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A STUDY ON CHALLENGES AND FEATURES OF NEEDLE AND SURFACE ELECTRODE FOR MUSCLE FORCE ESTIMATION

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ABSTRACT
The magnitude of muscle force is important for analyzing joint loading in Biomechanics and many applications like Ergonomics, Biofeedback, Rehabitation and Sports medicine. But it cannot measure by directly. In this study, we present the procedure of acquiring EMG signal to measure Muscle force by Non-invasive and Invasive method. The Surface Electromyography is the Noninvasive (not inserting into muscle) and Needle Electro myography is Invasive (Inserting into muscle) method. The first sections in this document cover technical aspects such as Needle EMG inspection, types of needle electrode, How to insert the needle, Patient preparation, Needle movement, muscle selection, Examining resting muscle and contracting muscle. The second section covers features of Surface EMG including types, Multichannel SEMG and Electrode placements. Finally we compared both the methods and discussed about estimating muscle force by EMG magnitude.

KEYWORDS: Electromyography, Needle Electrode, Surface Electrode, Multichannel SEMG and Muscle force.

1. INTRODUCTION

Electromyography (EMG) is the device which offers with the detection, evaluation and utilization of electrical signals forming from skeletal muscles. The electric signal produced during muscle contraction, known as the myoelectric signal, is produced from tiny electrical currents generated by the exchange of ions across the muscle membranes and find out with the help of electrodes. Electromyography is applied to estimate and main the electrical activity generated by muscles of a human body. The device from which we get the EMG signal is known as electromyography and the resultant report obtained is referred as electromyogram.[1]

Electromyography empowers us to produce power, make activities and permit us to do endless different capacities through which we can cooperate with our general surroundings.

The electromyography is a bioelectric signal which has, over the years, built up a tremendous scope of utilizations. Clinically, electromyography is being utilized as indicative apparatus for neurological disorders.[1] It is fast and again being utilized for evaluation of patients with neuromuscular sicknesses, low back pain and disorders of motor control. Other than physiological and biomechanical inquire about, EMG has been created as an assessment apparatus in applied research, physiotherapy, restoration, sports medication and training, biofeedback and ergonomics research.[2]

Movement of the human body is an ideal combination of the brain, sensory system and muscles. It is inside and out an efficient exertion of the brain with 28 significant muscles to control the trunk and limb joints to create powers expected to counter gravity and move the body forward with least measure of vitality expenditure.[3] The development of the human body is conceivable through muscles as a team with the brain. At whatever point the muscles of the body are to be enlisted for a specific movement, the brain imparts excitation signals through the Central Nervous System (CNS). Muscles are innervated in bunches called 'motors Units'. An motor unit is the intersection point where the motor neuron and the muscle filaments meet. At the point when the motor unit is actuated, it delivers a 'Motor Unit Action Potential' (MUAP). The initiation from the Central Nervous System is repeated ceaselessly for whatever length of time that the muscle is required to produce power. The persist in an activity of muscle produces motor unit activity potential trains. The trains from simultaneously dynamic motor units superimpose to create the resultant EMG signal. A gathering of muscles are engaged with a specific development of the human body. The quantity of muscles enrolled relies on the action where the body is included. In specialized terms, at whatever point it is required to create more noteworthy power, the excitation from the Central Nervous System expands, increasingly motor units are actuated and firing rate of all the motor units increment bringing about high EMG signal amplitudes.[4]

Muscle power (force) is the mainly calculated by the quantity of active motor units (MUs), their size (cross-sectional region), and their firing rate. In this manner, on a basic level, both spatial (active MUs) and transient (firing rates) data is required to assess muscle force. The elements deciding force are frequently abridged in the term muscle enactment, which is definitely not a physiological variable, yet rather a theoretical time-changing model information variable that scales the model yield, muscle force. This information is traditionally assessed by methods for single time-fluctuating standardized EMG amplitude, which is influenced by MU size, MU number and terminating rates. As of late, the additional estimation of the spatial data gave by multi-channel EMG has been accentuated in a few reports on EMG applications. It was additionally demonstrated that this methodology improves EMG-based force estimation.[5] Beyond this the EMG amplitude is affected by factors not related to force generation, such as the wave shape of motor unit action potentials. With respect to this problem we have suggested new solution to improve muscle force estimation from EMG.

2. BASICS OF NEEDLE ELECTRODE

Needle EMG includes recording the electrical signs that are created from muscle filaments by embedding needle Electrode. Standard EMG examines include embedding an recording electrode into a muscle, gradually moving the needle through various districts of muscle, and recording the electrical signals that are happening very still, started by the needle development, and during voluntary muscle contraction.[6] In needle electrode the capacity to record ordinary and anomalous electrical movement from muscle is operator dependent. Needle EMG examiner requires various abilities and information. Needle placement and data recording are totally fundamental so as to acquire precise and solid waveforms.[7]

There are an assortment of needle electrode lengths and types. Needle electrode determination relies upon various patient and examiner contemplations. Needle electrode must be sterile. Dispensable, standard electrodes are accessible at a sensible expense and ought to be utilized for every patient. While increasingly costly needle terminals, for example, single fiber needle EMG electrodes, might be disinfected and reused, this isn't prescribed for those utilized in routine practice. Such electrodes are regularly sharp and undistorted. Once in a while, they may not be sharp and will oppose inclusion. On the off chance that an electrode enters the skin with trouble, going it through a sterile cotton ball or wipe may recognize obstacles from bowed tips. To decide whether a group of cathodes are not very much made, they ought to be inspected under a low force magnifying lens. Needles must be straight. A needle that has been bowed ought not to be fixed for preceded with use since a little break in the protection may cause a short out and bring about needle EMG signal distortion.

The recording surface of muscle must be the right size and shape, just as completely spotless. Dispensable, sterile needles from the producer may once in a while be left with an extremely slender, ineffectively leading film on a superficial level. This film builds the impedance and may cause a low-voltage, unpredictable, positive waveform. This must be perceived since it might be confused with end-plate commotion, positive sharp waves, or fibrillation possibilities. The film might be scattered inside a couple of moments in the muscle. If not, the needle ought to be supplanted. The shaft must be steady in the center to keep it from severing in a patient. The connection with the link must be unblemished. A poor connection can bring about intermittent 50 Hz or unpredictable interference. Electrical impedance ought to be checked if a break or short is suspected.

There is a discussion with regards to whether concentric needles or monopolar needles ought to be utilized for the needle EMG information procurement. While there are a few contrasts, they are moderately minor. In any case, it is significant that the examiner utilize a similar sort of needle electrode that was utilized in getting the typical qualities utilized in their research facility. The examiners favor concentric needles since they don't require a surface reference, the signal is crisper, and the assessment might be directed more rapidly.[7,8]

2.1. Instructions to Insert Needle in to muscle

The muscle to be tried ought to be palpated during discontinuous contraction to localize its outskirts with the examiners thumb and forefinger. It is useful to make the skin rigid at the site of inclusion, especially where the skin is free. The tight skin is best pulled a short separation distally over the muscle to diminish bleeding (when discharged, the skin will pull back over the needle site in the muscle). The needle electrode ought to be held immovably in the fingers like a pen and embedded easily and rapidly through the skin into the subcutaneous tissue or superficial layers of the muscle at roughly a 45 degrees point. This limits force necessary to accomplish entrance of muscle, and it likewise may divert the patient preceding skin cut. Rest the hand holding the needle on the skin so as to make needle development agreeable and exact. Your opposite hand is situated on the limits of the muscle for help with limitation during needle movement. A little flick of the examiner's forefinger over the expected addition site may help with diminishing the patient's perceived discomfort.

2.2. Needle Electrode Types

There are a few distinct sorts of needle electrode utilized during routine clinical EMG to record the electric movement inside muscle. For most routine examinations, concentric or monopolar electrodes are utilized.

2.2.1. Concentric-needle electrode

The concentric needle consists of two electrodes; the first electrode is a wire electrode, typically platinum that is insulated and housed within a steel cannula acting as the second electrode. The surface area of the wire electrode depends on the wire diameter and the bevel angle of the needle and is usually between 0.01 and 0.09 mm^2, typically 0.07 mm^2. The differential recording is then achieved by measuring the voltage between the wire electrode (active electrode (E1)) and the entire cannula shaft (reference electrode (E2)). The main spike component of the MUP is generated by approximately 2-12 fibers within a radius of about 0.5-1 mm around the tip of the needle. More distant fibers contribute to the initial and late parts of the potential. Due to the short distance between the electrodes, a great common mode voltage recorded by the active and reference electrodes is present leading to the elimination of much distant activity and providing a relatively sharp and self-contained MUP.

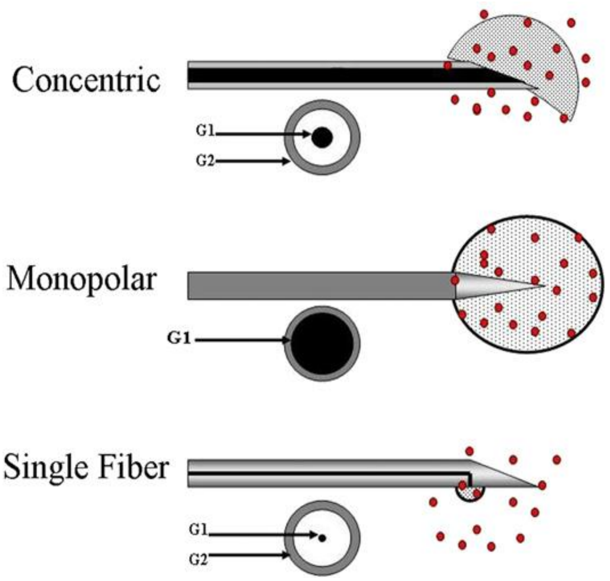

Fig. 1: Types of Needle Electrodes.

2.2.2. Monopolar needle electrode

Monopolar needles for EMG recordings are usually constructed from a stainless-steel core that is coated with Teflon except for an exposed cone tip of 1-5 mm that acts as the active electrode. The recording area is approximately 0.03-0.34 mm^2. The potential difference is measured between the exposed tip of the needle and a second reference electrode. This reference electrode may be a needle placed subcutaneously or a surface electrode at some distance from the active electrode. The reference electrode should be placed over an electrically silent area, such as a tendon or a bone. Impedance mismatch between the active monopolar needle and a surface electrode can lead to a reduced common-mode signal and greater artefacts, including power line interference (50 or 60 Hz). Monopolar needles record larger amplitudes and greater duration than concentric needles, but the number of phases is comparable.

2.2.3. Single fiber electrode

Single fiber EMG electrodes have an active region consisting of a platinum wire approximately 25µm in diameter exposed on a side port of a steel cannula, with the cannula itself serving as the reference lead (similar to a concentric needle). Within the pick-up range (a semicircle with a radius of 300 µm, pick-up area 0.0005 mm) in healthy muscles there are usually no more than 2-3 fibers, allowing for pairs of fibers to be easily obtained. Concentric needles can also be used to Collect "single-fiber-like" data; this is achieved by increasing the cutoff frequency of the high pass filter so as to help distinguish individual spikes within the MUP.[7,9]

2.3. Setting up the patient

Most patients will have gotten data about the needle assessment before the examination and may have a couple of inquiries. In any case, it is as yet accommodating to clarify that this assessment contrasts from the nerve conduction studies in that no outer electrical boosts are applied. The patient ought to likewise be educated that nothing is embedded through the needle or expelled from the needle as it might be utilized to record muscle activity. You ought to clarify that the needle will be embedded into various muscles and that there will be some inconvenience, which is unavoidable yet by and large all around endured. You ought to likewise clarify that needles are disposed of after each utilization.

2.4. Muscle selection

The muscles to be checked are chosen at first dependent on the clinical issue. Certain calculations or conventions can help direct the way to deal with an individual patient; be that as it may, changes from the calculations are as often as possible essential relying upon the discoveries got during the examinations. In assessing certain diseases, the appropriation of discoveries will regularly change among muscles just as in various locales of a similar muscle. For instance, in numerous myopathies, variations from the norm are all the more generally observed in proximal muscles; in certain myopathies, for example, dermatomyositis, the shallow layers of the muscle may show more noticeable changes than more profound parts. In a patient with suspected amyotrophic parallel sclerosis (ALS), different distal and proximal limb muscles provided by various roots and nerves might be important to look at to show a far reaching sickness of motor neurons. In a patient with a presumed single root radiculopathy or mononeuropathy, the needle assessment will be progressively centered on muscle in a single limb.

2.5. Needle movement

During the assessment, three sorts of action are recorded: (1) the action that happens with or following each needle movement very still (insertional movement), (2) immediately firing action very still, and (3) action during voluntary muscle contraction (voluntary activity). Since theneedle electrode essentially records action from a little zone in a muscle, the electrode must be moved to record the action in numerous various locales of the muscle to acquire a progressively complete appraisal of the fundamental changes that may have happened in the motor units or muscle filaments. The movement of the needle through the muscle is the prevalent generator of the inconvenience experienced during the assessment. To lessen this inconvenience, the muscle ought to be analyzed by moving the needle along a straight line through the muscle in short advances (0.5–1 mm). Complete appraisal of a muscle typically expects 2 to 4 distinct goes through the muscle.

2.6. Analyzing a resting muscle

Assessment of the muscle at rest is performed to evaluate for irregular unconstrained releases that might be markers of a basic infection. A few kinds of electrical signals ordinarily happen in a resting muscle. Insertion action is the electric reaction of the muscle to the mechanical harm by a little movement of the needle. Assessment of inclusion action requires a delay of 0.5 to 1 second or all the more after end of needle movement to watch any tedious or gradually terminating potential, for example, rare fibrillation potential or fasciculation potential. Insertional action might be expanded, diminished, or inspire explicit waveforms, for example, myotonic discharge.

2.7. Looking at a Contracting muscle

The contracting muscle is inspected utilizing similar needle techniques with respect to resting muscle. The contracting muscle is best inspected with the muscle held at a degree of contraction that initiates a couple of motor units (low-to-moderate effect). Particular activation of the muscle of interest and adjoining muscles is expected to decide needle position while looking at profound muscles, muscles that are hard to palpate, or little muscles. Steps in testing a contracting muscle include:

- Withdrawing the needle to a subcutaneous situation before requesting muscle contraction.
- Positioning the limb and muscle and starting withdrawal before moving the needle into the muscle. Advance the needle until you experience MUAPs with a fast ascent time and a sharp, clicking sound.
- Proper limb situating with the end goal that the action of synergistic and adjoining muscles is restricted.
- Asking the patient to play out a movement that just requires initiation of the muscle being inspected.
- Palpating the contracting muscle so as to help direct the needle development.

2.8. Other Factors considered for needle Electrode

Small muscles are best tried with an angled needle course through the muscle to stretch the needle's way. Profound muscles and obese patients require a needle of satisfactory length. In the event that the needle was to sever, it would almost certainly do as such at its center point, which is its most vulnerable point. On the off chance that a needle was to be embedded to a profundity more prominent than its length and it broke, it is hard to evacuate. A few muscles, for example, the deep Para spinal muscles, might be hard to reach without a long needle, even in normal estimated patients. Needles of up to 120 mm length ought to be accessible and ought to be utilized in such conditions.[8]

3. FUNDAMENTALS OF SURFACE ELECTRODE

Surface EMG electrodes give a non-obtrusive (non-invasive) strategy to estimation and discovery of EMG signal. The hypothesis behind this electrode is that they structure a chemical balance between the recognizing surface and the skin of the body through electrolytic conduction, so that current can stream into the electrode. These electrodes des are straight forward and extremely simple to actualize. Utilization of needle and fine wire electrode require exacting clinical supervision and accreditation. Surface EMG electrode requires no such conventions. Surface EMG electrodes have discovered their utilization in motor behavior considers, neuromuscular accounts, sports clinical assessments and for subjects who object to needle additions, for example, youngsters. Aside from this, surface EMG is as a rule progressively used to distinguish muscle action so as to control gadget expansions to accomplish prosthesis for truly impaired and excised population.[1]

3.1. Electrode Geometry

Throughout the history of electromyography, the shape and the layout of the detection surface of the electrode have not received much attention. Most likely because past users of Electromyography have been interested only in the qualitative aspects of the EMG signal. The advent of new processing techniques for extracting quantitative information from the EMG signal requires greater focus on the configuration of the electrode. The major (but not all) points to consider are:

1. The signal to noise ratio of the detected signal,
2. The bandwidth of the signal,
3. The muscle sample size, and
4. The susceptibility to crosstalk.

- Signal-to-noise ratio**:** The signal-to-noise ratio proportion is a function of convoluted connections between the electrolytes in the skin and the metal of the detection surfaces of the electrode. Do the trick it to state that there are a few methodologies for decreasing the noise, for example, utilizing huge surface zones for the detection surfaces, utilizing conductive electrolytes to improve the contact with the skin, and evacuating dead (less conductive) dermis from the outside of the skin. Through experimentation, location surfaces made of unadulterated (>99.5%) silver as bars 1 cm long and 1 mm in width give an adequately good medium to the detection surface. The amplitude of the EMG signal is straightforwardly relative to the separation between the detection surfaces. Henceforth, this separation ought to be maximized. In any case, expanding this separation acquaints unfortunate attributes with the electrode structure. As the electrode becomes larger, it gets unwieldly and can't be utilized to distinguish EMG. signals from generally little (in width just as long) muscles, for example, those found in the hand, lower arm and the leg. Also, as the separation expands the sifting qualities of the differential amplification diminishes in bandwidth.

- Bandwidth: The data transfer capacity of the EMG signal is influenced by the between location surface dispersing and the conduction speed of the muscle. The differential arrangement has a spatial filtering highlight that can be communicates as a bandpass filter in the spectral frequency region of the EMG signal. For a normal conduction speed of 4.0 m/s and a between recognition surface separation of 1.0 cm, the pass frequency is 200 Hz and the null point is at 400 Hz. This bandwidth catches the full recurrence range of the EMG signal and reduces noise at higher frequencies.
- Muscle test size: The muscle test size need not be huge on the grounds that the muscle strands of motor units are dispersed all through the majority of the muscle cross-segment. Along these lines, it isn't important to cover an enormous segment of the muscle with the detecting surface of the electrode to acquire a delegate test of the EMG signal for a specific arrangement of active motor units.
- Cross-talk susceptibility: The susceptibility to cross-talk is an often overlooked design aspect of EMG electrodes. The more prominent the width and length of the detection surfaces and the more noteworthy the inter detection surface separation the closer the electrode will be to nearby muscles. Therefore, bigger electrode are progressively susceptibility to identifying signals from neighboring (parallel and underneath) muscles. In circumstances where this issue is of concern, it is fitting to decrease the size of the electrode.[10]

3.2. Types of EMG Electrodes
There are two types of surface EMG electrodes: Gelled and Dry EMG electrodes.

3.2.1. Gelled EMG Electrodes
Gelled EMG electrodes contain a gelled electrolytic substance as an interface between skin and electrodes. Oxidation and reduction reactions take place at the metal electrode junction. Surface electrodes are usually made of silver/silver chloride (Ag/AgCl), silver chloride (AgCl), silver (Ag) or gold (Au). Silver – silver chloride (Ag-AgCl) is the most common composite for the metallic part of gelled electrodes. The AgCl layer allows current from the muscle to pass more freely across the junction between the electrolyte and the electrode. This introduces less electrical noise into the measurement, as compared with equivalent metallic electrodes (e.g. Ag). Due to this fact, Ag-AgCl electrodes are used in over 80% of surface EMG applications.

Disposable gelled EMG electrodes are most common; however, reusable gelled electrodes are also available. Special skin preparations and precautions such as (hair removal, proper gel concentration, prevention of sweat accumulation etc.) are required for gelled electrodes in order to acquire the best possible signal.

Fig. 2: Gelled EMG Electrode.

3.2.2. Dry EMG electrodes
Dry EMG electrodes do not require a gel interface between skin and the detecting surface.

Fig. 3: Dry EMG Electrode.

These electrodes may contain more than one detecting surface. In many examples, an in-house pre-amplification circuitry may also be employed in these electrodes. Dry electrodes are usually heavier (>20g) as compared to gelled electrodes (<1g).This increased inertial mass can cause problems for electrode fixation; therefore, a material for stability of the electrode with the skin is required.[1]

3.3. Multi-channel SEMG
Traditionally, a single pair of electrodes is used for the recording of surface EMGs from individual muscles. The possibility of sampling the myoelectric activity from different locations on the same muscle, however, is attracting progressively more clinicians, physical therapists and researchers.[11]

In same time, EMG data collection guidelines aim to increase signal amplitude while minimizing noise, thus increasing the signal-to-noise ratio.[12] A sEMG measurement has a disadvantage in that it has difficultly measuring directly the activation at a specific muscle and it requires multiple site measurements to recognize the muscle activation.[13] To address this problem the development of sEMG equipment that records the input of multiple electrodes placed on one muscle has increased the possibility of detecting single MU characteristics. The complex nature of this new multi-channel sEMG signal, to be henceforth referred to as 'high-density surface EMG' or HD-sEMG.[14]

The goal of finding a high amplitude signal by using HD-sEMG depends electrode placement should meet three criteria: 1) repeatability, 2) consideration of individual body imensions, and 3) a high signal yield (i.e., high amplitude). Higher amplitude signals could be used to identify the area of the muscle with the most activity.[15] In addition, maximum mean and median power spectral frequencies (MNF and MDF, respectively) are associated with areas near the Innervation Zone. In the IZ, action potentials are incomplete or non-propagating, therefore shorter in duration and lower in amplitude than propagating action potentials. The action potentials also tend to move in opposite directions away from the IZ, resulting in signals that are similar in shape but opposite in phase. Due to differential amplification, signal amplitude over the IZ will be substantially reduced.[16]

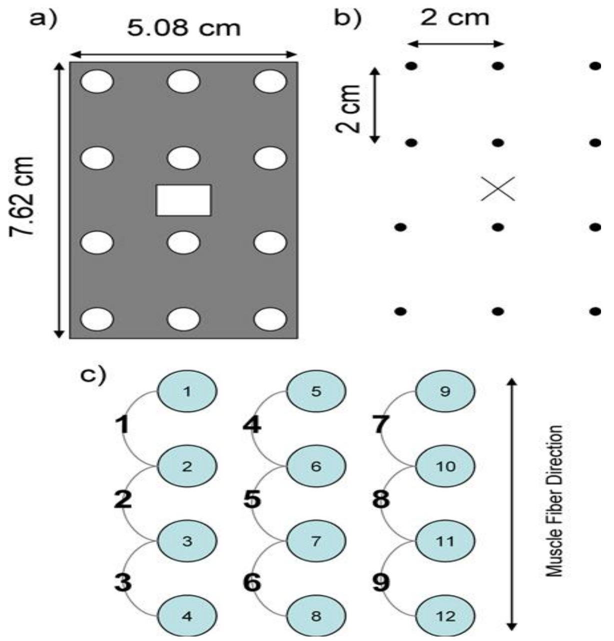

Fig. 4: Array placement and electrode pair formation.

a) The grid used to mark electrode locations.
b) Marks made on the skin using the grid. The "x" denotes the guideline-recommended electrode location, while the dots are used to mark where electrodes are placed.
(c) The formation of 9 bipolar electrode pairs from 12 monopolar electrodes.

In this method, Instead of attempting to place a single electrode pair optimally, which is a time-consuming process, an electrode array is placed on top of the muscle of interest and an automated method is used to select an optimal electrode pair based on sEMG signal characteristics. The electrode array could be integrated in a wearable sleeve to enable quick placement of the array.[17]

An electrode array approach (HD sEMG) offers a more accurate and repeatable method of locating the best site for sEMG data collection.[18] The results of this study demonstrated that RMS appears to be the best parameter to provide a quantitative measure for electrode selection. Other parameters, Such as WL, MNF, and MDF, had also high repeatability but low inter-parameter agreement with RMS, which suggests that these parameters can provide additional information that could be integrated with RMS.

The terminologies, multi-channel and high-density have been used interchangeably to denote the sampling of myoelectric activity with several surface electrodes.[19] On this respect, multi-channel is generic and, thus, confusing, as it possibly refers either to the sampling from the same or from different muscles.[20] From the past investigation, (1) the formation of postural synergies using multiple pairs of electrodes, each positioned on a different muscle in the lower limbs and in the trunk. These authors have, then, used a multi-channel system to record surface EMGs from different muscles. Conversely, to identify which muscle location provides surface recordings with highest quality. (2) Recorded multiple EMGs from individual muscles in the lowerlimb. In this case, a multi-channel system was used to sample from different regions of a single muscle. While high-density is less ambiguous, and preferred over multi-channel, when referring to the ability to record multiple EMGs from individual muscles, there are no indications concerning the number of electrodes for a detection system to be classified as high-density. Currently, high-density-surface-EMG (HD sEMG) implies multiple electromyograms recorded from a single muscle with either mono- or bi-dimensional arrays of surface electrodes.[21]

Systems for the detection of HDs-EMG show great diversity with respect to the size and the shape of the grid of electrodes, the material with which the grid is built, the distance between electrodes and the electrode-skin contact (dry or gelled). This assortment of attributes relies chiefly on the muscles from which EMGs shall be recorded. A small grid of closely spaced electrodes (from 2.5 to 5.0 mm inter electrode distance, IED) fits well for the acquisition of HDs-EMG from the tiny muscles of the hand and face.[22] For example, a grid of silver-pin electrodes (2.5 mm IED) to investigate the ability of subjects to control the recruitment and the rate coding of single motor units in the adductor pollicis muscle. The activity of individual motor units in the facial musculature with a flexible, bidimensional grid of 60 silver-coated electrodes (4 mm IED), mounted on a Polymid carrier. This matrix was fixed on the skin with double-sided adhesive foam and the electrode-skin contact was assured with a conductive cream.[23] In contrast, mapping the myoelectric activity in muscles of greater dimension requires larger arrays of electrodes. The individual contribution of each of the calf muscles to the total plantar flexion torque has been assessed with a large matrix of 128 electrodes, either during isometric contractions or in quiet standing.[24] Depending on the muscle architecture, a particular detection system could be urged. To detect HD-sEMG from the external anal sphincter, a muscle with circular architecture, designed a circumferential array of 16 equally spaced electrodes, embedded on a cylindrical probe with 14 mm diameter.[25] Rather than reflect a lack of needed standards, all the available grids of electrodes indicate how peculiar a muscle or a motor task.[26]

3.4 Recent Developments in Surface EMG

Apart from Surface EMG, EIM is a non-invasive technique for evaluating neuromuscular diseases that rely upon the application and measurement of high-frequency, low-intensity electrical currents.[27] Since the electrical current applied is high frequency (e.g., 50 kHz), it does not excite tissues, there are no bioelectrical signals being generated, and so the electrodes are not referred as "active" or "reference" electrodes—rather both current and voltage electrodes assess the region of tissue beneath and between them. EIM is a bioelectrical impedance-based technique with four electrodes used to assess diseases affecting the nerves and muscles. Two of the four electrodes are used as the current sources. The other electrodes, located between the current source electrodes, are used as voltage detectors. EIM has been applied to the diagnosis of muscle diseases and their medical.[28]

Electrical impedance tomography (EIT) is a method used to detect muscle activation. EIT is a non-invasive method used to create a tomography image by applying surface electrodes and a current source. A part of the body is modeled using the electrical conductivity, permittivity, and impedance. EIT has been widely applied to the medical research field.[29, 30]

3.5. Skin preparation

Application of surface EMG electrodes requires proper skin preparation beforehand. In order to obtain a good quality EMG signal, the skin's impedance must be considerably reduced. For this purpose, the dead cells on the skin e.g. hair must be completely removed from the location where the EMG electrodes are to be placed. It is advisable to use an abrasive gel to reduce the dry layer of the skin. There should be no moisture on the skin. The skin should be cleaned with alcohol in order to eliminate any wetness or sweat on the skin.

3.6. EMG electrode placement

The application of EMG electrodes requires adequate know how of the skeletal muscles. In most cases, two detecting surfaces (or EMG electrodes) are placed on the skin in bipolar Configuration. In order to acquire the best possible signal, the EMG electrode should be placed at a proper location and its orientation across the muscle is important. The surface EMG electrodes should be placed between the motor unit and the tendinous insertion of the muscle, along the longitudinal midline of the muscle. The distance between the center of the electrodes or detecting surfaces should only be 1-2 cm. The longitudinal axis of the electrodes (which passes through both detecting surfaces) should be parallel to the length of the muscle fibers by following SENIAM Norms.

The EMG detecting surfaces should be placed in between the motor unit and the tendon insertion of the muscle. Detecting surfaces placed on the belly of the muscle has proved to be a more than acceptable location. Here, the target muscle fiber density is the highest. When then electrodes are arranged in this way, the detecting surfaces intersect most of the same muscle fibers, and as a result, an improved superimposed signal is observed.

The electrodes should not be placed elsewhere. In the past, a misconception prevailed that the EMG detecting surfaces should be placed on the motor unit. But, as a matter of fact, the electrode location on the motor point serves as the worst location for signal detection. Similarly, the electrodes should neither be placed at or near the tendon nor at the edge of the muscle. The muscle fibers become thinner and smaller in number when they approach the tendon of the muscle resulting in a weak EMG signal, proving the fact that electrode. Placement near the tendon is not feasible. If the electrode is placed at the edge of the muscle, the chances of crosstalk from other muscles will considerably increase, and the resultant signal will be disturbed by those of other muscles.

3.7. Reference electrode placement

The reference electrode (at times called the ground electrode) is necessary for providing a common reference to the differential input of the preamplifier in the electrode. For this purpose, the reference electrode should be placed as far away as possible and on electrically neutral tissue (say over a bony prominence). Often this arrangement is inconvenient because the separation of the detecting electrode and reference electrode leads requires two wires between the electrodes and the amplifier.

It is imperative that the reference electrode make very good electrical contact with the skin. For this reason, the electrode should be large (2 cm x 2 cm). If smaller, the material must be highly conductive and should have strong adhesive properties that will secure it to the skin with considerable mechanical stability. Electrically conductive gels are particularly good for this purpose. Often, power line interference noise may be reduced and eliminated by judicious placement of the ground electrode in the selected muscle of neutral tissue.

4. Comparison Between Surface And Needle Electrode.

Parameter	Surface Electrode	Needle Electrode
Method	Non –Invasive	Invasive
No. of Motor Unit Coverage	More	Less
Noise Content	More	Less
Cost	Low	High
Usage	not applicable for Deep muscle	applicable for Deep muscle
Applicable	Applicable for all type of people	Not applicable for child
Skin preparation	Accurate Requirement of Skin Preparation	More Accurate Not Needed
Sensitivity	Insensitive at recording very small amplitude potentials	Sensitive for recording very small amplitude potentials

5. DISCUSSION

In the muscle force estimation the key factors are quantity of active motor units (MUs), their size and firing rate. Apart from this location of electrode placement decides the magnitude of EMG and Wave shape because basically EMG signal are vector sum of motor unit action potentials and traveling waves of MUPs are bi-phasic or Tri –phasic nature i.e. additive and Subtractive nature. This makes constructive and destructive effect in EMG that referred phase cancellation phenomenon. In presence of phase cancellation, the EMG represents large variability in magnitude that affects muscle force estimation. The No. of MUs varying on people and randomly placed in muscle so single pair of electrodes does not represent whole muscle activity. In that case an array of electrode is placed in multi-channel to cover the whole muscle which improves EMG performance to detect the muscle force.

6. CONCLUSION

From this Study, We presents that both the methods are acceptable for EMG acquisition to measure muscle force but it betterment is depends on electrode location in muscle. In SEMG low amplitude signal are not in sensitive so, Needle EMG is best choice in this case because it is sensitive for low amplitude signal and it is closely contacted the muscle. Because of low coverage area of needle EMG and needle movement is required to cover more muscle fiber make the pain and not applicable for elders and Childs. In Deep muscle (like Vastus Lateralis) surface EMG is not applicable in that case we practice the needle EMG and most of the physician follows the Surface EMG because of its simplicity in practice. So the present overview guide the user through possible and necessary information about EMG acquisition system to meet the objective of giving insight in the possibilities and limitation of Surface EMG and Needle EMG technique for muscle force estimation.

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