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Original Study **OS (1-6)**

Electromyography in the evaluation of dorsalhyperkyphosis: a new diagnostic protocol.

Alessia Bagalà, Giuseppina Salvo, Giuseppe Gambardella
Multifunctionalmedical center, physiokinesitherapy center, sports medicine center ISTITUTO NEW DE DELTA S.R.L. Headquarters Messina

Abstract

Correction or improvement of hyperkyphosis can be achieved by developing the muscles involved in correcting the posture of the dorsal spine, as indicated by many authors. Several research studies have revealed that electromyography (EMG) techniques are effective in evaluating muscles and guiding their treatment. The dependability and utility of this technique have already been tested on a group of sixteen patients. After the physiatrist evaluation and a radiographic examination, the angle of the D1-D12 curve has been calculated, it is considered hyperkyphotic if the degrees are ≥ 45°. Cases with hyperkyphosis have been subjected to EMG investigation: assessing resting activity, moderate activity and maximal activity of some of the muscles involved in this pathology (supraspinatus, subspinatus, trapezius). The results have been used to plan the most effective treatment for hyperkyphosis correction. As the protocol used is proven to be effective, it will be used to target the rehabilitation program to a large number of patients.

Key Words: hyperkyphosis; electromyography; rehabilitation

Authors contributed equally to this study

Corresponding Author: AlessiaBagalà - alessiabagala.93@gmail.com

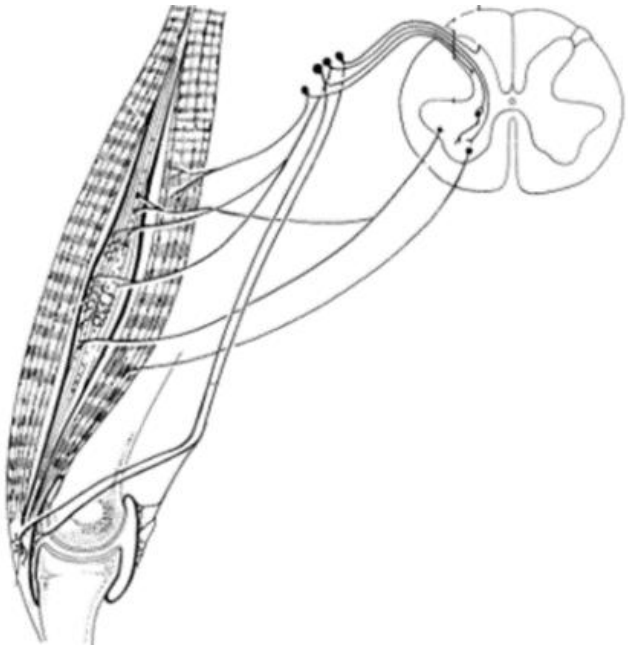
Introducing Member: Giuseppe Gambardella

Introduction

Hyperkyphosis is a sagittal plane spine disorder characterized by an increase in the dorsal curve compared to the physiological value (1-2). Although clinical examination can provide information about the condition of the muscles connected to the spine, we can expect an instrumental investigation, such as electromyographic (EMG) examination, to provide more and better information (2). Therefore, we assumed that EMG can be useful and guide the therapist on how to work on each muscle group. Changes in spinal mechanics are considered to be the cause related to hypertrophy and/or atypical hypotrophy of some muscles (3). EMG is commonly used in patients with motor disabilities to improve their ability to assess various physiological responses and possibly learn self-control over these responses, but it is rarely used to monitor routine muscle efficiency (3). Muscle wasting is defined by a decrease in the volume of muscle tissue, which results in weakness or partial loss of motor function; hypertrophy is defined by an increase in the

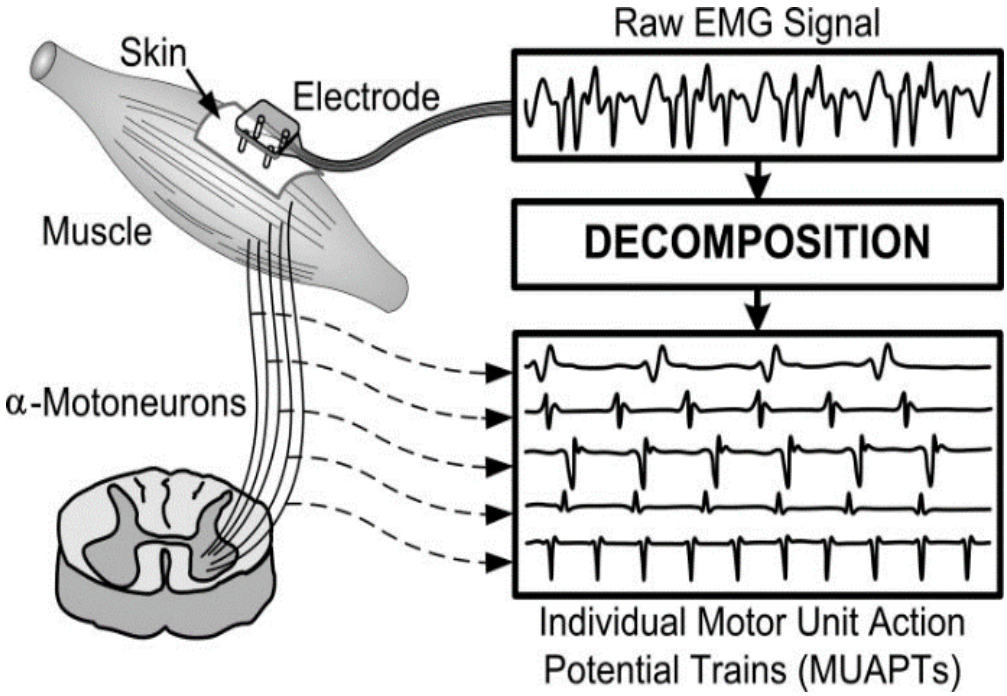
volume of cells that comprise muscle tissue (fig.1).

Fig.1. Motor unit representation



Muscles whose activity has been reduced by due to alterations in spinal mechanics becomehypertrophied, this leads to an alteration in the electromyographic tracing, which will be characterized by a lower number of PUMs (Motor Unit Potentials) out of proportion to the exerted effort (fig.2).

Fig.2. Individual Motor Unit Action Potential Trains



In hypotrophic tracing, as each motor unit contains fewer muscle fibers, the duration of the potential PUMs increases (4). The main parameter to investigate PUMs is duration, which is

expressed on the trace from the moment the signal leaves the isoelectric line until its stable re-entry. In light of this, it seems clear that the study of the amplitude and duration parameters of PUMs present in the EMG trace is critical to assess muscle function, identify any associated spinal pathology, and confirm recovery with target exercise (5).

The objective of this study is to create an electromyographic research protocol on the muscles involved in hyperkyphosis. To this end, we evaluated whether electromyographic could be a useful tool to identify the muscles involved in hyperkyphosis and for record the effects of physiotherapy. We tried to offer some insights into the appropriateness of applying this method in clinical studies and as a common diagnostic approach.

Method and Materials

The selection of the patient population involves several phases: i. -an accurate collection of anamnestic data is necessary to discover any other pathologies.ii- a clinical evaluation of the spinal curves and a diagnosis based on a physical examination was performed in each patient .iii- the D1-D12 angle is calculated in a X-ray of the entire spine in standing position. Using the specified inclusion and exclusion criteria, patients can be selected for inclusion in the study based on the above data evaluation.

Inclusion criteria

- Patients with hyperkyphosis ≥ 45°.
- Patients aged 11 to 60 years.

Exclusion criteria

-Patients aged > 60 years, due to onset of senescence phenomena of the skeletal system.

-Patients with alterations in other kypho-lordotic curves or with associated vertebral pathologies, such as scoliosis, degenerative skeletal, muscular and neurological pathologies that may invalidate the examination.

- Patients with general conditions that may interfere with muscle metabolism, such as certain dysendocrinias (e.g., diabetes, dysthyroidism, major heart disease, renal insufficiency, respiratory system deficits, severe hepatopathy, etc.), and patients with other conditions that may interfere with muscle metabolism.

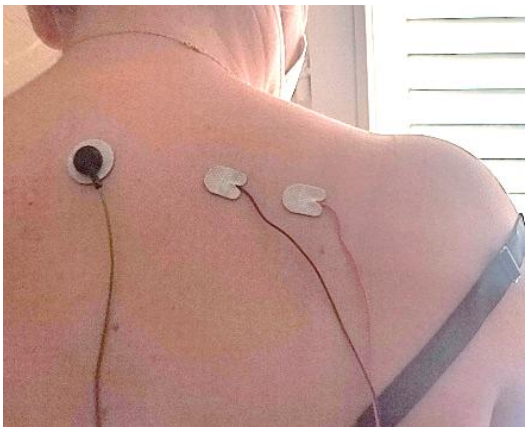
Selected Patients

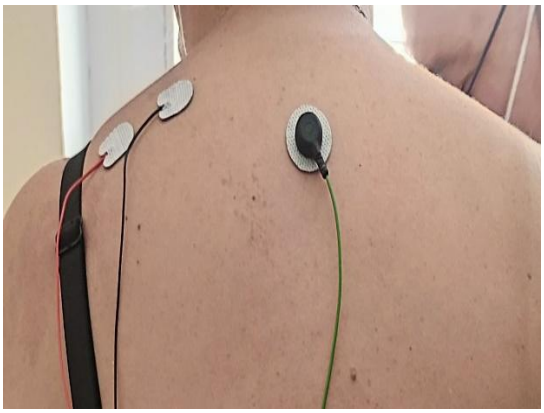
After subjecting 45 patients to a selection process, only 16 passed the inclusion and exclusion criteria; 10 women and six men with a prevalence between 11 and 35 years old.

Electromyographic (EMG) examination

Electromyographic is an examination to view the electrical activity of muscles. In our case, electromyographic examination is performed using by an equipment with bipolar recording channels. (fig.3).

Fig.3 a) Position of the electrodes in subspinous muscle **Fig. 3.b)** Position of the electrodes sin supraspinatus muscle



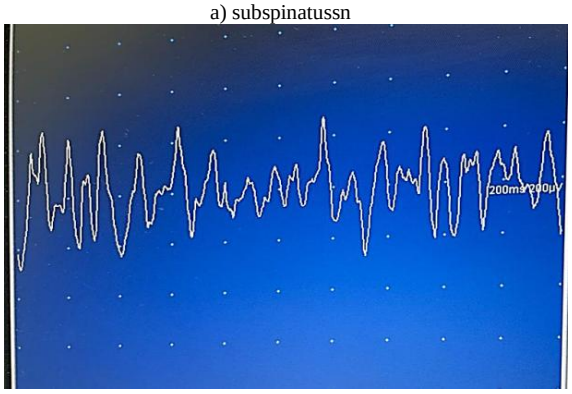


Electromyographic evaluation

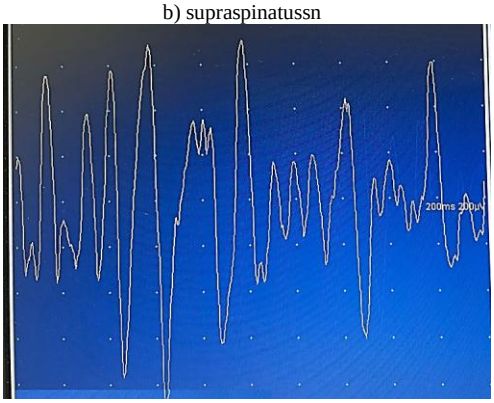
Electromyographic evaluation is structured in three stages. The first stage consists of studying the tracing of the muscles at rest (resting activity). PUM research is eventually conducted with the assistance of the patient in the second and third phases. In the second phase, the muscle under examination undergoes a slight contraction (transitional activity), followed by a maximally intense contraction (maximal exertion activity). (fig.4)

Fig4. EMG recording

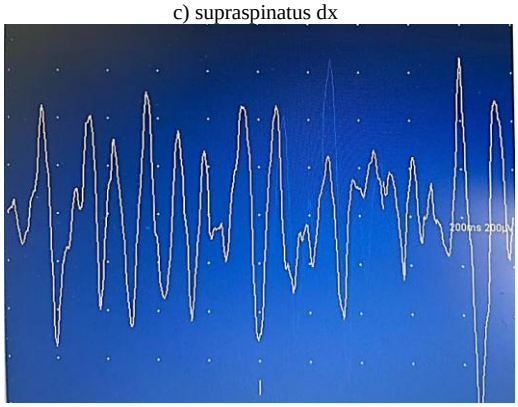
a) subspinatussn



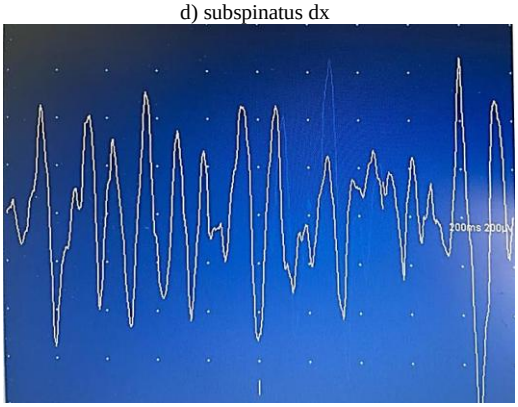
b) supraspinatussn



c) supraspinatus dx



d) subspinatus dx



The electromyographic examination was carried out by bilaterally evaluating the supraspinatus, subspinatus, and trapezius muscles, since they are more superficial and easily recruited by both examiner and patient. The EMG is recording with a time window of 200 m/s and a sensitivity of 200 µV related to signal amplification (remember that the amplitude is directly proportional to the number of activated muscle cells)

Results

This evaluation protocol was tested on 16 patients. Muscle trophism and electromyographic parameters were found to be well correlated. A direct connection was discovered between the extent of hyperkyphosis and the data provided by EMG. In the examples below, the difference between the tracings is evident, with a low PUM, longer duration, and greater amplitude in the left hemilateral, indicative of hypotrophy, coinciding with the diagnosis of hyperkyphosis. In nine patients, PUMs were found to be interferentially poor during intermediate and maximal exertion activities, with reduced amplitude and increased duration bilaterally; this clearly indicates muscle hypotrophy. Using this investigation of muscle groups bilaterally, hypotrophy is noted in six predominantly unilateral ones, indicating compensatory activity caused by the pathology.

Discussion

As the target muscles of our study (supraspinatus, subspinatus, and trapezius) are superficial, they can be easily studied with surface bipolar electrodes. Because of the difficulty of activation by voluntary muscle contraction, the other muscles involved in hyperkinesis, such as the rhomboids and latissimus dorsi, were excluded from the electromyographic study. The study demonstrates the usefulness of electromyographic examination in the evaluation of patients with hyperkinesis; in particular, a clear correlation was observed between the extent of kyphosis, EMG alteration, and muscle trophism. This has high clinical value, not only in diagnosis but also in monitoring progress.

Conclusion

In conclusion, electromyography can be useful in the diagnosis of hyperkyphosis and in monitoring the improvement of the pathology through target exercise (6). A number of patients selected was adequate to validate the method that will be used in our research project, in which it may be useful to pose a prognosis and refine the kinesitherapeutic treatment of hyperkyphosis. According to this, our results demonstrate that EMG is a rapid method for investigating target muscles that can be used in conjunction with traditional rehabilitation techniques to improve motor skills and functional use of these muscles.

Conflict of interest

The authors declare that they have no conflict of interest that could be perceived as prejudicing theimpartiality of the research reported

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