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Interpretation Strategy for Clinical EMG Data

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INTERPRETATION STRATEGY FOR CLINICAL EMG DATA

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INTRODUCTION

Kinesiologic EMG (KinEMG) is a well established quantitative method to measure and analyze the muscle activation during various tasks, exercises and treatment regimes. Today's technology allows an easy access and operation of KinEMG devices. However, the meaningful setup, analysis and interpretation of EMG data are still under the responsibility of the user. Due to the lack of established and standardized clinical protocols, normative data and interpretation techniques, more systematic schemes have to be developed to facilitate the potential use of EMG analysis.

HYPOTHESIS AND ANALYSIS QUESTIONS

The most reasonable way to start and decide for an EMG analysis is the observation of a clinical problem or the need to document objective data on the neuromuscular status of a patient. In a next step, a hypothesis or "expectation" has to be formulated. This again can be translated to an analytical question. Within the range of available kinesiological biomechanical methods, EMG is the outstanding choice for detecting muscle activation. The following categories of analytical questions can be addressed by KinEMG:

- Is the muscle active? Nominal type (on/off)
- Are muscles more or less active? Ordinal type (more/less)
- When is the muscle on/off? Metric (Time scale)
- How much is the muscle active? Metric (MVC normalized)
- Does the muscle fatigue? Metric (Regression/slope)

A variety of sub-categories, using more "clinical" terminology can be derived, e.g. "Does the muscle fire when it should", or "Is the interplay of synergists correct in timing?"

OBSERVATION CRITERIA

To interpret a clinical KinEMG finding it is useful to overview and systematically apply a system of observation categories. Based on the question type (nominal, ordinal, metric) this is done by qualitative terms, calculated values or data tendencies. Due to its relative nature (micro volts vary from subject to subject) it is helpful to describe clinical EMG with a mixture of qualitative terms and signal ratios.

Group A focuses on the single selected muscles and describes the EMG signal in terms of amplitude, frequency and timing characteristics:

- Magnitude of amplitude — increased, decreased, absent
- Timing of activation — too early, late or asynchronous
- Time domain changes — amplitude increase/decrease; frequency increase/decrease; regularity and constancy

Group B describes activation characteristics between muscles:

- Side symmetries — percentage differences
- Activity of antagonists — lack/increase of co-activation dysfunctional timing
- Activity of synergists — lack/increase of co-contraction (stabilization activity) dysfunctional timing

COMPARISON ANALYSIS

When planning KinEMG investigations it is very important to target reasonable comparison conditions. Because typically patient data cannot be MVC normalized, the strategy is to create ratios and quantity differences between two findings. The following comparison classes can be considered:

- Pre-test : Post-test — to show tendencies
- Left to right side — differences between affected/ unaffected side
- Activity A vs. B — muscle innervation in different test positions
- Signal portion A vs. B — time domain changes of amplitude and frequency
- Muscle A vs. B — qualitative comparison of synergists and antagonists
- Patient vs. Norm-curve — dysfunctional EMG patterns

INTEGRATION OF EMG DATA

An EMG measure monitors the muscle activation, but does not directly reveal information about its cause. To answer the question "***Why***" is probably the most challenging step within interpretation schemes. It strictly requires a set of preliminary information, based on medical diagnosis, physiotherapeutic investigation and anamnesis data. Several biological systems interact and influence any kinesiological finding:

- Psychological and behavioral aspects (e.g. pain expectation, stress)
- Central nervous structural damage/disability (e.g. stroke)
- Lack of motor ability (untrained)
- Wrong or inappropriate motor control programs
- Damage or disability of sub cortical structures and pathways
- Insufficiencies of local reflex systems and sensory receptors
- Biomechanical and structural problems in and around joints
- Physiological status (muscle atrophy, fatigue)

The clinical value of KinEMG depends on the appropriate integration of EMG data and its link to pending therapy decisions.

Clinical Integration of EMG Findings

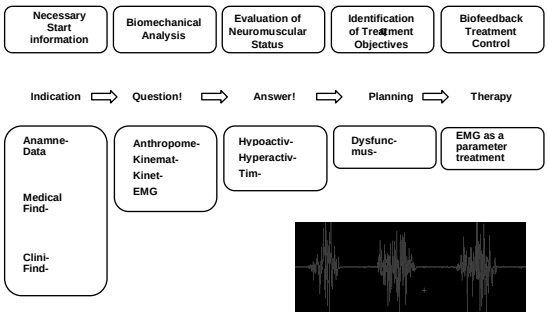

Fig. 1: Process scheme explaining the integration of KinEMG

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