement are inevitable given the role of ligaments in arthrodial stabilization. The case for more refined or specific tissue effects is not made. Likewise, because of the size of the applicator tip, extension to the broader field of fascia or muscle is impractical.

At the other end of the application scale is whole body vibration. In chiropractic this is used as a tone building application and for pre-treatment muscle relaxation. As in use in sports physiology and weight loss, described in the next paragraph, the effect is attributed in a general way to tonic vibratory reflex without more detailed investigation of actual benefit. In addition, research remains mixed as far as confirming attributed benefits.

Sports physiology and fitness

In the area of sports fitness training, whole body mechanical vibration using a variety of vibrating platforms has emerged as a popular means of improving muscle tone and therefore increasing strength (Cardinale and Lim, 2003; Delecluse et al., 2003). Other benefits described are weight loss and increased lean body mass. The effects are attributed generally to the involvement of tonic vibratory reflex in place of arduous resistance training. Obviously, there are a variety of issues in selecting this therapy including variation in effect with different training schedules, inconsistent demonstration of strength/power with use of vibration, as well as lack of clarity as to optimal amplitude to engage natural dampening in the musculature (Cardinale and Wakeling, 2005).

In ascribing the effectiveness specifically to engagement of tonic vibratory reflex, detail is lacking. Tonic vibratory

reflex (TVR) involves an observed physiologic set of responses that are not easily characterized; as will be discussed later in the article, various researchers have described different aspects of the phenomenon with varied results, reflecting that the processes are not yet completely understood. TVR is discussed later in this article in the context of the population coding model of neuromuscular coordination. The scientific relevance of this explanation will be discussed below.

Deep oscillation

A further technology marketed as Hivamat 200 (Jahr et al., 2008), claims to create fascial change by applying an intermittent electrostatic charge to the collagen matrix. This is described as creates cyclic movement in the deep tissues leading to mechanical pumping and the redistribution of fluids. The modality is marketed as an adjunct to surgical or other wound healing, sports medicine and respiratory diseases (Seffinger, 2009). Reference data regarding mechanisms is limited but outcome studies after treatment of acute sports injuries report decreased edema, pain reduction, and enhanced healing with limited fibrosis (Aliyev, 2009).

Scientific conceptual basis — tonic vibratory reflex (TVR)

In order to understand the attributions of these therapies to TVR, a background in the development of the population coding model of neurocoordination is helpful.

The contemporary view of population coding derives from Donald Hebb's attempts in neurophysiology to reconcile the spatial limitation with the extensive functions of the brain (Spatz, 1996). Hebb proposed an encoding process sensory interpretation, memory, and action execution since the skull could not contain enough space for task-dedicated tissue for these tasks. In essence, it emphasizes that neuronal coordination involves patterns of rhythmic activity, not just dedicated cells and pathways in binding of stimuli into meaningful experience. Functionality would result from phasic relationships and patterns of depolarization besides sheer connectivity. Individual neurons could participate synchronously in several operations simultaneously. Despite limitations to the theory, the theme of rhythmic depolarization and phase synchrony presents a defensible model of neural coordination applicable on a peripheral as well as central level (Windhorst, 1996). Neural coordination, in this model, is rhythmic and the controlling feature is phase synchrony across and between cell populations constituting different functional tissues.

Both reflex and voluntary movements have been shown to demonstrate periodic rather than constant depolarization. Gross voluntary motion, muscle tone, and posture (including the cerebellar component) are composites of cyclic depolarization rather than a linear process (Windhorst, 1996; Farmer, 1998; Zedka and Prochazka, 1997). This is similar to the experience of appreciating a constant object on a video screen which actually represents a signal refreshed at a rate of 24 cycles per second. One realizes from this that muscle tone, with its adaptive tendon and epimesial/perimesial (connective tissue) tension is a function of rhythmic activity (McAuley et al., 1997). This tension from posture, movement has a reciprocal relationship with fascial tension. Fascia either directly or indirectly participates in the balance of tensions coordinated by the neural or neuromuscular system. Population coding is a concept which complements the system of coordinative reflexes traditionally viewed as a primary means of neural and neuromuscular coordination.

The applicable point to bodywork is that neuromuscular activity, both afferent and efferent, is rhythmic. Physical tone of structural tissue, including that occurring after trauma or strain, is determined by states of phasic depolarization.

Rhythmic reflexes — Tonic Vibratory Reflex (TVR) and related effects

If neurocoordination in general is rhythmic in character, reflexes involve a phasic component. TVR is a complex phenomenon that was originally described by Hagbarth and involves the contraction of muscle in response to vibration in the range 0—100 Hz (Hagbarth and Eklund, 1966). Martin and Park note a frequency dependent excitation—contraction coupling leading to muscle fatigue (Martin and Park, 1997). Many others show altered performance, notably blindfolded subjects typically misperceive the extent of their intended action during voluntary movement, representing a kinesthetic illusion (Cody et al., 1990). Changes in muscle spindle activity betray involvement of discoordination of gamma-alpha motor neuron coordination controlling muscle tone (Vallbo and Al-Falahe, 1990; Burke et al., 1976). In composite, these effects describe TVR as a discoordination or confusion of proprioception. But proprioception is a coordination of vestibular, ocular, cerebellar, cortical and alpha gamma reflex effects. As a result, tonic vibratory reflex involves a complex of interactions. Curiously, locally applied vibrations cause reflexively coordinated movements of other body parts (Zedka and Prochazka, 1997; Han and Lennerstrand, 1999; Rossi et al., 1985). Additionally, spino-cerebellar disease or degeneration diminishes this effect (Abbruzzese et al., 1982).

The application of rhythmic afferent input can have intriguing effects. A most dramatic application of the principles described under TVR occurs in the work of microneurographic pioneer, Schalow and Blank (1996). Beginning with work in open spinal surgical fields in partially cord-transected patient in hopes of reestablishing bladder control, Schalow developed a means of identifying pools of homologous nerve types, functional populations. He demonstrated that there was a distinctive difference in patterns of phasic synchrony in the firing of homologous muscles of the lower extremity between his paretic patients and normal controls.

In application Schalow was able to show patient recovery of spontaneous movement and limited gait by suspending subjects in harness over a spring board. Initially subjects were raised and lowered passively to simulate bouncing. Progressively limbs would reflexively respond.

During this protocol, it was observed that the natural phasic character of rhythmic depolarization of neuromuscular firing gradually returned to postural muscles and the patients began spontaneous gait-associated movements. This activity involved progressive challenge of the patient to initiate synergistic contraction of the limb muscles. This research does not directly demonstrate the application of vibration in the modalities cited in this article. However since it also involved externally applied rhythmic pressure to the limbs, possibly it entrained, by rhythmic afferent input, the natural protogenic pattern involved in gait. It is hoped that the current article will contribute toward precipitating such research.

The extension of the relevance of these reflexes in the context of inappropriate muscle tone, including that underlying joint restriction seems plausible. As such, TVR could explain a large part of the effect of the percussion vibrator, as well as the repetitive thrust devices. The attribution to the broad range of effects of the vibrating platforms is plausible but only in a general, non-specific sense.

When one factors in the presence of spindles in the myotendinous junctions (van der Wal, 2009) and the alteration of spindle reflexes with TVR (Vallbo and Al-Falahe, 1990) a picture of relevance emerges. Although these neuroreflexive relationships pertain to the special connective tissue identified as striated muscle, the recent identification of adaptive actin fibers in fascial tissue make this line of thought worth pursuing (Schleip et al., 2005). Empiric use of the procedures and devices described next underscores this relevance.

Application to clinical use of mechanical devices

As noted above, TVR is an intervention with complex results. A summary of effects should support the following conclusions. The excitation—contraction uncoupling that occurs leads to a derecruitment of some fibers as well as requiring the remaining fibers to work harder to maintain posture increasing the rate of fatigue. To remain standing, subjects are obliged to activate their postural or anti-gravity muscles in an uncoordinated and inefficient manner. The engaged fibers are therefore receiving resistance training by another method. They are selectively overused to ensure body posture in their compromised state. In essence, it would appear that this is resistance training, only under conditions in which the gross muscle is operating in a state of disorganization. See Table 1 for further suggested mechanism.

Scientific conceptual basis — energetic phase coherence or the ''energy body''

Although operating in the same frequency range as TVR, Robert Fulford conceptualized the application of oscillatory force in a different way. Considering matter on all levels of organization, including the body, as fundamentally an expression of vibrating energy, he saw somatic dysfunction, the result of trauma and strain underlying complaints of pain, as a dysrhythmia. As mentioned above, he referred to the residual tension in fascia resulting from trauma as an

Table 1 A contemporary list of proposed physiological mechanisms for the effectiveness of vibration.

Contemporary hypothetical explanations of effectiveness of vibration	
Hypothetical mechanism	Rationale and reference
Cumulative creep through successive cyclic loading of collagen fibers	Mechanical characteristics of collagen and the dynamic reciprocal functional and metabolic role in repetitive motion with muscle (Solomonow, 2009)
Resetting alpha—gamma coordination in muscle activation changing tension patterns distributed by fascia	An extension of the muscle energy model (Mitchell, 1998)
Phase coherence of quantum state of fascia as a tensegrity matrix	Application of the tensegrity structural model to the fascial organization of biologic systems. The fibrin matrix distributes force underlying structure and function (Chen and Ingber, 2007). Fibrous network as a communication grid for coordinating encoded information within the fascial network; involves quantum vibrational energetic phase coherence (harmonics) for health being (Ho, 2008)
Entrainment of endogenous physiologic oscillators	Population coding model of neuro biologic function underlying recurrent activity (including depolariazation/repolarization cycle of neurons), rhythm of coherent depolarization of cells depicts a functional state. Phasic state changes entrain changes in rhythmic function of a population, resulting in functional change (Windhorst, 1996; Zedka and Prochazka, 1997; Farmer, 1998).
Application of tonic vibratory reflex	Another route to altering tone through muscle spindle reflexes (Comeaux, 2008)
Metaphysical	Descriptions using the term 'energy' as the term 'ether' was used in the twentieth century await empiric correlation (Comeaux, 2001)

''energy sink'', or drain, by which the natural vibratory capacity of tissue was restrained from healthy resonance. The kinetic energy of injury was retained in the tissues. Modeling his thought from that of Walter Russell and Randolph Stone, he considered the fascia to be a medium of transmutation of thought (another form of vibration) to action, in a biophysiologic as well as figurative sense (Stone, 1986; Russell, 1974). Treatment then was aimed at revitalizing, reenergizing tissue to a native state of healthy resonance (Comeaux, 2002).

A further element of resonant function, described in these last three sources, is the appreciation of thought and intention as other forms of constitutive vital energy. In this context, the fascia is considered the matrix or conduit for this vital energy. Consistent with the research which claimed to demonstrate the actual, demonstrable effect of thought on physical outcomes (Jahr, 2008), Fulford felt that on a subtle level the practitioner's intentions and attention altered health outcomes. Prior to the development of functional magnetic resonant imaging, Fulford modeled the patient and their physiologic function around the concept of the etheric or energy body or energy field. Fulford's terminology derived partly from early neurologic research of Burr's L-field or life field (Burr, 1972) and partly from the esoteric literature. The concepts and description appear esoteric and beyond the realm of conventional science. However, the phenomena demonstrated on functional MRI and similar technologies associate electromagnetic vibrational activity with cerebral neurologic events in response to stimulus (Friston et al., 1994). These similarities may be interpreted as representing semantic rather than substantive variance of Fulford's model of the body from conventional scientific view.

Additionally, Fulford's syntheses can be viewed as presaging the integration of quantum physics into bioscience as well as the current quest to understand the physiology of consciousness. Mae-Wan Ho and others have begun to describe the relevance of vibrational phase coherence as an additional physical parameter of the body's coordinative function (Ho, 2008). Significant progress has also been made to measure the congruence yet independence of mental and spiritual activity from the molecular biology of the brain. The current community of endeavor expressed in Beauregard's *The Spiritual Brain* (Beaurgard and O'Leary, 2007), underscores Fulford's claim that ''thoughts are things'', that mental life has physical consequence through but not dependent exclusively on physiological processes. Additionally, experiments in the Hearth Math initiative suggest physiologically relevant interpersonal effects of inherent rhythmic function (McCraty and Atkinson, 1999). Vibrational function, both naturally initiated or evoked by application of external vibratory force, begin to appear physiologically relevant.

Summary

Vibration and oscillation have been and continue to be a component in the application of force in bodywork. Various mechanical devices are proposed as adjuncts or improvement in the application of manual diagnosis and treatment. Percussion vibration, computer assisted thrust devices, deep oscillation, and whole body vibrating platforms are formats of which this author is aware. The physiological effectiveness of these devices is partially elucidated and currently under debate. Further research into mechanisms and effectiveness is invited.

Disclaimer

The description here of the use of any mechanical device is not intended as a suggestion for use beyond a practitioners training and scope of license. Skills development rather than accessibility of a device defines effective and ethical use of any tool in patient care.

References

Abbruzzese, G., Abbruzzese, M., Ratto, S., Favale, E., 1982. Contribution of tonic vibration reflex to the evaluation and diagnosis of cerebellar disorder. Journal of Neurology, Neurosurgery & Psychiatry 45, 526–530.

Abrams, A., 1922. New Concepts in Diagnosis and Treatment – Physico-clinical Medicine. Physicoclinical Co., San Francisco.

Aliyev, R., 2009. Clinical effect of the therapy method deep oscillation in treatment of sports injuries. Sportverletz Sportschaden 23 (1), 31–34.

American Association of Colleges of Osteopathic Medicine, 2009. Glossary of Osteopathic Terminology. rev April 2009. American Association of Colleges of Osteopathic Medicine, Chevy Chase, MD. www.aacom.org/resources/PAges/glossary.aspx (accessed 12/09).

Arthro stim. http://www.impacinc.net/client/index.php?action=show_video (accessed 12.07.09).

Beaurgard, M., O'Leary, D., 2007. The Spiritual Brain: a Neuroscientist's Case for the Existence of the Soul. Harper Collins, New York, NY, p. 267.

Bower, R., 1904. Adjuncts in osteopathy. Journal of Osteopathy Oct, 365.

Burke, D., Harbarth, K., Lofsdedt, L., Wallin, B., 1976. The responses of human muscle spindle endings to vibration during isometric contraction. Journal of Physiology 261, 695–711.

Burr, H., 1972. Blueprint for Immortality, the Electric Picture of Life. Saffron Walden, p. 14.

Cardinale, M., Lim, J., 2003. Electromyography activity of *Vastus lateralis* muscle during whole-body vibrations of different frequencies. Journal of Strength and Conditioning Research 17 (3), 621–624.

Cardinale, M., Wakeling, J., 2005. Whole body vibration exercise: are vibrations good for you. British Journal of Sports Medicine 39, 585–589.

Chen, C., Ingber, D., 2007. Tensegrity and mechanoregulation: from skeleton to cytoskeleton. In: Findley, T., Schleip, R. (Eds.), Fascial Research. Urban and Fischer, Munchen, p. 20.

Cody, F., Schwartz, M., Smith, G., 1990. Proprioceptive guidance of human voluntary wrist movements studied using muscle vibration. Journal of Physiology 427, 455–470.

Colloca, C., Keller, S., 2001. Electromyographic reflex responses to mechanical force, manually assisted spinal manipulative therapy. Spine 26 (10), 1117–1124.

Comeaux, Z., 2000. The role of vibration and oscillation in the development of osteopathic thought. AAO Journal 10 (3), 19–24.

Comeaux, Z., 2002. Robert Fulford DO and the Philosopher Physician. Eastland Press, Seattle, WA, p. 91, 95, 130.

Comeaux, Z., 2008. Harmonic Healing: A Guide to Facilitated Oscillatory Release and Other Rhythmic Myofascial Techniques. North Atlantic Books, Berkeley, CA.

Delecluse, C., Roelants, M., Verschueren, S., 2003. Strength increase after whole body vibration compared to resistance training. Medicine and Science in Sports and Exercise 35, 1033–1041.

Farmer, S., 1998. Rhythmicity, synchronization and binding in human and primate motor systems. Journal of Physiology 509 (1), 3–14.

Friston, K., Jezzard, P., Turner, R., 1994. Analysis of functional MRI time-series. Human Brain Mapping 1, 153–171.

Hagbarth, K., Eklund, G., 1966. Motor effects of vibratory stimulus in man. In: Granit, R. (Ed.), Nobel Symposium 1, Muscle Afferents and Motor Control, pp. 177–186. Stockholm.

Han, Y., Lennerstrand, G., 1999. Eye position changes induced by neck muscle vibration in strabismic subjects. Graefe's Archive for Clinical and Experimental Ophthalmology 237, 21–28.

Hartman, L., 2001. Handbook of Osteopathic Technique, third ed. Nelson Thorne Ltd., Cheltenham, UK, p. 34.

Ho, M., 2008. The Rainbow and the Worm, third ed. World Scientific Publishing Company, Singapore.

Huijing, P., 2007. Muscle as a collagen fiber reinforced composite: a review of force transmission in muscle and whole limb. In: Findley, T., Schleip, R. (Eds.), Fascia Research. Elsevier GmbH, Munich, p. 90.

Impulse IQ. http://neuromechanical.com/index.php?option=com_content&task=view&id=73&Itemid=110 (accessed 12.07.09).

Jahr, S., Schoppe, B., Reisshauer, A., 2008. Effect of treatment with low-intensity and extreme low-frequency electrostatic fields (Deep Oscillation) on breast tissue and pain in patients with secondary breast lymphoedema. Journal of Rehabilitation Medicine 40 (8), 645–650.

Keller, T., Colloca, C., Harrison, D., Moore, R., Gunzburg, R., 2007. Muscular contributions to dynamic dorsoventral lumbar spine stiffness. European Spine Journal 16, 245–254.

Kruser, F., 1937. Light Therapy. P B Hoeber, Inc., New York, NY.

Lederman, E., 1997. Harmonic Technique. Churchill Livingston, Edinburgh.

Martin, B., Park, H., 1997. Analysis of the tonic vibration reflex: influence of vibration variables on motor unit synchronization and fatigue. European Journal of Applied Physiology 75, 504–511.

McAuley, J., Rothwell, J., Marsden, C., 1997. Frequency peaks of tremor, muscle vibration and electromyographic activity at 10 Hz, 20 Hz, and 40 Hz during human finger muscle contraction may reflect rhythmicities of central neural firing. Experimental Brain Research 114, 525–541.

McCraty, R., Atkinson, M., 1999. The role of physiological coherence in the detection and measurement of cardiac energy exchange between people. In: Proceedings of the Tenth international Montreux Congress on Stress, Montreux, Switzerland.

Mitchell, F., 1998. The Muscle Energy Manual, vol. 2. MET Press, Lansing, MI, p. 94.

Rossi, A., Rossi, B., Santarcangelo, E., 1985. Influences of neck muscle vibration on lower limb extensor muscle in man. Archives Italiennes de Biologie 123, 241–253.

Russell, W., 1974. The Universal One. University of Science and Philosophy, Schwananoah, VA.

Schalow, G., Blank, Y., 1996. Electromyographic identification of spinal oscillator patterns and recoupling in a patient with incomplete spinal lesion: oscillator formation as a method of improving motor activities. General Physiology and Biophysics 15 (10), 121–220.

Schleip, R., Klinger, W., Lehman-Horn, F., 2005. Active fascial contractility: fascia may be able to contract in a smooth muscle-like manner and thereby influence musculoskeletal dynamics. Medical Hypotheses 66, 66–71.

Seffinger, M., 2009. Supplementing manual therapy for lymphedema. JAOA 109 (4), 214–215.

Snow, A., 1912. Mechanical Vibration: its Physiologic Application in Therapeutics. The Scientific Authors' Publishing Co, New York, NY.

Solomonow, M., 2009. Ligaments: a source of musculoskeletal disorders. Journal of Bodywork and Movement Therapy 13 (2), 136–154.

Spatz, H., 1996. Hebb's concept of synaptic plasticity and neuronal cell assemblies. Behavioural Brain Research 78, 3–7.

Still, A., 1892. The Philosophy and Mechanical Principles of Osteopathy. Hudson-Kimberly Publishing CO, Kansas City, MO, p. 60, 250.

Stone, R., 1986. Polarity Therapy, vols. I and II. CRCS Publishing, Sabistopol, CA.

Sullivan, J., 1904. Vibrators. JO, May: 201–203.

Vallbo, A., Al-Falahe, N., 1990. Human muscle spindle response in a motor learning task. Journal of Physiology 421, 553–568.

van der Wal, J., 2009. The architecture of the connective tissue in the musculoskeletal system — an often overlooked functional parameter as to proprioception in the locomotor apparatus. In: Findley, T., Schleip, R. (Eds.), Fascia Research II. Elsevier GmbH, Munich, pp. 21–23.

Vithoulkas, G., 1980. The Science of Homeopathy. Grove/Atlantic Press, New York, NY.

Wernham, J., 2003. Rhythm in Osteopathy. By author, Maidstone, Kent.

Windhorst, U., 1996. The spinal cord and its brain: representations and models — to what extent do forebrain mechanisms appear at the brainstem spinal cord levels. Progress in Neurobiology 49, 381–414.

Zedka, M., Prochazka, A., 1997. Phasic activity in the human erector spinae during repetitive hand movements. Journal of Physiology 504 (3), 727–734.