

Evidence based investigation and rehabilitation planning with Surface Electromyography (SEMG)

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SEMG is a modern electrophysiologic modality. It can be utilized within the realm of rehabilitation medicine and ergonomics in its dual capacity as an investigative and rehabilitative guiding tool.

It is a quantitative modality. Thus, the electro-myographer can document statistically the diagnostic/investigative findings as well as the pattern of muscular functional improvement during the program of rehabilitation. Both the testing and the neuromuscular rehabilitation/re-education program can be accomplished in an office/hospital setting or in the field, such as needed in ergonomics or sports medicine.

The equipment itself may be as small as a cell phone. Fiber-optic wiring may be as long as 50 ms. and may even be used in training on land or in swimming pools. Memory sticks are portable and may be connected to a computer after the SEMG work. Software programming including the statistical aspects will be available as whole packages in a matter of months, to enable the clinician or technician to take full advantage of the effectiveness and efficiency of this technology.

Since it is not possible to review the subject in detail within the space allowed regarding different clinical and ergonomic/ training aspects of this methodology, it may be more practical to list a number of relevant muscular functional & dysfunctional parameters salient to its use.

Muscular fatigue may be the result of overload and inadequate rest, metabolic dysfunction or disease. SEMG, in its *frequency domain*, can document the presence of abnormal (low) median frequency (Hz) in muscles affected by fatigue. It can also document the improvement in the median frequency with adequate exercise and other treatments.

Thus, the electromyographer can document objectively the presence of subjectively experienced fatigue and its improvement over time with adequate rehabilitation. Conversely, it may allow ruling out symptom magnification and/or malingering, in work, athletic, clinical or ergonomic settings.

Loss of ability to relax the muscle appropriately and contract it to the necessary amplitude of contraction to accomplish a given task relates to disturbed CNS motor engrams. All muscles need to rest in order to get rid of catabolic substances and recharge with oxygen and nutrients.

The SEMG amplitude domain (microvolt RMS) allows for an easy and accurate detection of the normal ability to return to the appropriate resting tonus and maintain it. It can also document the loss of the ability to rest, generally associated with fatigue and pain. The same applies to the activity potential tonus necessary to accomplish a given task at an expected level of effort. Both parameters are essential in all human muscular activity, with special relevance to ergonomics, athletics and rehabilitation medicine. A number of

parameters of muscular dysfunction have been defined. They include hypertonus, hypotonus, spasm, myokimia and contracture. The laws of homeostasis and gravity prevail at all times in regards to skeletal muscle function.

Loss of bilateral muscular symmetry may be encountered when there is a history of unilateral injury which has not been completely rehabilitated. The continuum between the acute injury event, splinting and protective guarding can be followed adequately with SEMG dynamic studies. The loss of homonymous contralateral muscular balance can be assessed and rehabilitated. The overall aim is to reestablish a symmetry of activity potentials within 20% for any two contralateral muscle pair for any given motion. Redressing this situation re-establishes the need for muscles to expend the least energy in the most efficient manner for any bilateral activity. Inability to redress the asymmetry results in excessive unilateral effort, itself a precursor to myofascial dysfunction, fatigue and pain.

Radiculopathy and neuropathy. SEMG can be applied in the investigation of the unilateral diagnostic quest for either of these neurologic conditions. A database and published protocols have documented the amplitude potential values for 183 muscles innervated by 29 nerves, cervical, thoracic and lumbo-sacral roots. Adherence to those protocols allows the investigator to define and apply the necessary differential diagnosis.

Rehabilitation of muscular function through given joints ROM. Determination of the database and a series of articles prepares the rehabilitation specialist to establish a quantitative program of neuro-muscular re-education in any field of choice. Tables of myotatic units of primary muscles allow for a sequencing of muscular effort values through any given joint segment of motion. Thus, the clinician doesn't have to guess anymore what muscle or what motion to address in what temporal sequence during the rehabilitation period. The data indicate clearly the sequence that may be followed "from easy to hard". This sequencing allows for the last amount of effort and fatigue on the part of the patient or subject.

Modern health care and ergonomic or sports medicine practice have evolved from a subjective realm based on experience and reputation as well as clinician ego into an objective, measurable and repeatable/demonstrable clinical science. Modern methodologies allow for objective quantification and statistical analysis of the investigative results and of the rehabilitative progress. Legal and insurance realities require the clinician to demonstrate objectively the diagnostic conclusions and the critical pathway of the rehabilitation or re-education programs.

SEMG is a unique methodology in terms of fulfilling most requirements of modern equipment and technology. It is not invasive. The equipment may be utilized with ease in an office or field environment. Testing is objective and measurable. It is 95% repeatable and reliable. The test results are applicable to the rehabilitation program. The clinician, sports trainer or ergonomic scientist can demonstrate to the participant the rationale of the work. Last of all, the methodology is applicable to the rehabilitation or education of the neuro-motor engram in a variety of conditions.