This article examines the economic and human costs of muscle pain and the role of biofeedback in treating chronic muscle pain. The article reviews the physiology of the musculature and the myofascial mantle and the contributions of physiological dysfunction to pain. The article critiques the relaxation model as an inadequate foundation for biofeedback treatment of pain and calls for more comprehensive education for biofeedback practitioners in muscle physiology yet emphasizes the promise of surface electromyographic treatment for chronic pain and for opioid abuse, when the muscle biofeedback intervention is well informed by medical and physiological knowledge. Medical factors that commonly contribute to pain are examined, along with a number of preventable sources for poor outcomes for muscle biofeedback treatment.

Muscle Pain and the Role of Biofeedback

The Economic and Human Costs of Muscle Pain

Muscle pain is a very common clinical finding. For instance, back pain and neck pain cost the United States $560 to $635 billion (calculated in 2010 dollars), and the cost is not expected to decrease (Gaskin & Richard, 2011). The same authors estimate that 100 million Americans suffer unrelenting pain, many are disabled, and many face premature death.

We also currently live in an epidemic of epic proportions in terms of opioid use and abuse. Within the right clinical context, surface electromyographic (SEMG) biofeedback may become a major modality to reduce these costs and diminish the human suffering associated with opioid abuse in a noninvasive and productive way (Sella, 2006, 2008).

SEMG biofeedback is a useful modality to reduce pain and optimize muscle function. However, it is much more effective when the SEMG interventions take into account the physiology of muscle pain and after a number of factors affecting the pain are ruled out. The unfortunate corollary is that if these (or other) factors are not ruled out, biofeedback is unfairly considered a failure. In the remainder of this article, we will examine (a) a comprehensive understanding of muscle physiology, (b) factors that contribute to the onset of pain, (c) the challenge of educating health professionals successfully to conduct effective SEMG biofeedback treatment of pain, (d) the possibility of collaborative and integrative team-based pain treatment, and (e) identifiable and preventable factors that can produce poor outcomes for biofeedback treatment.

The Relevance of Muscle Physiology for Effective Pain Treatment

The Myofascial Mantle

This article integrates scientific and clinical knowledge, with observations from the first author’s 30 years as a physician and biofeedback practitioner treating muscular disorders.

The general evolutionary view is that vertebrates have an endoskeleton and invertebrates have an exoskeleton. Although this is true in terms of the existence and functions of bones, the vertebrate body could not exist and function without having a virtual exoskeleton as well. The latter is three dimensional and comprises no less than 60% of the body structure and weight. It is composed of the myofascial mantle and its contents.

The myofascial mantle imparts the shape and turgidity of the body and allows internal motility and external motion without crushing any internal organ. The very shape of the body, including much of the head, is more a function of the size and shape of the muscles and fascia rather than that of the bones. Bones are protected and covered by muscles and ligaments. Joints are protected by capsules, bursae, and tendons.

Most fascial components are composed of collagen, elastin, and related materials. The tensile strength of collagen, based on a three-stranded helical molecule, is equivalent to that of stainless steel of the same dimensions (Lodish et al., 1999). It is this tensile strength that
Physiological Perspectives on Muscle Pain

We tend to think of muscle pain as an autonomous phenomenon, outside the scope of its physiology. A simplistic view of biofeedback for muscle pain assumes that if we can get the muscle to relax with the assistance of SEMG biofeedback, the pain will simply go away. Although this may occasionally be the case, most of the time the relaxation-based procedure will not succeed because the diagnostic premise is wrong.

Muscle tonus has two phases: the resting phase and the activity phase. The key to all muscular function is the availability of energy. A good example of the energy requirement and availability is the cardiac muscle. Although blood courses through the heart at all times, it is available to the coronary system only during diastole, when the heart muscle is not pumping it out of the heart. Angina, or cardiac pain, occurs most commonly when the cardiac muscles do not get enough oxygen and nutrition from the coronary arteries.

Similarly, skeletal and visceral muscles obtain their energy and oxygen supply mostly when the muscles are relaxed and can supply the arterial system to provide the supply. A contracting muscle constricts the blood vessels and limits the blood it receives. This does not allow necessary energy resupply. The common fallacy of equating the resting tonus (when the muscle gets the oxygen and energy supply) with the expression of baseline misses this understanding of muscle metabolism and probably leads to a poor understanding of the consequences. Muscular tissue with poor nutrition will use available reserves quickly during activity and then go through the sequence of fatigue, pain, and dysfunction, similar to the example of angina and the heart muscle.

Going Beyond the Relaxation Model for SEMG Practice

Further to understanding the concept of relaxation, and why the relaxation model does not work adequately for biofeedback-based pain treatment, is the fact that we must reeducate not only the resting tonus but also, gradually, the activity tonus.

After a heart attack, effective treatment involves cardiac rehabilitation; the same is necessary for the skeletal muscles. SEMG biofeedback aims to redress the resting tonus potentials and the activity potentials. Only when both are treated can we get overall success in pain treatment. Teaching relaxation skills may be a fine concept in dealing with emotional issues. The proponents and practitioners of muscle relaxation biofeedback need to augment their understanding of muscle physiology if they aim to practice SEMG biofeedback. Muscular pain is often related to a lack of energy resources as well as other dysfunctions such as spasms, hypertonus, and hyperactivity.

Effective biofeedback treatment of neuromuscular pain disorders, accordingly, cannot take place entirely in a reclining chair. Functional and dynamic assessment can identify patterns of muscular bracing, left-right asymmetries in muscular activation, coactivation of muscles not functionally contributory to a movement pattern, and poor recovery following exertion. Whatmore and Kohli (1968) summarized many of these patterns of muscle dysfunction as dysponesis, errors in physiological energy expenditure not functionally appropriate for the current intended actions. They described dysponetic activity patterns as reversible, through a process of neurophysiological reengineering.

Biofeedback is one of the shortest paths to the maintenance of an engram, to the generation of a new engram, and to neuromodulation in the case of neuromuscular pathology. The concept of an engram here refers to the motor memory of a movement pattern, stored in the brain and nervous system (Wolfe, 1983, p. 16). Because of muscle memory, and the muscle engran, maladaptive muscular activation patterns can be persistent. The engran is virtual software storing the kinetic pattern or kinetic melody of muscle activity, and the engran is subject to transformation through newly patterned movement or, in this case, biofeedback neuromuscular reeducation.

Biofeedback, however, is a tool that works best when it is applied correctly within the right context. As Abraham Maslow observed, “I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail” (1966, p. 15). In a society that is not too prone to adopt new modalities, this is not in the best interest of biofeedback or of any other newer modalities. The use of biofeedback is best applied in a rigorous and well-based scientific context.
Biofeedback Assessment and Treatment of Myofascial Dysfunction

Factors Commonly Involved in the Etiology of Pain

There are a number of factors that may result in muscle and related tissue pain. They commonly include some of the following: (a) contusion with sprain and strain, (b) trigger-point formation, (c) hematoma, (d) edema, (e) neuralgia acting as muscle pain, (f) peripheral vascular disease, and (g) joint inflammation (arthrosis, arthritis) with resulting radiation including muscle pain, loss of strength, and loss of range of motion.

Although the list can go on for many pages, what is relevant at this point is to consider a simple example that may illustrate one etiology of muscle and related tissue pain. Muscular contusion from a variety of external injury factors, including blunt trauma, may damage muscle tissue and result in an internal hematoma with edema. The presence of edema may result in pressure on the muscle tissue, moderate enough to allow arterial blood to come in but too elevated to allow venous and lymphatic blood return to leave the tissue. Pain ensues as a result of various factors including accumulation of catabolic substances (e.g., substance P and other noxious substances), poor oxygen supply (i.e., relative hypoxemia), and CO₂ accumulation (i.e., relative hypercarbia).

One result of the localized edema may be poor range of motion of the affected joint and, in time, relative loss of strength and conditioning of the affected joint or limb. Some consider this under the concept of splinting. The contralateral limb may act in a protective guarding capacity and, in time, may suffer from overwork and wear and tear.

The astute clinician needs to recognize the etiology of the pain and dysfunction and treat any medical pathology before instituting biofeedback as the final modality to improve/optimize function and eradicate dysfunctional muscle learning. It is helpful to use a checklist, either a mental checklist or an actual checklist, of possible symptoms and possible diagnoses for the kinds of physical and psychological disorders one commonly encounters in the pain population. The checklist can also include appropriate treatment options and treatment principles.

The Challenge of Training Health Care Workers in the Art and Science of Biofeedback

It is a challenge to identify clinical practitioners who have the comprehensive medical, physiological, and behavioral understanding to conduct comprehensive assessment and biofeedback treatment of muscle pain. However, a collaborative interprofessional approach is possible. One clinician can investigate the medical factors and physiological dysfunction contributing to pain. Another professional can implement the biofeedback assessment and treatment. Thorough dialogue among these professionals is critical, and the biofeedback professional must be cognizant and thoroughly trained to address the factors mentioned above, including assessing and reeducating both resting muscle tone and active muscle tone. This means an ongoing dynamic and functional muscle assessment on a recurring basis through the course of treatment.

Let us take the example of trigger points. The trigger point may be treated simultaneously by a variety of health care professionals with a number of modalities. A physician may inject an anesthetic directly into the trigger points. A physical or myofascial therapist may follow up with exercises to stretch muscles and fascia and/or with manual pressure to release the trigger points. An SEMG practitioner may engage the patient in muscle biofeedback training to normalize resting and activity tonus of the affected muscles. This collaborative treatment program will most often be more effective than any one of the practitioners attempting to provide standalone therapy.

Nonbiofeedback Factors Producing Poor SEMG Biofeedback Outcomes

What are some nonbiofeedback factors that hinder achieving a successful biofeedback outcome? A simple classification of such factors can define them as extrinsic and intrinsic. Extrinsic factors could be classified in terms of poor outcome as being the resultant of commission or omission. At times, this classification may be blurred by overlap of the two factors.

Errors of commission in the practice of biofeedback. In terms of commission, there are several possibilities, any one less fortunate than the next. Iatrogenic factors, in which the treatment or the health care worker causes the adverse effect, are number one on the list. We can all think of the story that when a shaman declares, “you will die at the crack of dawn,” the unfortunate patient and believer may go into shock and die at the allotted time. In our society, some clinicians still hold sway over many people, and their predictions not only come true but also leave behind a patient who will be difficult to treat by any subsequent well-meaning clinician.

Professional incompetence is number two on the commission list and should also come within this category. Simply put, a clinician should not offer treatment for a condition for which he or she is not competent by training, knowledge, skill, and experience. It is rare, even in the realm of surgery, that one has to operate in a case that one
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is not competent, never mind in cases related to biofeedback. All the clinician has to do is be honest about it and offer to refer to someone competent in the application area. Most, if not all, patients would be grateful and respect the clinician more for this referral.

Objective versus subjective practices also have also a place on this list. In terms of muscular and related tissue investigation and treatment, there are a number of objective modalities that apply, for instance, the measurements of the pertinent joint range of motion, strength, agility, and resistance.

In addition, and no less relevant, psychological testing may contribute to the assessment process in any case in which any psychosomatic or somatoform conditions may apply. Clinicians who know that objective testing imparts greater strength to the diagnosis and may shorten the treatment time factor in an effective and efficient way and don’t do it, commit a commission and not an omission error. Those who don’t know need further training.

Omission errors in the practice of biofeedback. Omission errors are common in health care and are a large component in the medico-legal field generally known as malpractice. A simple example may be a piece of gauze left in a patient’s body, notwithstanding the number of people who are supposed to count the number of pieces of gauze before and after a surgery. Medication errors are also common, either giving the wrong dose or the wrong medicine. Although every effort is made to prevent such errors, they may be with us for a long time. In the realm of muscle dysfunction and pain, there are omission errors that may be preventable.

The prevention of such errors can be achieved by applying SEMG assessment procedures and SEMG/biofeedback treatment modalities. SEMG provides a number of objective assessment and treatment modalities that can easily be substituted for subjective modalities, which belong to the past and which may result in further tissue suffering.

One example may be the common subjective complaint of hand muscle strength loss. The testing modality commonly used in medical practice is that of assessing the issue by asking the person to “squeeze my fingers.” There is little value in this manner of unreliable assessment. Instead, one can substitute the objective modality of the grip-meter, or similar instrumentation, which objectively measures any loss of grip strength (in pounds or kilograms). Further testing with SEMG can determine which muscles are dysfunctional and whether the dysfunction lies in resting tonus or activity tonus dysfunction.

As to omission errors in the field of muscle dysfunction and pain, any biofeedback clinician who has inadequate knowledge of muscle anatomy, muscle physiology, and muscle pathology is well advised to learn these bodies of knowledge in order not to risk committing any omission error.

Technical errors producing poor outcomes in biofeedback. Technical errors may be considered errors of omission and should be corrected as soon as they are discovered. Human error has lived with us for a long time and is not likely to go away. Equipment dysfunction, including poor calibration, faulty electrodes, or detached electrodes, are but few of the many equipment-related omission errors. A more common error is that of interpretation of test results, ranging from faulty interpretation of statistics to the misinterpretation of clinical results.

Anyone involved in the chain of events, from the investigation to the interpretation of results, and the determination of the treatment plan, needs to take responsibility and learn to avoid such omission errors in the future.

Establishing rapport and orienting the patient to the treatment. One relevant extrinsic omission error is that of poor rapport and incomplete education, explanations, or instructions given by the clinician to the patient/client. This can occur anytime on the timeline of the clinical relationship. Patients/clients need to be able to give clear verbal or written feedback demonstrating their understanding of all instructions, explanations, and education during the course of the myofascial investigations or later during the treatment/ reeducation or rehabilitation period. Many health professionals adopt a formal teach-back technique, in which the patient is required to paraphrase what the practitioner has said and what it means to the patient (Parker, 2000, p. 281). This requires a time factor of education/learning ability, which may vary from person to person. At certain times, even an experienced clinician may recognize that the patient/client involved may not be a good subject to learn from this clinician and then should transfer the patient/client to someone else who achieves a better rapport.

Intrinsic factors producing poor outcomes for SEMG biofeedback. Intrinsic factors are related to the poor response to SEMG biofeedback by the patient or client. Successful biofeedback of myofascial dysfunction requires motivation on the part of the patient/client. This subject, already discussed above, deserves to be stressed further in because of the risk of omission errors. It takes an astute and experienced physician sometimes to uncover the lack of motivation on the patient’s part.

Commission factors involving poor motivation may be the result of litigation processes and the system in which they
thrive. They may also be the result of symptom magnification, functional overlay, and the presence of psychosomatic conditions or somatoform disorders. Objective testing, including physical evaluations and psychological testing, may uncover the etiology/ies of the lack of motivation, but the test findings do not necessarily transform the subject’s motivation into a positive factor for biofeedback success.

In many chronic conditions of myofascial pain, there may also be socioeconomic factors that result in poor motivation to improve, either with SEMG biofeedback or any other modality. A change in the family dynamics in which the patient/client has learned to play the disabled role and eschew social or financial family responsibilities may be a factor that the clinician should be well aware of.

Intrinsic omission factors are multiple and sometimes embarrassing both for the patient/client and for the clinician. They may involve poor eyesight or color blindness, poor hearing, or discomfort in the sitting position. Although the question “Why didn’t you tell me?” comes immediately to the mind of the clinician, the situation may be more complex than that. The person may not be aware of the poor eyesight or color blindness. The clinical experience of many clinicians brings anecdotes on these subjects.

One relevant intrinsic omission factor may be that of attention span. Although we are all aware of the need for 20 minutes for a good workout in an SEMG biofeedback session, that span of time may be too much for some people of all ages, especially children. The clinician should be clearly aware of the optimal attention span of any myofascial biofeedback patient/client and work with it rather than against it.

Conclusions

Have we covered all of the commission and omission factors, extrinsic or intrinsic, contributing to poor SEMG biofeedback outcomes? I should hope not. I leave the incompleteness of this account as an open invitation for comments from well-meaning colleagues who wish to impart their clinical pearls in an ongoing dialogue for creating a more optimal standard in SEMG practice.

The take-home messages of this article is the following: Muscle pain is a major problem with high economic and human costs. The relaxation model is not adequate to guide SEMG assessment and treatment of myofascial pain. It is essential that the biofeedback practitioner gain a comprehensive understanding of muscle kinesiology and muscle physiology to understand the origins of chronic pain and to design effective treatment programs. Attention is needed to assess muscle function and tone in the resting state and in activity. As in cardiac rehabilitation, it is necessary to recondition, strengthen, and educate skeletal muscles, in their resting and active states. When one health professional cannot master the full range of medical and physiological knowledge and diagnostic expertise needed, interprofessional collaboration within a team in regular communication may provide effective pain treatment.

References


