Muscle Repositioning

A New Verifiable Approach to Neuro-Myofascial Release?

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SUMMARY

The clinical observation of involuntary motor activity during application of a particular style of myofascial release (Muscle Repositioning—MR) has led to the hypothesis that this technique might evoke neurological reactions. Preliminary EMG recordings presented here show involuntary tonic cervical erector action during MR. Involuntary eye movements were also observed. This article presents these experimental data, along with clinical observations during the application of MR in the treatment of musculoskeletal conditions. The author hypothesizes that MR might constitute a novel manual technique: it produces unique palpatory sensations for the practitioner (*e.g.*, a sense of firmness to the touch and the integration of bodily segments into a single block) that correspond to unique sensory experiences for the client. The article raises the possibility that MR's specific sensory input might activate the central nervous system, thus eliciting neural reactions. These reactions, in turn, might be related to the technique's efficacy. As the EMG objectively measures reactions contemporaneous with subjective palpatory phenomena, MR potentially brings the objective and subjective into congruence. EMG monitoring of touch could serve as an objective criterion in the development of treatment protocols, as well as a feedback tool for teaching. Greater objectivity, precision and reproducibility are all possible outcomes of such an approach. The author believes that MR can be used in various therapeutic settings—either as the principal approach, or as an adjunct to a variety of other approaches.

INTRODUCTION

Manual Therapies, Enduring and Subjective

Manual therapies are part of human cultural history. Over the centuries, countless manual therapies have been developed, and even now many traditional approaches are still used alongside modern techniques. But perhaps because some manual therapies are difficult to study, their mechanisms of action are poorly understood. This hinders their further technical development and scientific validation, as well as their acceptance by the general public.

One persistent difficulty in the study of manual therapies is their reliance upon subjective criteria for both diagnosis and treatment. Because each touch is a unique event that combines countless attributes of the practitioner, the client, and the relationship between them, it is virtually impossible to control and standardize the variables present in the interactions—many of which are not yet scientifically understood in any event.

Most manual therapies are inherently subjective. The practitioner palpates (and interprets) what is hard, immobile or displaced, and/or sees (and interprets) what is supposedly wrong or displaced. Thus, in many manual therapies, the practitioner is either guided by sensation or follows a predetermined protocol. Either way, subjectivity is unavoidably in the background. The majority of manual therapies cannot be practiced through anything other than the practitioners' sensations, which is one reason it is so difficult to identify reliable variables for the study and teaching of such disciplines.

Perhaps because of these difficulties, most documented studies of manual therapies are clinical outcome trials. Although these studies are important for evaluation of the efficacy and indications of the modalities concerned, they fail to bring a deeper understanding of their mechanisms of action—or to enhance their objectivity and reproducibility. Might there be other ways to reach these goals? If so, what variables could help standardize and objectify an inherently subjective practice?

One possible approach is to monitor physiological reactions. A detectable physiological reaction to a maneuver might or might not contribute to its therapeutic effect. However, it might be an indicator of or means of monitoring the therapeutic effect, and in that sense be an objective measure that could work toward reproducibility of the treatment outcome. Moreover, if the physiological reaction does indeed contribute to the therapeutic effect, the reaction might also shed light on the modality's mechanisms of action.

The literature documents the evaluation of many different physiological effects in the search for the mechanisms of action of manual modalities, most of them using surface electromyography (EMG). There have been documented alterations on motor-neuronal excitability produced by spinal manipulation and mobilization techniques. Both inhibition (*e.g.* Dishman and Bulbulian, 2000, 2001; Murphy *et al.*, 1995) and excitation (*e.g.*: Colloca and Keller, 2001; Dishman *et al.*, 2002; Herzog et al., 1999) of motoneuron activity as accessed by the Hoffmann reflex (H-reflex) has been observed. Improvement of pathologically affected reflex activity has also been reported (Floman *et al.*, 1997). Similarly, muscle massage has been demonstrated to modulate the H-reflex (Morelli *et al.*, 1991). Such studies might both illuminate the mechanisms of action of the concerned methods and, at least theoretically, lead to the development of standardization criteria for the techniques. However, with respect to spinal manipulation and mobilization techniques, given the short duration of the treatments and the rapidity of reactions measured, the EMG recordings show only what has happened after the treatment is finished.

But if the duration of the maneuver is long enough and the physiological effect persistent enough during its application, the physiological signal could be monitored in real time as the maneuver is performed. In that case, the feedback of the signal might help steer the manual technique as it is being applied. Should this be feasible in the ordinary clinical context, the monitoring of the physiological signal might lend objectivity to the practice of the manual therapy, as discussed below.

This article describes preliminary results observed during the application of a particular style of myofascial release called Muscle Repositioning (MR) (Bertolucci *et al.*, 2007) (*see* the Discussion section, below, for a description of the principal features of MR). Involuntary physiological reactions (tonic muscular activity and eye movements) were detected during the performance of an MR maneuver in the occipital region.

The author hypothesizes that MR might characteristically evoke particular neurological reactions, as the search for similar reactions in response to maneuvers at other body locations suggests (*see* Discussion).

To the author's knowledge, this phenomenon has not yet been described in the literature. It suggests the possibility that physiological signals might serve as feedback mechanisms to bring more objectivity and reproducibility to this and possibly other manual therapies. This article also describes some conceptual aspects of the MR technique, and raises some related questions and observations.

Methods

Surface EMG activity (NeuroEducator II, Therapeutic Technologies) of the cervical erectors of six healthy subjects was studied. These volunteer subjects worked as physical therapists in the rehabilitation facility where the data were collected. All were females, with ages ranging from 22 to 32 years (mean age 24.67 years).

The electrodes were positioned bilaterally at the level of C4, 3 cm from the midline (*Figure 1*). The supine subjects were asked to relax and release the weight of their heads onto the treatment table. Starting from a state of electrical silence, recordings were taken in two situations:

Reference recordings (voluntary elevation of the head from the table, maintaining the position for a short period of time, and relaxing again). They showed activity (co-contraction) of the cervical erectors (*Figures 3a and 4a*).

During an MR maneuver in the occipital region (*Figures 3b-d and 4b-h*).

The maneuvers were performed by the author, a physiatrist for twenty years and a Rolfing® Structural Integration practitioner for sixteen years. Each consisted of giving support to the weight of the subject's head and delivering a specific combination of forces (shear of skin and minute translation and rotation of the head) so as to produce the palpable sensation of hardening (firmness) that characterizes this technique (see Discussion below). The practitioner continued the maneuver until he felt a tissue release, which generally took between ten and fifteen minutes (*Figure 2a-c*).

Mean RMS values of the EMG signal were calculated; and video recordings were made.

Figure 1:
This figure depicts electrode positioning. The electrodes were positioned bilaterally on top of the cervical erectors, at the level of C4, 3 cm from the midline. Ground electrodes positioned on the acromion.

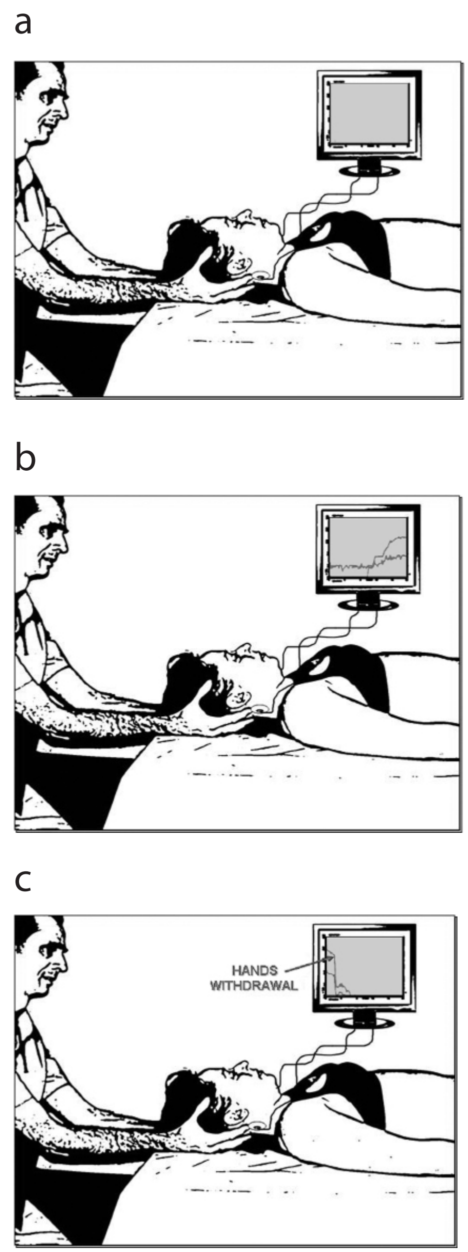


Figure 2:
Schematic representation of the experimental setting: (a) the maneuver starts from a state of electrical silence, (b) sustained EMG signal appears and fluctuates during its application and (c) the signal falls abruptly after a tissue release is felt, when the hands are withdrawn. Often the signal persisted at a reduced level for a few seconds thereafter.

Results

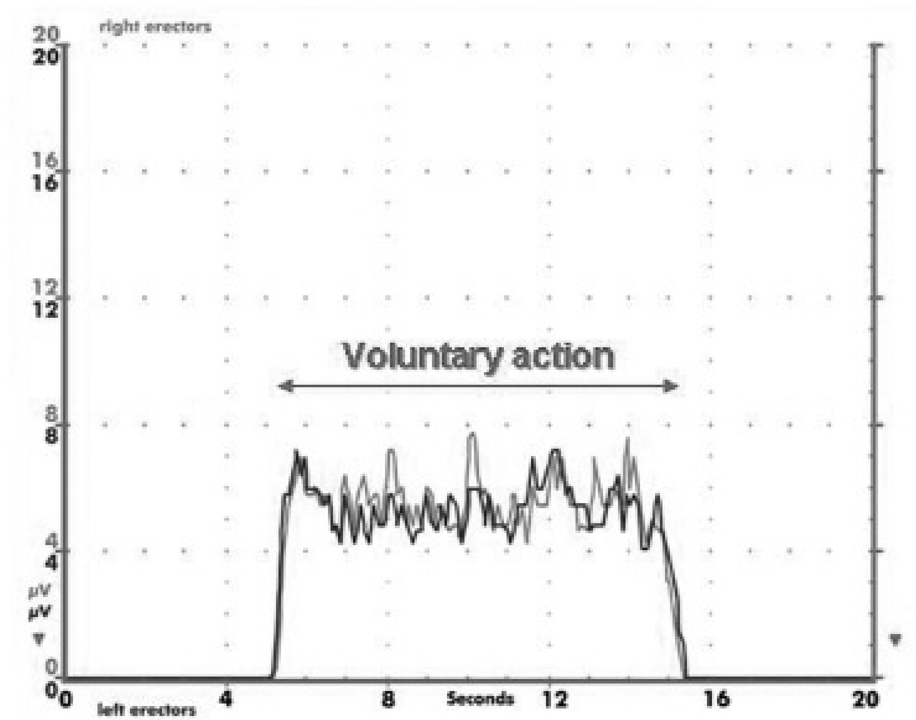
All subjects demonstrated sustained involuntary electrical activity of the cervical erectors. The signal started a variable amount of time (0.5-1 min) after the start of the maneuver, lowered immediately after its end, and commonly persisted at a reduced level for few seconds thereafter. During the maneuver, the initially low signal characteristically rose progressively and then fluctuated. During the maneuver, the author also observed the involuntary and progressively more forceful extension of the subject's head that pushed the practitioner's hands down into the table. The intensity of this force seemed to correlate with the level of the signal: the higher the signal, the more intense the force. Usually, after the signal and the force of extension reached a maximum value, both fell suddenly. Immediately thereafter, tissue release and muscle relaxation were evident.

In most cases, the recordings were bilaterally asymmetrical; but the side showing the greater signal intensity at the outset would come to show the lesser intensity at some point during the maneuver. This shift apparently occurred in response to the practitioner's small movements of the subject's head. Frequently, the signal was more symmetrical towards the end of the maneuver, when the subject's head was closer to the midline.

Figures 3 and *4* show recordings from two subjects, which readings are representative of and similar to recordings for all subjects. RMS mean values for all six subjects are summarized below:

Subjects	Right (μV)	Left (μV)
A	0.81	3.32
B	6.28	10.29
C	1.26	2.50
D	21.70	3.93
E	4.67	17.68
F	1.78	3.03

a



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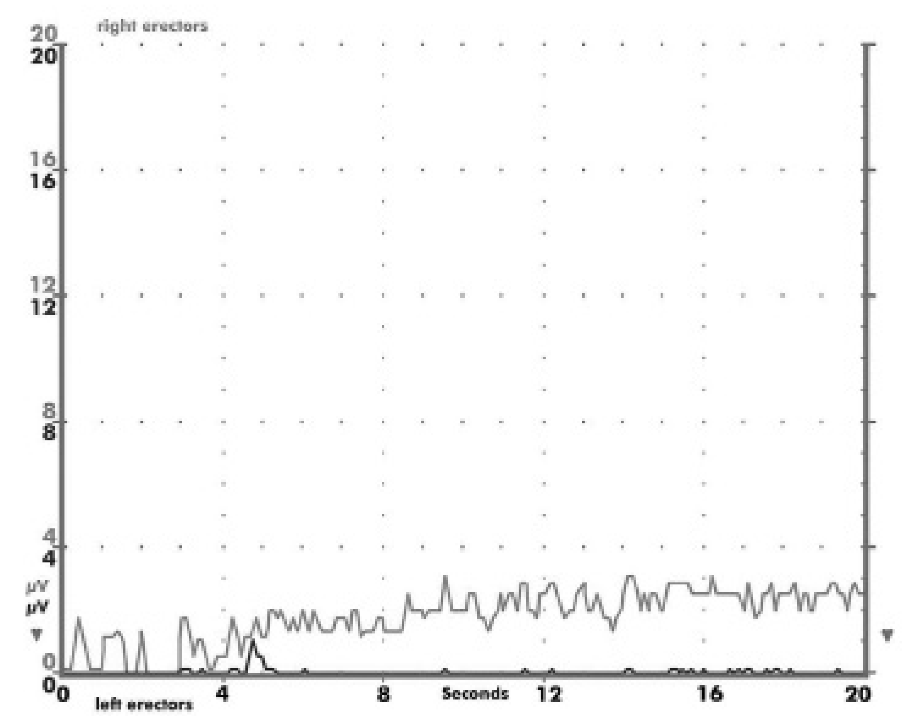
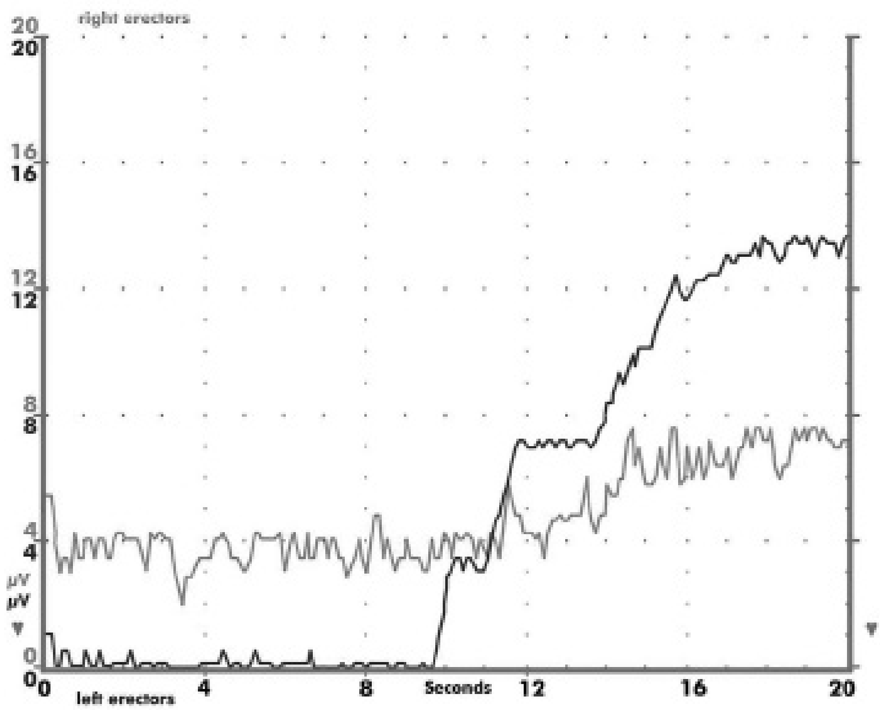


Figure 3:
Graphic representation of the EMG recordings of one subject: (a) voluntary sustaining of head against gravity, (b) progressive onset of involuntary EMG activity, more intense on the right side, (c) activity on the left side becomes more intense and (d) abrupt fall of signal at the end of maneuver, when tissue releases and hands are withdrawn.

c



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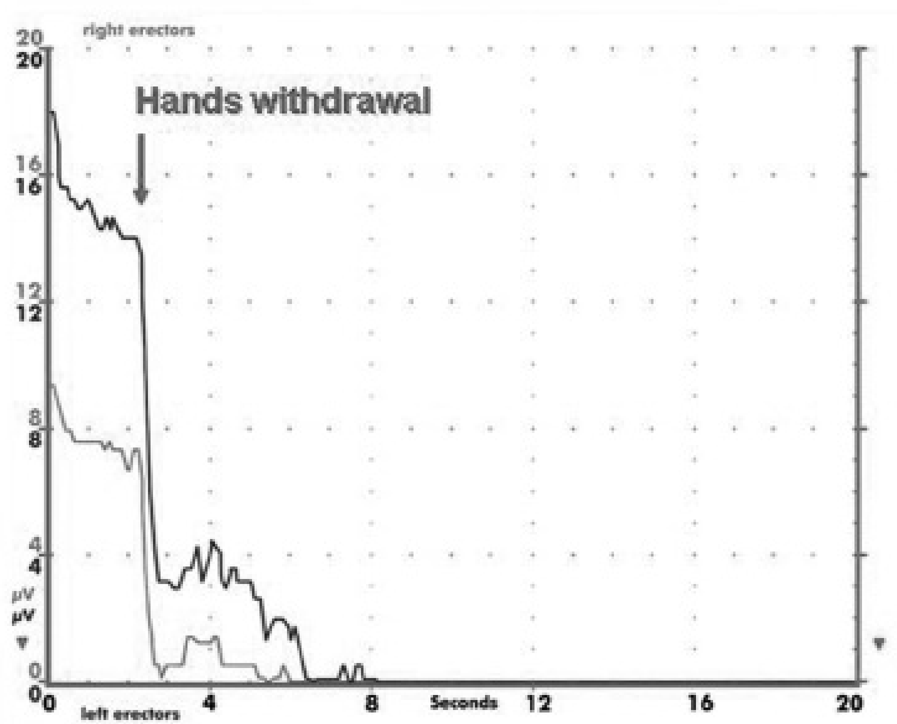


During the second half of the maneuver, involuntary horizontal eye movements were observed in four of the six subjects (see video links). These movements of the cornea (as it projects outward in relation to the sclera) were observable on the surface of the eyelids. They were mostly slow, periodic, side-to-side horizontal movements, the amplitude and velocity of which varied during the maneuver. The videos can be seen at the link http://musclerepositioning.blogspot.com/, where additional documentation is also available.

Discussion

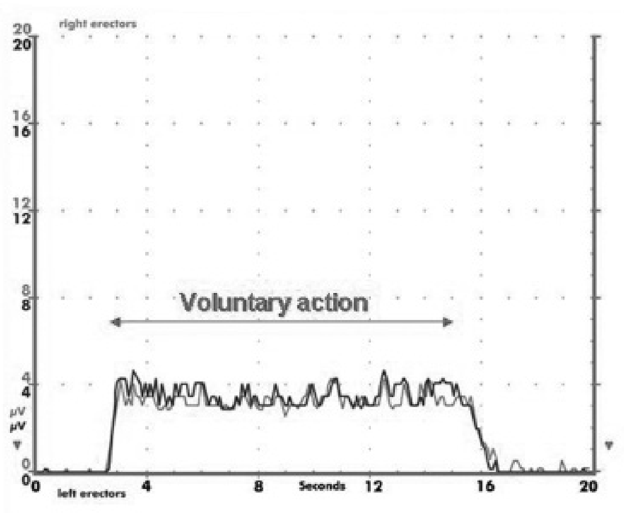
This article has two goals—one based on the experimental data presented above, and another based on the clinical observations. The first goal is to show the presence of an involuntary muscle reaction, which was absent prior to the maneuver, appeared during application of the maneuver, and disappeared almost immediately after the maneuver. The reference recordings are presented to illustrate the tracings of a sustained voluntary muscle action of the target muscles, but do not include a quantitative analysis of signal intensity. The second goal, based on five years' clinical observation of such involuntary muscle responses, is to describe what might constitute a novel manual technique. Therefore, prior to examining the experimental findings in more detail, it is important to understand certain key historical and conceptual aspects of MR.

History

The author developed the MR technique during his sixteen years' clinical practice in the treatment of musculoskeletal disorders. It started serendipitously during Rolfing Structural Integration sessions the author administered to other Rolfing practitioners. These "client" colleagues observed that the maneuvers they were receiving were somehow "different" from the techniques familiar to them. As they made this observation more and more often, the author and a group of Rolfing practitioners began an empirical research project to investigate whether MR was indeed significantly different, as a technique, from those techniques traditionally employed in Rolfing. At first, the author assumed the role of "client", and instructed the participants to perform MR-style maneuvers on him.

Figure 4:
Graphic representation of the EMG recordings of another subject: (a) voluntary sustaining of head against gravity, (b) progressive onset of involuntary EMG activity; (c e) progression of the maneuver, right side showing higher EMG signal, (f) left side shows some activity when right side signal is the highest, (g) left side shows higher activity than the right side when the maneuver ends and signal falls abruptly; signal persists on left side for a few seconds and (h) final relaxation.]

a



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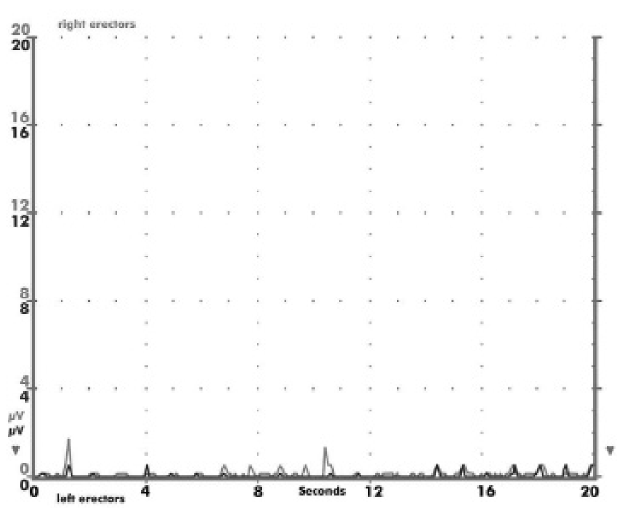

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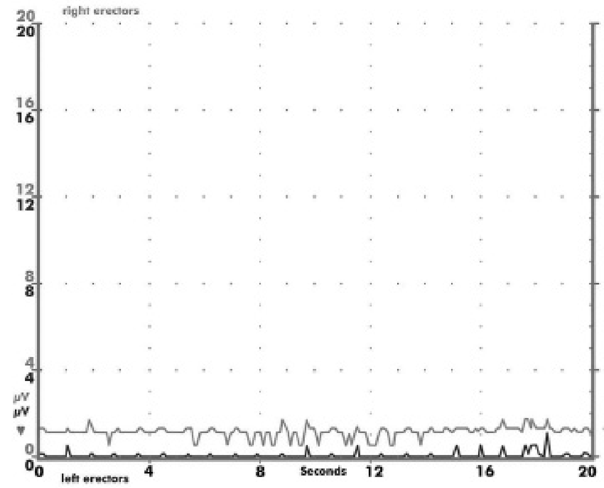

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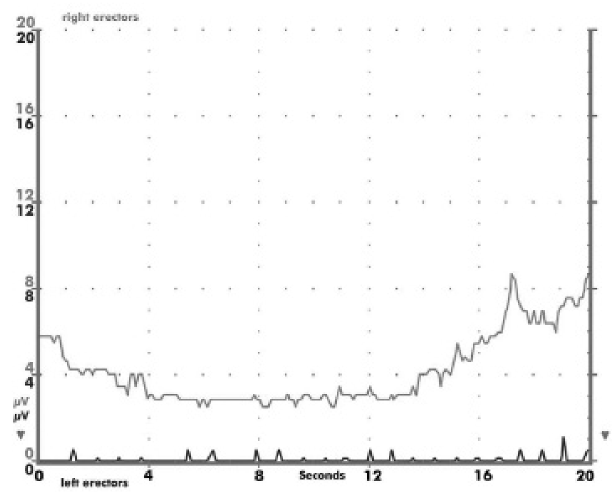

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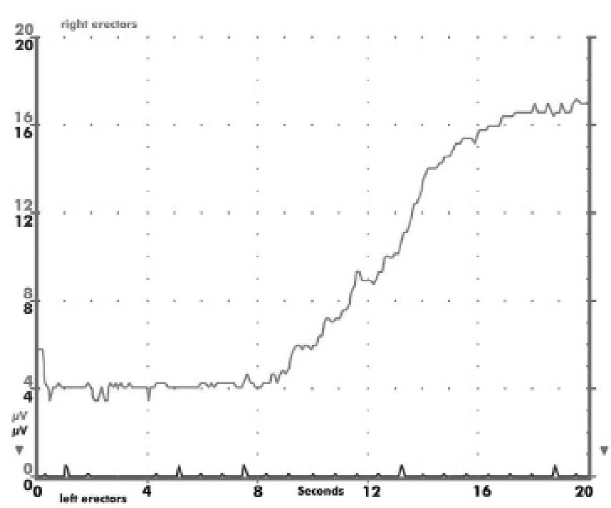

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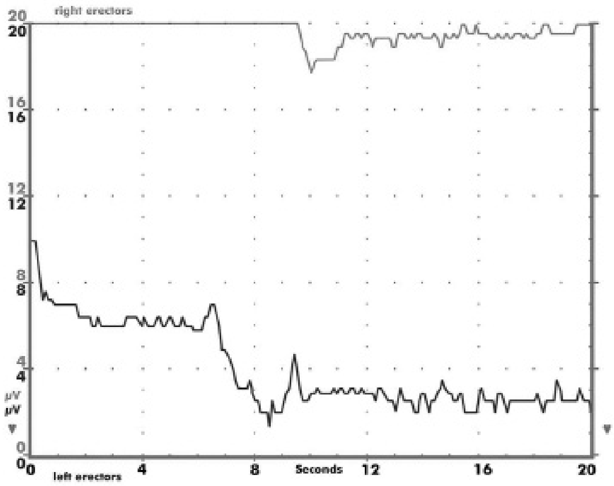

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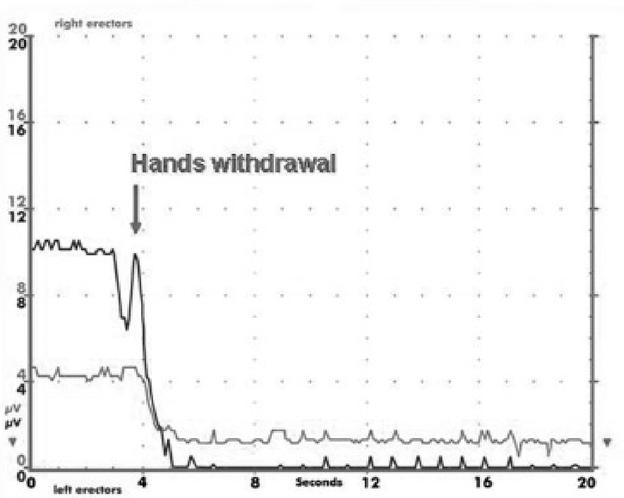

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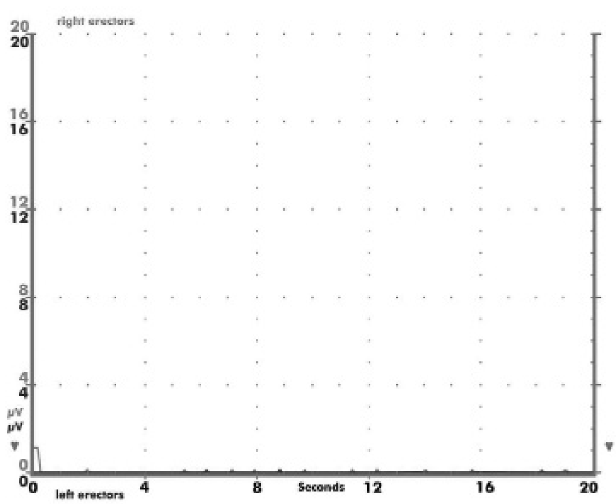

The participants immediately recognized the MR approach to be unlike their customary techniques. In particular, they were asked to rely on parameters they did not customarily consider, such as the firmness of the tissue they engaged during the maneuver and the integrative response of other body segments (*see* next section for details). Participants also recognized the sensations experienced by both client and practitioner as unfamiliar (*see* section below). Such particularities support the hypothesis that MR might be a distinct technique. It seems to affect the fascial system in a singular way, while engaging the nervous system at the same time. The main features of MR are summarized below:

Touch Integrates Body Segments

The technique begins with a singular way to engage and twist connective tissue structures (fascia) around harder structures (*e.g.* bones, joints). Initially, the practitioner's hands anchor a portion of skin and move it in relation to the underlying tissues in a particular way. The palpable resistance to this mechanical input guides the practitioner to orient the touch in the proper direction. Apparently, the input reaches first the superficial fascia, and then stresses progressively deeper fascial structures as the maneuver proceeds. A curious phenomenon then appears: a relative immobilization among the client's body segments, suggesting that stressing the soft tissues in this fashion generates an inter-segmental linking of body parts, which presents itself as unification (or integration) of the client's body into a single block.

This phenomenon can be seen (*see* video links) and also palpated when small shaking movements are imparted to the client's body. The body segments move in phase throughout the body, rather than in the waves through the segments that ordinary shaking induces. With MR, the segments move in synchrony; with ordinary shaking, the movement begins where the body first receives input, and reaches the rest of the body sequentially.

The client, too, senses the difference in the body's response to integrative versus ordinary shaking. When receiving the integrative touch, the client often describes a sensation of expansion in the cephalo-caudal direction, or the formation of an *axis* through the body. As discussed later, this brings to mind one of the sensations cultivated during the practice of certain martial arts. In the clinical experience of the author's group, the exploration of these sensations helps the client to differentiate various qualities of movements and postures in daily life.

The Sense of Firmness

Once the MR touch generates inter-segmental integration, the practitioner senses a unique firmness under the hands. It is a singular springy sensation that causes the force the practitioner applies to rebound. The feedback of this firmness is a hallmark of the MR technique, and should be present continuously as the technique is applied. The practitioner usually detects a progressive intensification of the firmness during the maneuver. The author believes that this phenomenon might be related to the tonic reactions described below.

Involuntary Reactions Suggest Involvement of the Nervous System

Until recently, the author interpreted the phenomena of inter-segmental integration and firmness as purely mechanical; i.e., twisting the fascias would tense them, which would compress the joints, which would unite the segments on either side of them. This might be accurate as far as it goes; but something beyond pure mechanics seems to be happening.

If the manual contact with the sense of firmness is sufficiently precise and sustained, another class of phenomena often follows: the client begins to show involuntary motor reactions of various kinds. The first reaction of this sort observed was a progressive isometric activity of the cervical erectors, during which the practitioner felt his hands pressed into the table by the involuntary extension of the subject's head and upper cervical spine. This reaction can be so strong that the muscular activity can be seen and palpated.

Other observed involuntary motor activities include horizontal eye movements, tremors, and clonic and tonic appendicular movements. A few subjects have even shown the extreme reaction of involuntarily rising from supine to a seated position (*see* video links). The observation of such phenomena led the author's group to hypothesize that the MR touch might stimulate neurological reflexes, and also to perform the preliminary measurements here described.

Broadening the Initial Hypothesis

The EMG data presented here represent the first attempt to test the aforementioned hypothesis. Having detected tonic cervical reactions during a maneuver in the occipital region in all subjects tested, the author then watched for similar muscular activity in response to other maneuvers and in other body locations. So far, a maneuver in the thoracic region of one subject has elicited involuntary activity in the cervical erectors. The same technique evoked tonic activity in the abdominal muscles of another subject (*see* video links). These initial data suggest that evocation of reflexive motor activity might be a hallmark of MR in general—a hypothesis that awaits clarification based on further EMG recordings. Perhaps the cervical reaction was the first one observed clinically because the upper cervical spine's density of muscle spindles, higher than in any other spinal region (Kulkarni *et al*., 2001), renders the cervical segment especially sensitive to MR stimulus.

Does MR provide a procedure-specific sensory input that activates those neural reactions? Such reactions were observed only when this particular technique was applied. By contrast, local (sham) maneuvers in the occipital region—with no attempt to induce the characteristic inter-segmental unification and firmness—failed to produce the reactions. It has been demonstrated that mechanical strain of the ligaments and muscles of the spine evokes reflex activation of the paraspinal muscles (Holm *et al.*, 2002; Solomonow *et al.*, 1998). Similarly, the MR mechanical input might stimulate mechanoreceptors (*e.g.*, those in the spinal facet joints, joint capsules and ligaments, as well as proprioceptors in the cervical muscles) to create a combination of afferent discharges to the central nervous system that produce the reactions described —probably all of which are reflexive.

Mechanical and Neurological Basis for Segmental Integration and Firmness

In the experience of the author's group, a certain degree of firmness—and also inter-segmental integration—arises at the outset of a maneuver. What's more, during the course of the maneuver, both reactions show a progressive increase in their intensity. Therefore, the author proposes that such firmness might result from the concerted action of two factors—one mechanical and the other neurological. The mechanical factor is generated by the practitioner's hands; and consists of the particular combination of forces (*i.e.*, tension, compression and shear) imparted to the subject's fascial system. Such forces, when added to the pre-existing forces in the fascial system, might compress the joints enough to produce the degree of firmness that arises at the start of the maneuver. If the duration of the mechanical input is sufficient, the second factor apparently comes into play: the nervous system seems to engage to generate a progressively higher tonic response, which might account for the progressively intensifying sense of firmness during the maneuver. The sense of firmness intensifies in parallel with the increased intensity of the EMG signal. When these reach a maximum point, both decline precipitously—and at that moment, the practitioner feels the tissue release.

Tonic Reactions Might Be Related to Postural Reflexes

Based on the following, the author hypothesizes that the neurological responses observed might be related to tonic postural reflexes:

The responses extend the cervical spine, which is an anti-gravity action.

As the maneuver progresses, the practitioner can sense (through the small shaking movements) the progressive engagement of spinal segments until the whole trunk and legs feel integrated as a single unit—a quality conducive to the maintenance of body position against gravity.

EMG tracings obtained in the abdomen are similar to those obtained in a subject standing still (*see* video links).

MR maneuvers induce in many subjects sensations similar to those that arise during the practice of some martial arts, in which (as discussed later) postural reflexes are cultivated.

Following MR treatments, subjects frequently report greater perceived stability in standing and walking.

Experienced practitioners have also observed that the quality of the subject's movement becomes more stable, integrated and fluid. In this sense, MR appears to be an approach that simultaneously releases myofascial restrictions and provides postural integrative stimulus.

Involuntary Eye Movements and Shifts of Consciousness

Vision is central to postural regulation. In particular, gaze control is closely related to the position and movement of the head. In humans, gaze is controlled primarily by vestibular reflexes, through the vestibulo-ocular reflex (VOR). But additional reflex pathways that influence oculo-motor activity come from the neck—*i.e.*, the cervico-ocular reflex (COR) (Fuller, 1980; Jurgens and Mergner, 1989), which functional relevance is still unclear. The COR has both slow and fast components. The former is also elicited by other axial body stimulus, *e.g.*, of the trunk and legs (Mergner *et al*., 1998). Perhaps the tonic activity of the cervical erectors during the maneuver stimulates mechanoreceptors in the neck—which would induce slow-phase COR-like responses, which, in turn, would generate the involuntary eye movements. These eye movements were observed when particular head positions (unique to each subject) were maintained for sufficient time. Such stimulus might also produce saccule and utricle afferents and evoke responses normally associated with the VOR. Semicircular canal afferents are not likely to contribute, as the eye movements occurred when the subjects' heads were stationary.

The mechanisms and physiological importance, if any, of such eye movements are unknown. One might speculate, taking into account the possible connection between the MR technique and the mechanisms of postural tonus control, that these eyes movements represent an adaptation of oculo-motor control mechanisms to altered postural tonic reflexive patterns.

Other intriguing events often accompany the eye movements, such as shifts in breathing rhythm (deeper exhalation and reduced frequency), as well as shifts in consciousness. After MR treatments, subjects described having been "asleep and awake at the same time" or in "dream-like state", having lost track of time, and similar states. Although the significance of this is unknown, it appears that autonomic and reticular formation afferents might be affected by the MR sensory input.

Clinical Efficacy and Reflex Reactions

First, as already discussed, a positive correlation has been observed between the intensity of the tonic reaction (as measured by the EMG signal) and the degree of palpable tissue firmness. Second, in the author's clinical experience, the greater the maximum firmness during a maneuver, the more effective the clinical outcome. If these correlations are indeed characteristic of the MR technique, eliciting such neural reflexes in clinical practice would be desirable in and of itself, in that their presence might very well enhance the effectiveness of the treatment.

Our subjects were asked to make subjective self-assessments of certain physical characteristics before and after the maneuvers. The clinical effects the subjects reported after the maneuvers were: greater ROM of the head, overall muscle relaxation, a sense of lightness throughout the body, and often more stability in the feet. Although not objectively verified, these subjective observations suggest that after the maneuver, muscle tonus decreases. Other authors have already documented elevated EMG signals during a manual procedure and a drop off afterwards (DeVocht *et al*., 2005; Herzog, 1996). The practitioner's subjective experience is of increasing tonic muscular activity in the cervical region, during which the subject's system seems to be struggling against some resistance (possibly from soft tissue restrictions), followed by a sudden diminution in tonus (possibly a sign that the resistance has been overcome, see Surgical Touch section below), accompanied by a sense of release and relaxation.

Perhaps the tonic activity enhances the efficacy of the maneuvers by creating more support for the practitioner's manipulations. Given the characteristic progressive rise in firmness, one might be observing a positive feedback loop in which the more supported the subject's body, the stronger the tonic reaction—which reaction, in turn, induces even greater firmness (more support), and thereby greater efficacy to the touch. This cycle seems to build to a point at which both subject and practitioner feel the tissues release (possibly when tissue restrictions are overcome); thereafter, both tonic reaction and firmness abruptly diminish.

QUESTIONS AND IMPLICATIONS

Tonic Response As a Possible Mutual Regulatory Mechanism

The MR practitioner senses that the subject's system recognizes the manual input and actually responds to it. An observation from MR training classes illustrates the point. As a pedagogical method, the instructor often places his own hands over the student's hands to monitor the subject's response.

When the student achieves the "right" feeling, two things happen at once: the student finds the manual sensation pleasant; while the subject immediately senses that the mechanical stimulus is appropriate, and expresses this with words such as, "This is what I need," "Don't stop," or "You got it."

The subject's reaction appears to be induced by the student's contact, and not by some suggestion as a result of the instructor's presence. The shift in sensation that the subject and student experience simultaneously takes place not immediately upon the instructor's intervention, but only after the passage of some time, the length of which is variable. What's more, the mutual experience of "rightness" between the subject and student endures even after the instructor has moved on. Therefore, it seems that the subject and student have formed a relationship at the sensory level, in the context of which they mutually and simultaneously identify a very specific stimulus as "right."

It might be that MR stimulates some atavistic mutual regulatory mechanism, and that the interaction between practitioner and subject is similar to grooming behaviors of primates and other animals? In the clinical experience of the author's group, a client's expressed sense that the practitioner's touch is appropriate brings an element of safety to the work that actually strengthens the social bond of the therapeutic relationship. What's more, the activity of self-observation enriches the client's experience. It is possible that the phenomena observed in connection with MR might be no more than the result of the client's self-observation, as opposed to being the product of any neural mechanism. However, minute shifts in the quality of touch produce clear changes in the client's experienced sensations; the feeling of "rightness" may be replaced by the sense of "simple pressure," or even "threatening pressure."

In any event, within the context of an ongoing therapeutic relationship, the client's reports of those observations can inform the practitioner's treatment decisions.

The Possibility of Simultaneous Diagnosis and Treatment

When, as is commonly the case, a manual therapist first performs diagnostic tests and then proceeds to treatment, diagnosis and treatment are discrete events. However, in MR, the reflex reactions (manifested as firmness to the touch) are a continuous source of diagnostic information that might facilitate the work as it is happening. In addition to pre-treatment diagnosis, the MR practitioner can monitor the results of the maneuver in real time and adjust the mechanical input accordingly. In other words, the practitioner's diagnosis and treatment occur simultaneously as a single event.

In the clinical experience of the author's group, when the sense of firmness is lost, so is the inter-segmental integration. What's more, the subject senses the touch no longer as global and comprehensive, but rather as no more than a local stimulus. If the practitioner ceases to feel the firmness, the qualities of the touch should be corrected (*e.g.*, the practitioner should change the direction or nature of the forces) so as to reconnect with the sense of firmness. At that point, both the practitioner and the subject re-experience the characteristic sensations.

This singular and reliable phenomenon of firmness is one of the most important resources for both clinical practice and teaching of this method. Participants in the author's group have learned to trust the efficacy of directing touch toward the firmer sensation—even when this takes the maneuver on a different path than the one the practitioner might have expected at the outset. That having been said, we cannot be certain that the information the sense of firmness conveys is useful; we have not yet performed studies to compare the efficacy of the maneuver when the practitioner adjusts the mechanical input in response to the information to its efficacy when the practitioner disregards the information.

Physiological Monitoring Might Unite the Objective and the Subjective

If one accepts that the tonic reactions are physiological responses to mechanical stimuli, one might speculate that MR does indeed have a physiological basis. The client's system is participating automatically in the treatment. The firmness may be interpreted as a reflection of the client's physiologic state, to which the treatment is continuously connected and adapted. The proper location and direction of the necessary mechanical stimulus cannot be foreseen. Adjustments to combinations of forces, mainly shear and torsion, are required from one moment to the next.

As already discussed, the degree of firmness correlates positively with the intensity of tonic activity detected by the EMG. Because increased tonic muscle activity (like isometric contraction) could integrate body segments by reducing joint mobility, it is likely that the tonic reactions actually cause the firmness. It follows that the EMG signal could be a surrogate for the firmness as a feedback mechanism to guide the quality of the touch. As the EMG signal is an objective measurement alongside the firmness, which is subjective, this approach potentially brings the objective and the subjective into congruence.

As discussed above (see Introduction), most studies dealing with objective monitoring of physiological effects of manual therapies are before-and-after studies. While these might help us to understand the possible physiological effects of the manual therapies, they do not constitute a resource towards objectivity.

In contrast, real-time measurements that can be used as feedback tools might yield more objective ways to study and teach manual therapies. Some studies (Burns *et al*., 2007; Descarreaux *et a*l., 2006; Harms *et al*., 1999; Rogers and Triano, 2003; Triano et al., 2003, 2006; Van Zoest and Gosselin, 2003) have already shown the potential benefits of using feedback signaling in the teaching of manipulative therapies. At the same time, there is evidence that it is possible to immediately influence neurophysiologic variables through touch (*e.g.* Colloca *et al.*, 2003; DeVocht *et al.*, 2005; Symons *et al.*, 2000). Therefore, there is a theoretical possibility that the monitoring of physiological variables may serve as feedback and thus lend objectivity to the practice of manual techniques. Particularly noteworthy in this regard are the findings, similar to those described here, of sustained increase of EMG during a manual treatment of the spine. (DeVocht *et al.*, 2005).

The author knows of no other descriptions in the literature of manual techniques using real-time monitoring of physiological variables as feedback for continuous adjustment of quality of touch. MR is well suited to such monitoring because: (a) the maneuvers are long lasting and (b) the signal is continuously present during the maneuver.

This gives the practitioner the opportunity to actually monitor the client's response to his manual input. If a certain objective signal were indeed to correspond to a desired client reaction, the appearance of which depends on the technical adequacy of the touch, the potential value of such monitoring would be obvious. In the teaching setting, the subjective sense of firmness could be tuned by comparison to the objective EMG signal; in the development of treatment protocols, the EMG could serve as an objective criterion. Greater objectivity, precision and reproducibility are all possible outcomes of such an approach.

Surgical Touch and Myofascial Force Transmission

To achieve the desired firmness, the MR practitioner approaches the soft tissues at an oblique angle. This angle—coupled with the counter-pressure given by the inertia of the integrated body segments —seems to direct the resultant vectors so as to produce internal shear forces among musculoskeletal structures in very precise directions. During the maneuver, the result of such combination of forces is a clear sensation of relative movement among myofascial compartments. Initially, it takes place in small increments, which grow larger toward the end of the maneuver and are commonly followed by the subject's experience of a burning sensation.

To the practitioner, the feeling resembles that of the blunt dissection surgical technique, in which the surgeon discriminates neighboring structures with a blunt instrument—often the fingers. In surgery, blunt dissection generates minimal lesions because it discriminates structures at pre-existing points of natural separation —along the so-called planes of cleavage. Although, of course, the MR practitioner lacks the advantage of the visual input that exposed tissues provide the surgeon, the tactile input is similar. Therefore, during an MR maneuver, it is sometimes possible to discern which of the compartment's cleavage planes are likely to be involved, especially when addressing larger muscle compartments.

Perhaps MR directs and concentrates forces so as to release abnormal adhesions in irregular connective tissue (tissue in which fibers lack the type of directional orientation found in regular connective tissue such as tendons), within muscle compartments, and among other fascial structures. As these adhesions influence relative muscle positions, one might speculate that one of MR's mechanisms of action is reestablishment of relative muscle mobility, which allows the muscles to assume optimal relative positions during movements. Such repositioning might in turn lead to more advantageous myofascial force transmission, as described by Huijing (Huijing and Baan, 2003) and hence an improved motor function.

MR and Martial Arts

In the author's personal experience as a practitioner of martial arts, the tonic reactions described here bear a striking resemblance to postural and movement qualities cultivated in certain Chinese martial arts, such as *Tai-Chi-Chuan* and *I Chuan*. These disciplines include exercises intended to optimize involuntary postural reactions. Some sensations the exercises produce are the same as those observed during MR, such as the sense of expansion along the cephalo-caudal dimension; the inter-segmental integration; and the sense of firmness that should be present when exercises are performed with a partner. During such martial arts exercises, called *tui-shou*, in which the practitioners play with each other's postural balance, the presence of firmness in the contact interface—as well as its absence—is continuously tested in a manner similar to how firmness is tested during MR maneuvers. In fact, the author's martial arts peers have commented upon this similarity while receiving MR maneuvers. Notably, these Eastern disciplines are known to cultivate positive qualities of posture and movement that correlate with overall health and longevity (See, *e.g.*, Esch *et al*., 2007; Gorgy *et al*., 2008; Greenspan *et al*., 2007; Hong and Li, 2007; Yamaguchi, 2004). One can speculate that MR might similarly stimulate physiological self-regulatory motor and postural mechanisms. These changes are possibly reflexively mediated, as is the increase in muscle force after spinal manipulation, which has been documented previously (Keller and Colloca, 2000; Suter *et al*., 2000).

CONCLUSION

The conclusions that can be drawn from the material reported in this article are limited because the study used a single clinician. Currently, additional EMG evaluations are being undertaken involving other clinicians, different muscle groups and different maneuvers to confirm and expand upon the observations described here.

Future plans include development of qualitative research protocols to investigate the sensations experienced by both subject and practitioner, as well as electroencephalography (EEG) measurements to investigate the possibility of characteristic cortical rhythms. These data, matched to EMG readings, might reveal some important correlations. It is the author's hypothesis that characteristic EEG tracings (possibly related to the sensory-motor rhythm—SMR), EMG signals and subjective sensations will occur simultaneously during administration of the MR touch.

The practitioners in the author's group have been teaching MR in an experimental fashion for four years—primarily within the Rolfing community but also to chiropractors and physical therapists. The feedback is most encouraging, and although the data gathered in the student questionnaires are not yet formally arranged, their overall tone suggests that the results are worth the effort. The author believes that MR can be used in various therapeutic settings—either as the principal technique, or as an adjunct to a variety of principal approaches.

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POSTSCRIPT

The insights gleaned from the observations set forth in this article led our group to make further studies of MR. Summarized below are some recent observations, from both clinical experience and objective measurement, that we are using to refine our research protocol.

First, recent EMG recordings have shown that the MR touch can indeed evoke tonic activity in body regions distant from the contact region. For example, maneuvers in the costal arch have elicited involuntary tonic activity in cervical erectors and abdominal muscles. Second, once tonic activity is elicited during a maneuver, it appears to maintain itself with the support of progressive, but *less intense*, manual input; i.e., the tonic activity, once evoked, seems to be self-perpetuating. Finally, based on the clients' reported sensations, these remote tonic reactions seem to cause spontaneous tissue release. We have been exploring and observing the self-organizing quality of these reactions. Significantly, the intensity of a client's felt sense of tissue opening is sometimes greater remotely than locally, and seems to correlate with the perceived degree of *firmness*. Such firmness, in turn, tends to be directly proportional to the number of bodily segments *integrated* during the maneuver (*see* new video documentation at http://musclerepositioning.blogspot.com).

In other words, correlations among key features of MR—the EMG response, the firmness and integration (observed by the practitioner), and the sensations of tissue opening (reported by the client)—are becoming clearer.

The intentional inducement of remote client-generated spontaneous responses is accompanied by some noteworthy phenomena: the client's subjective experience is increasingly reminiscent of the languid tonic movement quality of the spontaneous morning stretch. In this connection, it also appears that visceral structures are being affected. These observations support the hypothesis of a physiological basis for the effects of MR, and also suggest ways that the practitioner's touch can be trained to be more efficient.

We have also begun to perform simultaneous EEG and EMG measurements. Outstanding among our recorded observations is the so-called sensorimotor rhythm (SMR) during an occipital region maneuver. The SMR was first described in cats[1] and is associated with motor learning. Apparently, while the cat is at rest and purring, it is processing the proprioceptive information stored in recent memory in order to enhance its motor capabilities. Neurofeedback training of the SMR rhythm has been used to treat disorders of learning and attention[2], as well as seizures[3]. Our observations of SMR, although preliminary, are exiting because they suggest the possibility of inducing recognizable auto-regulatory mechanisms through manipulation.

In keeping with these observations, our new research protocol will include EMG and EEG recordings, along with questionnaires to gather reports of the clients' and practitioners' subjective experience and observations. Moreover, to correlate these data with functional variables, we will include stabilometry recordings to assess standing balance.

We hope soon to have a more comprehensive understanding of these phenomena, both theoretically and practically, to share with our colleagues in the MR workshops we offer.

END NOTES

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