Muscle Repositioning: Combining Subjective and Objective Feedbacks in the Teaching and Practice of a Reflex-Based Myofascial Release Technique

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Muscle Repositioning (MR) is a new style of myofascial release that elicits involuntary motor reactions detectable by electromyography. This article* describes the principal theoretical and practical concepts of MR, and summarizes a workshop presented October 31, 2009, after the Second International Fascia Research Congress, held at Vrije Universitiet, Amsterdam.

The manual mechanical input of MR integrates the client's body segments into a block, which is evident as a result of the diagnostic manual oscillations the practitioner imparts to the client's body. Segmental integration is achieved when the client's body responds as a unit to the oscillatory assessment. It appears that manually sustaining the condition of segmental integration evokes involuntary muscle reactions, which reactions might correspond to mechanisms that maintain homeostasis, such as pandiculation. It might be that these reactions are part of the MR mechanism of action and underlie its clinically observed efficacy in the treatment of musculoskeletal disorders.

For the practitioner and the client alike, segmental integration provides unique sensations. In teaching MR, these paired sensations can be used as kinesthetic feedback resources, because quality of touch can be guided by the client's reported sensations, which should match the practitioner's sensations. Another form of feedback with respect to quality of touch is the visually discernable degree of segmental integration. Finally, because the involuntary motor activity elicited by the MR touch can be objectively monitored through electromyography and possibly other instrumented measurements, the MR approach might yield objectivity, precision, and reproducibility—features seldom found in manual therapies.

* The present work builds on part of an earlier publication: Bertolucci LF. Muscle Repositioning: a new verifiable approach to neuro-myofascial release? *J Bodyw Mov Ther* 2008; 12(3): 213–224.

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INTRODUCTION

Muscle Repositioning (MR) is a new style of myofascial release that elicits involuntary motor reactions detectable by electromyography[1,2]. The MR technique was discovered serendipitously during Rolfing Structural Integration sessions that the author administered to other Rolfing practitioners.† The "client" colleagues noted that the work they were receiving felt somehow different from techniques familiar to them. The observation was made so frequently that the author and a group of Rolfers undertook an empiric investigation of whether MR was indeed significantly different, as a technique, from techniques commonly employed in Rolfing.

The participants confirmed that the MR approach was unlike their customary techniques. They had to rely on parameters that they did not customarily consider, such as the firmness of the tissue engaged during the maneuver and the integrative response of other body segments. They also recognized as unfamiliar the *sensations* that client and practitioner alike experienced. The participants concluded that MR was most likely a distinct technique. It seems to affect the fascial system in a singular way, while simultaneously engaging the nervous system in a manner that might evoke homeostatic mechanisms. The principal concepts of MR are summarized in the subsections that follow.

Tissue Manipulation Integrates Body Segments

One hallmark of MR is a distinctive way of engaging and twisting connective tissue structures (fascia) around harder structures (bones, joints). First, the practitioner's hands anchor a portion of skin and move it in a particular way relative to the underlying tissues.

† Rolfing and Rolfer are service marks of the Rolf Institute of Structural Integration, Boulder, CO, U.S.A.

The palpable resistance to the initial 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. Something strange then happens: The client's body segments become immobile relative to each other, suggesting that the particular way in which MR stresses the soft tissues elicits the intersegmental linking of body parts, manifested as an apparent "unification" ("integration") of the client's body into a single block.

Segmental integration can be seen (video links are available at http://musclerepositioning.blogspot.com/) and also palpated when small oscillations are imparted to the client's body. With MR, the segments move as one, whereas with ordinary oscillation, the movement begins where the body first receives input and reaches the rest of the body sequentially. As a diagnostic tool, the oscillations work like sonar: The resistance the practitioner feels in response to the manual mechanical perturbation—and simultaneous visual observation—inform the practitioner about the level of integration present in the client's body.

The client, too, senses the difference in the body's response to integrative as compared with random oscillation. When receiving the integrative touch, clients can feel the synchronous movement in response to the diagnostic oscillations, often describing a sensation of expansion in the cephalocaudal direction or the formation of an "axis" through the body. As discussed later, this sensation brings to mind the sensations experienced during pandiculation, as well as those cultivated during the practice of certain styles of martial arts and yoga. 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, which is important to the treatment and in the prevention of musculoskeletal disorders. Finally, these sensations can be an important source of feedback to guide the quality of touch when MR is taught.

A Characteristic Firmness to the Touch

Once the MR touch generates intersegmental integration, the practitioner senses a unique "firmness" under the hands. This distinctive springy sensation causes the practitioner's force to rebound. This firmness feedback is key to the MR technique and should be present continuously. In addition to being part of the technique, the sense of firmness is also a form of intrinsic feedback in both the practice and instruction of MR. Usually, the practitioner feels the firmness progressively intensify during the maneuver. The author believes that this firmness might be 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, and continual adjustments to the composition of forces, mainly shear and torsion, are necessary.

How does the MR practitioner elicit the characteristic firmness? The tissues must be approached at an oblique angle. This approach, together with counterpressure from the inertia of the integrated body segments, seems to direct the resultant vectors so as to produce internal shear forces among musculoskeletal structures in precise directions. A clear sensation of relative movement among myofascial compartments is produced. The movement happens in small increments, which become larger toward the end of a maneuver, after which the subject often feels a burning sensation. For the practitioner, the feeling resembles that of blunt dissection surgical technique, in which the surgeon discriminates neighboring structures with a blunt instrument, such as the fingers. Blunt dissection creates minimal surgical lesions because it discriminates structures at natural separation points—along the planes of cleavage. In an MR maneuver, the practitioner can often discern which cleavage planes are most likely involved.

Perhaps the direction and concentration of forces in MR release abnormal adhesions in areolar connective tissue within muscle compartments and between other fascial structures. Because these adhesions influence relative muscle position, one of MR's possible mechanisms of action could be to re-establish relative muscle mobility and to let the muscles optimize their positions relative to each other in movement. This optimized relationship might produce better myofascial force transmission, as described by Huijing(3), from which better motor function might follow.

Involuntary Motor Reactions Suggest Involvement of the Nervous System

When manual contact with the sense of firmness is sufficiently precise and sustained, the client begins to show involuntary motor reactions of various kinds. These kinds of reactions were first recorded during a maneuver in the occipital region: isometric activity of the cervical erectors appeared and progressively intensified during the maneuver. Simultaneously, the practitioner felt his hands pressed into the table by the involuntary extension of the subject's head and upper cervical spine. The reaction can be strong enough for the muscular activity to be both seen and palpated (demonstrated at http://musclerepositioning.blogspot.com/).

Other involuntary motor activities observed include eyelid flickering, 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 (demonstrated at http://musclerepositioning.blogspot.com/). The observation of such phenomena led the author's group to hypothesize that the MR touch might stimulate physiologic neural reflexes, and to perform electromyographic (EMG) measurements to test the hypothesis.

EMG Monitoring Confirms Involuntary Motor Activity

In a previous study[1], EMG monitoring of the cervical erectors during an MR maneuver at the occiput showed the presence of an involuntary muscle reaction, absent before the maneuver, that appeared during application of the maneuver and disappeared almost immediately after the maneuver (Fig. 1). Involuntary horizontal eye movements were also observed (demonstrated at http://musclerepositioning.blogspot.com/). These movements were mostly slow, periodic, side-to-side horizontal movements, the amplitude and velocity of which varied during the maneuver. In a new set of EMG recordings[2], a maneuver in the thoracic region also elicited involuntary tonic activity in the cervical erectors (Figs. 2 and 3), in conjunction with synchronic lumbar activity in half the subjects. Taken together, these data suggest that evocation of reflexive motor activity might be a hallmark of MR in general.

Does MR provide a "procedure-specific" sensory input that activates the neural reactions? The reactions were elicited only when MR technique was correctly applied and not when local (sham) maneuvers were made with no attempt to induce the characteristic intersegmental unification and firmness. Mechanical strain of spinal ligaments and muscles has been shown to elicit reflex action of the paraspinal muscles[4,5]. The mechanical input of MR might similarly stimulate mechanoreceptors (for example, those in the spinal facet joints, joint capsules, and ligaments, and in the proprioceptors in the cervical muscles) to produce a particular combination of afferent discharges to the central nervous system, resulting in the apparently reflexive reactions described.

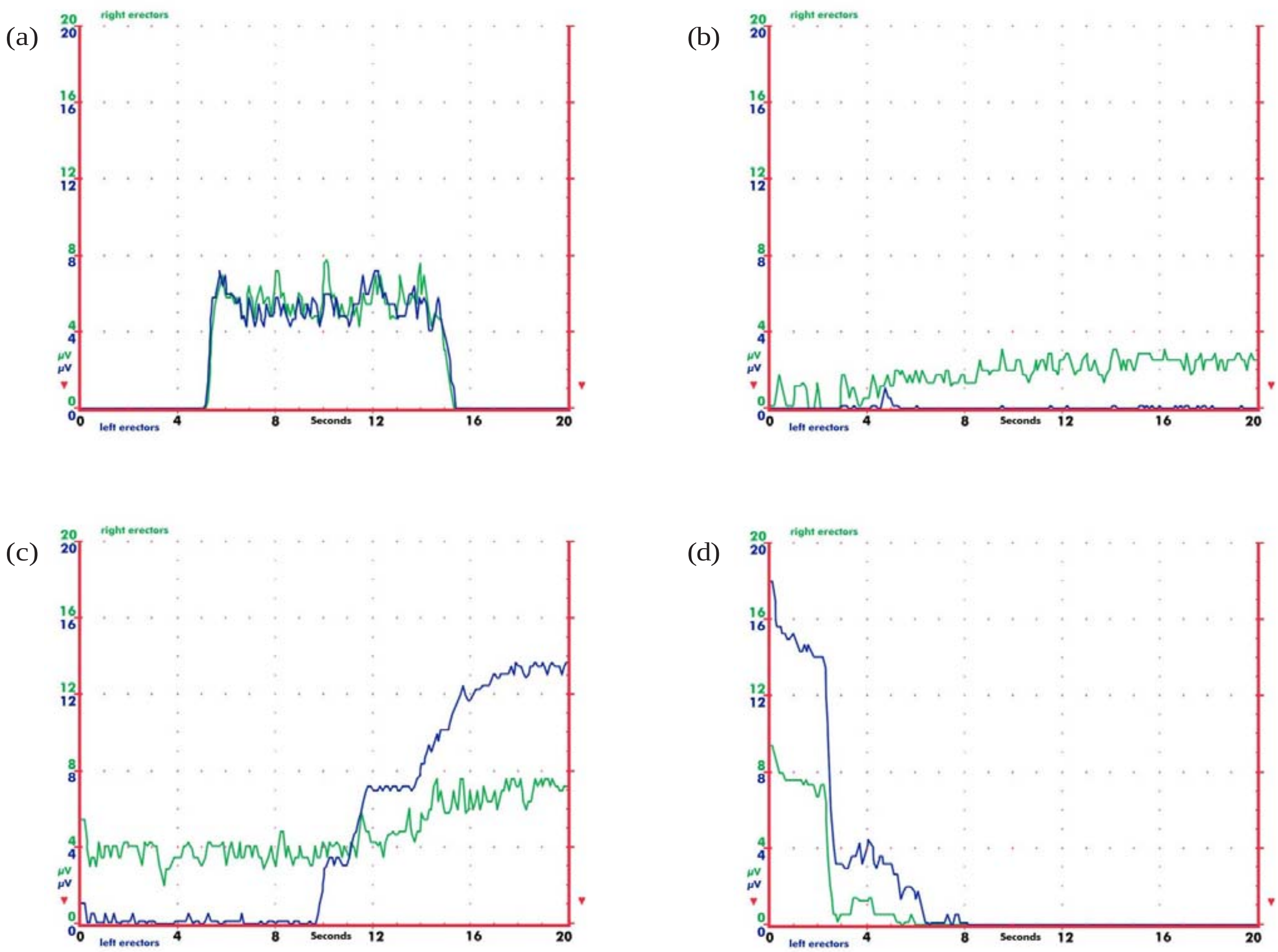

FIGURE 1. Involuntary cervical reaction during Muscle Repositioning maneuver in occiput: excerpts from electromyographic (EMG) recordings in one subject, showing (a) voluntary sustaining of head against gravity; (b) progressive onset of involuntary EMG activity, more intense on the right side; (c) activity on the left side becoming more intense; and (d) abrupt fall of signal at the end of the maneuver, when tissue releases and hands are withdrawn. The signal starts a variable amount of time (0.5 – 1 min) after the start of the maneuver, which often lasts 5 – 15 minutes. Signal is in microvolts; time is in seconds. Illustration previously published in Bertolucci 2008[1].

FIGURE 2. A Muscle Repositioning maneuver in the thorax. The practitioner applies a set of forces that elicit muscle tonic reactions. In this case, lumbar and cervical erectors are monitored on the right.

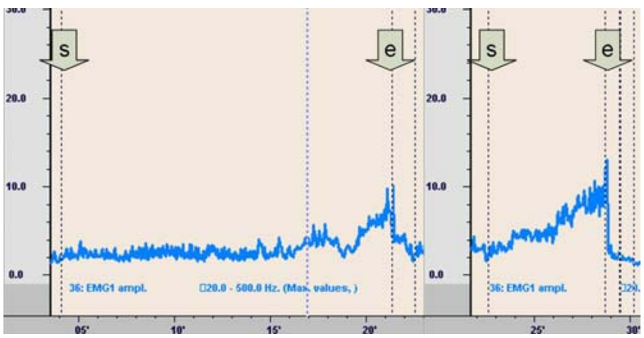

FIGURE 3. Involuntary cervical reactions during two subsequent thoracic Muscle Repositioning maneuvers. During the maneuver, the signal becomes progressively higher, peaks at or near the conclusion of the maneuver, and drops thereafter. Electromyographic (EMG) activity was more pronounced and ensued more quickly during the second maneuver. Signal is in microvolts, time is in minutes. s = start of maneuver; e = end of maneuver.

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 MR, eliciting neural reflexes would be clinically desirable in and of itself, because their presence might very well enhance the effectiveness of the treatment.

Perhaps the tonic activity enhances the efficacy of the maneuvers by evoking self-induced tissue stretching—that is, the internal forces produced by the involuntary reactions might participate in tissue release. The characteristic *progressive* rise in firmness suggests a positive feedback loop in which the longer the manual contact, the stronger the tonic reaction—which reaction, in turn, induces even greater firmness 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, tonic reaction and firmness both abruptly diminish. This involuntary tonic muscle action is reminiscent of pandiculation, as discussed next.

Similarities Between MR and Pandiculation as Homeostatic Activities

The responses induced by MR appear similar to those of pandiculation: an involuntary soft tissue stretch (Fig. 4) that occurs in most animal species and is associated with transitions between cyclic biological behaviors, especially sleeping and waking. Yawning is a special case of pandiculation that affects the mouth, respiratory system, and upper spine[6]. When yawning is accompanied by pandiculation in other body regions[7,8], the combined behavior is called the "stretch–yawning syndrome."

The yoga asana Downward Dog (Fig. 5), like many others, is reminiscent of an animal pandiculation position[9]. In fact, some say yoga is derived from automatic and spontaneous actions of sages deep in meditation, and that yoga should be practiced spontaneously[10]. Similarly, elements of martial arts training forms are also described in terms suggestive of animal pandiculatory patterns‡.

In the author's personal experience, the practice of *lao qi gong* requires automatic (involuntary) tonus in the deep postural muscles while the superficial muscles associated with voluntary activity are

FIGURE 4. A pandiculating cat: In pandiculation, soft tissue spontaneously stretches to achieve maximum body dimensions. (From http://yawning.info, reproduced with permission).

‡ W.Y. Cai (Associação Cai Wen Yu, São Paulo, Brazil, *lao qi gong* master). Conversation with the author; September 14, 2009.

relaxed (Fig. 6). Under these conditions—which cannot be produced voluntarily, but which emerge spontaneously with appropriate states of attention that enhance mechanosensing—the body is integrated as a whole and all its parts move synchronously. A blow delivered by this body would do no more than release stored elastic potential energy. This characteristic of *lao qi gong* suggests a tensegrity-based mode of action with a high pre-stress level. In fact, in the author's experience, the subjective sensations induced by some *lao qi gong* exercises are similar to those induced by pandiculation.

In any event, like the loading of pandiculation, the loading by MR of the myofascial system seems to integrate body segments by inducing co-contraction of antagonist muscles[1] in a way that elicits a measurable rise in tonic muscle activity indicative of an overall increase in tensional load in the fascial system, which load increase is likely to unite bodily segments.

FIGURE 5. Downward Dog: As in pandiculation, the subject seeks maximum body dimensions and stretches soft tissues accordingly.

FIGURE 6. Lao qi gong*: Instructor demonstrates a pose that should elicit a pandiculation-like response. Expansion of body dimensions and spontaneous motor action are features of pandiculation.*

In pandiculation, muscle activation begins locally and spreads to neighboring areas until it reaches a peak of distribution and intensity—that is, joints *progressively* stiffen through a chain of reflexes, in which neighboring segments are sequentially engaged to form an ever-larger block that eventually encompasses the entire body. Following the peak, the tissues release. A similar progressive engagement of body segments is induced by MR. The inclusion of each segment increases the overall tension within the block until, following the peak, the practitioner feels an abrupt soft-tissue release. The progressive segmental engagement is paralleled by an increasing involuntary tonic muscle activity observable both by palpation and by electromyography[1].

The author hypothesizes that MR and pandiculation elicit similar muscle activity because the manual forces applied during MR maneuvers mimic internal forces well enough to elicit mechanoreceptor afferents similar to those of pandiculation. In the clinical setting, MR clients have made spontaneous pandiculation-like movements (demonstrated at http://musclerepositioning.blogspot.com/) and have described their subjective experiences during MR as similar to their experiences during pandiculation. Some even report having resumed pandiculating in the morning, to which they attribute a greater sense of bodily well-being and relief from musculoskeletal symptoms.

Might MR be a combination of myofascial release and "assisted pandiculation," with the soft-tissue release elicited by a combination of the practitioner's manual input and the internally generated forces of tonic pandiculation-like reactions? If so, this combination of forces might produce a greater effect in the soft tissues than either routine manual input or pandiculation alone.

Is Tonic Response a Homeostatic Mechanism?

The utility of the client's reported sensations as feedback on quality of touch suggests that MR might be considered an "assisted" homeostatic drive, with mechanosensing afferents comparable to those underlying pandiculation behaviors. Similarly, when Ida Rolf began to explore her ideas, one of her first "successful" clients actually *guided* her touch[11].

The MR practitioner senses when the subject's system "recognizes" the manual input and actually responds to it. For example, as a pedagogical method, instructors often place their own hands over a 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, and the subject *immediately* senses that the mechanical stimulus is appropriate, expressing the sensation with words such as “This is what I need,” “Don’t stop,” or “You got it!” The participants seem to have formed a relationship at the sensory level that lets them simultaneously identify a very specific stimulus as “right.”

Perhaps MR stimulates some atavistic regulatory mechanism. Could the interaction between practitioner and client be similar to the grooming behaviors of primates and other animals? In rats, experimental stimulation of hypothalamic structures have elicited grooming, pandiculation, and other adaptive homeostatic behaviors[(12–14)], all of which are associated with pleasure and well-being[(15–18)], guaranteeing their perpetuation. 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. This sense of safety allows for further explorations of the subjective internal states induced by the touch—and their repercussions at the emotional and behavioral levels—which may facilitate the exploration of the psychobiological dimension as described by Prado[(19)] in regard to Rolfing Structural Integration. Self-observation enriches the client’s experience, and in the context of an ongoing therapeutic relationship, the client’s reports of those observations can inform the practitioner’s treatment decisions.

UNITING THE OBJECTIVE AND SUBJECTIVE WITH PHYSIOLOGICAL MONITORING

Assuming, as the author hypothesizes, that the tonic reactions elicited by MR are physiologic responses to mechanical stimuli, it would follow that MR might indeed have an objectively measurable physiological basis.

As mentioned earlier, the degree of firmness that the practitioner observes correlates positively with the intensity of tonic activity detected by the EMG. Like isometric contraction, tonic muscle activity has the capacity to integrate body segments by reducing joint mobility. Therefore, the tonic reactions likely *cause* the firmness. If so, the EMG signal would be a surrogate feedback mechanism for the palpated firmness as a guide to quality of touch. Using the objective EMG signal alongside the subjective sense of firmness potentially brings the objective and the subjective into congruence, a practice that may prove to be useful in the teaching setting, as preliminarily tried (discussed later in this section).

Studies that involve objective monitoring of physiologic effects of manual therapies are generally before-and-after studies. Although informative regarding the possible physiologic effects of the therapies, such studies cannot be the resource toward objectivity that real-time measurements are. Real-time measurements that can be used as feedback tools offer more objective ways to study, practice, and teach manual therapies. Some studies have already shown the potential pedagogical benefits of feedback signaling[(20–26)]. What’s more, given the evidence that neurophysiologic variables can be influenced *immediately* through touch[(27,28)], it is also possible that monitoring of physiological variables could provide objective feedback and thus lend objectivity to the practice and teaching of manual techniques. Particularly noteworthy are the findings, similar to those described here, of *sustained increase* of EMG *during* a manual treatment of the spine[(29)]. 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.

The MR technique is well suited to such monitoring because

- the maneuvers are long lasting, and
- the signal is continuously present during the maneuver, which means that the practitioner can monitor the client’s response to the manual input.

If a certain objective signal were indeed to correspond to a desired client reaction dependent on the technical adequacy of the touch, the potential value of monitoring would be obvious. Pedagogically, the subjective sense of firmness could be tuned by comparison to the objective EMG signal, and in connection with treatment protocols, the EMG could serve as an objective criterion. This approach has the potential to yield a degree of objectivity, precision, and reproducibility that are seldom found in the teaching and practice of manual therapies.

In the EMG studies already carried out by the author’s group, this physiologic signal did indeed seem to be a useful feedback tool, but a full understanding of its application as such awaits further research. Currently, MR is taught based on subjective feedback from instructor, practitioner, and subject, as discussed next.

Workshop Summary

This MR workshop was presented October 31, 2009, after the Second International Fascia Research Congress, held at Vrije Universitiet, Amsterdam.

Purpose

To introduce participants to the MR technique through a hands-on experience.

Methods

The concepts presented so far in the current paper were offered as an introductory theoretical presentation, followed by demonstrations of palpation exercises and three MR maneuvers. During the demonstrations, the instructors described the forces applied and the intended mechanical outcome. Participants then practiced in pairs. Instructors gave kinesthetic feedback based on placing their own hands over or under the participants’ hands.

Introducing the Look and Feel of MR

A particular and complex composition of forces characterizes the MR touch. Clinical observation has shown that the involuntary motor activity that might well be key to MR's clinical efficacy will happen only if the practitioner applies very *precise* force-resultant vectors. A preliminary exercise was designed to give the participants a clear idea of the appropriate mechanical conditions and their sensory counterparts.

Of course, during an actual MR maneuver, all essential mechanical components should be present at once. However, for didactic purposes (despite the variable didactic effectiveness of breaking a task into parts[30]), manual actions were divided into the following steps:

- Sliding the skin in various directions to find the direction in which the tissue offers the most resistance.
- Shearing the skin in the chosen direction until a barrier is reached.
- Applying pressure on an angle such that the client's body segments link into a single block.
- Assessing the degree of segmental integration by means of oscillatory to-and-fro movements imparted to the client's body.

At first, the participants were invited to visually assess the degree of segmental integration—that is, how many body segments appear to be united in a block in response to the oscillatory manual input. *Visible* linkage of bodily segments, evidenced by the *synchronous* movement of several segments, indicates segmental integration. The practitioners were encouraged to vary the mechanical input (for example, pressure, angle, portions of engaged skin) to find the force composition that elicited integration of as many segments as possible. For purposes of comparison, practitioners were encouraged to also try non-optimal force compositions.

Participants were also asked to use the subjective sensory experiences of both "practitioners" and "clients" to guide the manual input. Because segmental integration is accompanied by a singular firm and springy sensation, practitioners were encouraged to sense the degree of firmness felt under the hands during oscillations with and without segmental integration. The client was asked to participate by reporting and comparing sensations experienced during integrative and non-integrative manual stimuli. The practitioner then used this reported contrast as kinesthetic feedback: The more the client reached a feeling of the body moving as a block, the better the mechanical condition achieved and the more likely it was that a maneuver, if performed, would be adequate. Useful feedback also included common client reports of a sense of expansion along the longitudinal axis, a sense of "rightness" (that the manual input is adequate and desired), and the experience of the touch as pleasurable.

Practicing MR Maneuvers

After the introductory exercise, three maneuvers were first demonstrated and then practiced: one each in the thoracic and pelvic regions, and one on the back. As part of the technique, clients were asked to explore their bodily sensations before and after the maneuvers so that the experiential results could be appreciated.

To assure the presence of the requisite mechanical conditions, practitioners began by repeating the steps practiced in the introductory exercise. The maneuvers themselves then consisted of maintaining the manual input while continuously seeking greater palpable firmness and visually apparent segmental integration. To verify the status of these parameters, practitioners from time to time performed the oscillatory assessment and adjusted their manual input accordingly. During the maneuvers, practitioners and clients could both feel the relative movement among tissue planes and fascial compartments. Although initially small, the amplitude of this movement grew progressively larger and often peaked at the end of the maneuver. The maneuver is concluded by a comparatively abrupt tissue movement accompanied by the client's subjective experience of relief.

Outcome

The experience of this class was similar to that of MR classes taught in Brazil during the last 6 years. In questionnaires completed after the workshop, participants reported having had positive experiences—including improved range of motion, sense of well-being, stability in standing and walking, and related variables. The participants also felt that they had learned the main theoretical and practical concepts presented, and that they would be able to apply what they had learned in their work. The instructors observed that by the end of the workshop, most participants were able to deliver the basic MR touch. The participants expressed interest in receiving further training in MR.

DISCUSSION

Manual therapy demands fine-tuned motor control. Taking place in a fluid environment, some manual approaches can be classified as "variable open tasks"[31], which require rapid sensorimotor adaptation. This rapid adaptation is certainly the case with MR, which involves a composite array of manual mechanical stimuli that must continuously be reconstituted based on the client's responses.

Feedback, in its various forms, is recognized as a key factor in the development of manual therapy competencies[32]. The powerful influence of feedback in psychomotor learning is well known[31], as is the fact that practice without feedback might fail to produce any significant increase in skill[32]. Although MR presents a pedagogical challenge, it can be taught based on the feedback, because its key features are amenable to both subjective and objective measures.

Several forms of feedback can be used to teach MR. The workshop described here used subjective feedback from instructors, practitioners, and clients. An instructor, having demonstrated a maneuver, gave *extrinsic* kinesthetic and kinematic feedback by placing hands over or under the student's hands, allowing the student first to follow and then to replicate the instructor's manual input. Next, the mechanical outcome of the manual input provided both the *extrinsic* feedback of *visually* evident segmental integration and the *intrinsic* feedback of *palpable* firmness.

In psychomotor learning, coupling kinematic and intrinsic feedback appears to be most beneficial when it supplies information about components of a movement that cannot be measured objectively(33). This case seems to hold with MR, in which changes in the practitioner's manual input so minute and short-lived as to elude objective measurement often produce significant changes in the client's visible and palpable responses. It seems that the combination of kinematic and intrinsic feedback modalities helps students to build the complex sensorimotor engrams involved.

Finally, because MR characteristically elicits unique sensory experiences for the client, the practitioner can get feedback from the client's reported sensations. These reports, which complement and reinforce the visual and palpatory feedback, are invaluable in the teaching setting. The most obvious is the sensation of synchronous movement of segments during the oscillatory assessment, and the client can sense and report whether one or more body segments are *not* part of the integrated block. The practitioner can then adjust the composition of forces to achieve more complete segmental integration. In addition, clients often sense the manual input to be "right" or "appropriate," and even describe it as pleasurable. The client-students, having experienced the instructor's manual input, applied extrinsic kinematic feedback to guide the practitioner-students' hands to reproduce the sensory experience. As noted earlier, the sensory afferents responsible for this experience might be related to those underlying the pleasurable experience of pandiculation.

Because pleasure and well-being are natural rewards for activities necessary for survival, such as eating and reproduction, pleasure is a biologically important phenomenon closely associated with the maintenance of health. The neurobiology of pleasure is complex and still only partially understood. Serotonin, endorphins, and endogenous opioid mechanisms seem to play a role, involving limbic structures together with additional central circuits(34). Various complementary and alternative health practices—including massage therapy—have been shown to elicit pleasurable experiences involving the reward circuitry of the central nervous system (CNS), a fact that may account in part for their health-promoting capabilities(35).

When the manual input of MR elicits pleasure—perhaps by mimicking the proprioceptive afferents of pandiculation—it might be that the pleasure itself activates autonomic limbic-mediated mechanisms for the maintenance of homeostasis. The sensation of pleasure might also be processed by higher CNS centers to create an expectation of beneficial outcome, which expectation is known to promote health(36).

When subjects participate by reporting their sensations—and, in the teaching setting, by guiding the practitioner's hands—their own elevated engagement in the therapeutic process might facilitate self-regulation and health improvement(37). At the same time, the subject's feedback helps the practitioner to deliver the work. Over time, repeated feedback might improve the practitioner's touch skills.

In addition to these sources of subjective feedback, the author's research group has considered three sources of instrumented objective feedback:

- Monitoring *physiologic reactions* through EMG assessment of involuntary motor reactions. Through previous EMG studies, the author's group has already explored efficacy of the EMG signal as a feedback tool and has concluded that EMG seems to be appropriate because firmness, which is associated clinically with maneuver efficacy, correlates positively with the EMG signal intensity.
- Monitoring *cortical activity* through electro-encephalography (EEG). Preliminary EEG measurements during MR maneuvers have shown specific cortical activity—particularly the alpha–theta crossing and the somatomotor rhythm(38).
- Monitoring *kinematic outcome* through accelerometry. Multiple sensors might be attached to various regions of the client's body to assess the degree of movement synchrony among segments. The author's group is considering preliminary tests of this potential monitoring method.

CONCLUSIONS

Although MR is a myofascial release technique, it clearly engages the nervous system. The involuntary motor reactions elicited by MR might be related to natural mechanisms for the maintenance of homeostasis, which might account for MR's clinical efficacy in the treatment of various disorders. Despite its mechanical complexity, MR can be taught based on uninstrumented extrinsic and intrinsic feedback, thanks to the unique mechanical and sensory outcomes it produces. However, because MR also elicits reactions that can be monitored by instruments, MR could rely on instrumented feedback (for example, EMG, EEG, accelerometry) for teaching, clinical application, and research. Such approaches could bring more objectivity, reproducibility, and precision—qualities seldom associated with manual therapies.

CONFLICT OF INTEREST NOTIFICATION

The author declares that there are no conflicts of interest.

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