Electromyography - An Overview

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EMG can be a very useful analytical method if applied under proper conditions and interpreted in light of basic physiological, biomechanical, and recording principles. If ergonomic studies are correctly conducted and the limits of the interpretation process are accepted, EMG may be an effective tool for evaluating labour performance. Before considering the use of EMG, the ergonomist should be aware of which muscles will be impacted by the task. The ergonomist should be aware of the following: 1) Unless the work environment conditions exhibit a number of key characteristics, or 2) Unless specific additional measurements of the work positions are made simultaneously, The key to successful EMG use is understanding the nature of the signal collected, thereby separating the useful information of the signal from the noise and artefact. As a result, processes call for instrumentation, data processing, and interpretation. The same goal may be achieved using EMG as long as several body muscles are evaluated while a task is being performed. EMG is used more frequently, nevertheless, to assess lighter, repetitive labour when it is important to monitor the activity of certain muscles. This approach is frequently used in ergonomic study to compare the particular musculoskeletal stress (in given muscles) related to different work positions, postures, or activities, as well as to validate ergonomic concepts. Input for biomechanical models that explain the cooperative effects of muscle actions on a joint is also utilised. Therefore, the use of EMG is suitable when it is believed that a particular muscle or set of muscles is negatively impacted by the layout of the workplace. The complexity of muscle testing rises as the information gleaned from an EMG signal becomes more quantitative and meaningful. Applied ergonomic studies may entail a review of worker practises, workplace organisation, productivity, or tool design. Building an empirical foundation for preventative efforts requires an understanding of patterns of exposure to these biomechanical elements across a variety of body areas and agricultural activities.

History of EMG

Francesco Redi's documentation from 1666 served as the impetus for the creation of EMG. According to the paper, the electric ray fish's highly developed muscle produces electricity. In 1773, Walsh was able to show that the muscle of eel fish could produce an electrical spark. A. Galvani published a book in 1792 titled "De Viribus Electricitatis in Motu Musculari Commentarius" in which he demonstrated how electricity may cause muscular spasms. DubiosRaymond discovered that it was also feasible to capture electrical activity during a voluntary muscular contraction six decades later, in 1849. In 1890, Marey made the first recording of this activity and coined the name "EMG." An oscilloscope was utilised by Gasser and Erlanger in 1922 to display the electrical impulses coming from muscles. The myoelectric signal is stochastic, hence its monitoring could only provide a basic understanding of the situation. From the 1930s through the 1950s, the capacity to detect electromyographic signals progressively increased, and researchers started using better electrodes more often for the study of muscles. In the 1960s, surface EMG was first used clinically to treat more specialised illnesses. The first users of sEMG were

Hardyck and his team in 1966. Early in the 1980s, Cram and Steger developed a clinical technique for employing an EMG sensing device to scan a number of muscles. It wasn't until the middle of the 1980s that electrode integration methods had improved enough to enable batch manufacturing of the necessary compact and light-weight amplifiers and instruments. There are now several appropriate amplifiers on the market. Early in the 1980s, wires that create artefacts in the desirable microvolt range were made accessible. The characteristics of surface EMG recording have improved throughout the previous 15 years of study. In clinical procedures, surface EMG has become more often employed in recent years to record from superficial muscles, whereas intramuscular electrodes are exclusively utilised for deep muscle [2,3,5,6,7].

Classification of EMG

EMG, which depicts neuromuscular activity, is a measurement of the electrical potential that is present on the skin as a result of muscle contraction [1]. There are two ways to measure it: by placing electrodes on the skin's surface (noninvasive) or by inserting a needle into a muscle (invasive). Surface EMG (sEMG) and intramuscular EMG (imEMG) have been shown to have equal classification performance for data of a comparative nature (unmodulated), even though imEMG offers additional advantages to overcome the limitations of sEMG, such as maintaining robust electrode contact with the skin and the ability to record from profound muscles with little EMG crosstalk [4]. However, when evaluated on modulated data, imEMG's performance declined in comparison to surface [6, 7]. Since imEMG recordings depend on the recruitment of motor units, the greater selectivity of imEMG compared to sEMG is caused by wires that are only exposed at the tip. However, this may also be a drawback because the signal may provide local rather than global information; it is also possible that insufficient information was captured at low amplitude/frequency.

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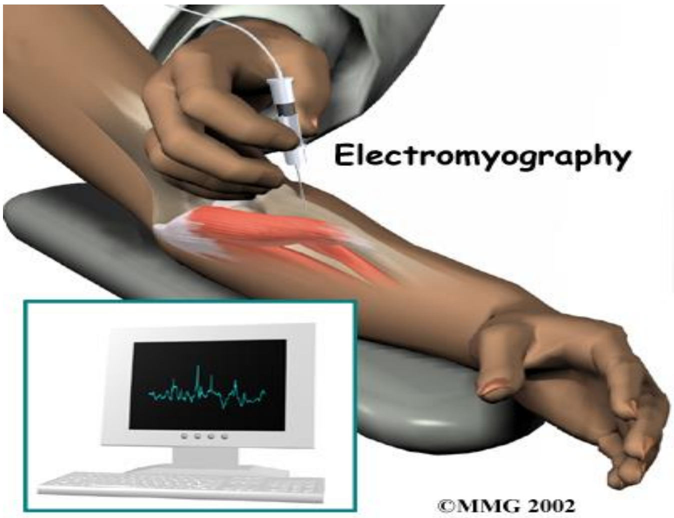

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Application of EMG

EMG may be applied in a wide variety of situations. Clinically, EMG is used to diagnose neurological and neuromuscular issues. Gait laboratories and physicians skilled in biofeedback or ergonomic evaluation utilise it for diagnostic purposes. EMG is also employed in a variety of research settings, such as biomechanics, motor control, neuromuscular physiology, movement disorders, postural control, and physical therapy.

Electrical noise and factors affecting EMG signal

Prior to amplification, the EMG signal's amplitude range is 0–10 mV (+5–-5). EMG signals pick up noise as they pass through various tissues. Understanding the properties of electrical noise is crucial. The following forms of electrical noise can be characterised as having an impact on EMG signals: 1. All electrical devices produce noise due to their inherent design. Using high-quality electrical components will only help to lessen this noise, which cannot be completely eradicated. 2. Ambient noise: This type of noise is produced by electromagnetic radiation. On the surface of the planet, it is almost impossible to escape exposure to the electric-magnetic radiation that continually bombards the surfaces of our bodies. The amplitude of the ambient noise may be one to three orders of magnitude larger than the amplitude of the EMG signal. 3. When motion artefact is added to the system, the information is distorted. Inconsistencies in the data are brought on by motion artefact. Motion artefact primarily comes from the electrode interface and electrode cable. By properly designing the electrical circuitry and setup, motion artefact may be decreased. 4. Signal instability that is inherent: The amplitude of an EMG is essentially random. The firing rate of the motor units, which in most circumstances fire in the frequency range of 0 to 20 Hz, has an impact on the EMG signal. The elimination of the noise is crucial since this form of noise is regarded as undesirable. 1. Causative factors: These have an immediate impact on the signals. Two types of causal factors can be distinguished: a. Extrinsic: This is because of the design and location of the electrodes. The EMG signal is primarily influenced by factors like the size of the detection surface, the shape of the electrode, the spacing between electrode detection surfaces, the location of the electrode in relation to the motor points in the muscle, the orientation of the detection surfaces in relation to the muscle fibres, and the location of the electrode in relation to the surface of the muscle. b. Intrinsic parameters include the number of active motor units, the make-up of the fibres, blood flow, the depth and location of the active fibres, and the quantity of tissue between the muscle's surface and the electrode. 2. Physical and physiological phenomena that are impacted by one or more causal causes are considered intermediate factors. The band-pass filtering characteristics of the electrode alone and its detection volume, the superposition of action potentials in the recorded EMG signal, and the velocity at which the action potential travels over the membrane of the muscle fibre are possible causes of this. Even close muscle crosstalk might result in Intermediate Factors. 3. Intermediate Factors have an impact on deterministic factors. The information in the EMG signal and the measured force are directly influenced by the quantity of active motor units, motor firing rate, and mechanical contact between muscle fibres. The motor unit action potential's amplitude, duration, and form might also be to blame.

The following methods can be used to maximise the quality of the EMG signal

There should be as little noise contamination and as much information from the EMG signal as feasible in the signal-to-noise ratio. 2. Signal peaks should not be distorted, and notch filters are not advised. The distortion of the EMG signal should be as small as feasible. The EMG signal processing only looks at positive values. Positive data is retained and all negative data is deleted during half-wave rectification. During fullwave rectification, each data point's absolute value is utilised. Full-wave rectification is typically recommended for rectification.

Conclusion

EMG signal carries valuable information regarding the nerve system. So the aim of this paper was to give brief information about EMG and reveal about history, classification of EMG, application of EMG and electrical noise and factors affecting EMG signal.

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