Ergonomics Workplace Analysis
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Lecture - 07
Assessment of Physical and Cognitive Work with Psychophysiological Methods

Hello all welcome back to one more lecture. Today we will be talking about various assessments for physical as well as cognitive work through psychophysiological methods. So, from last few lectures we whatever we discussed we talked about physical workload, mental workload. Now, there are lots of subjective assessment tools we used. Now, here in this particular lecture we will be talking about more of instruments.

So, here we will be describing the basics of those instruments: how we are going to use it and what are the interpretations of those instruments and then we will be taking you to the lab for the experimental setup.

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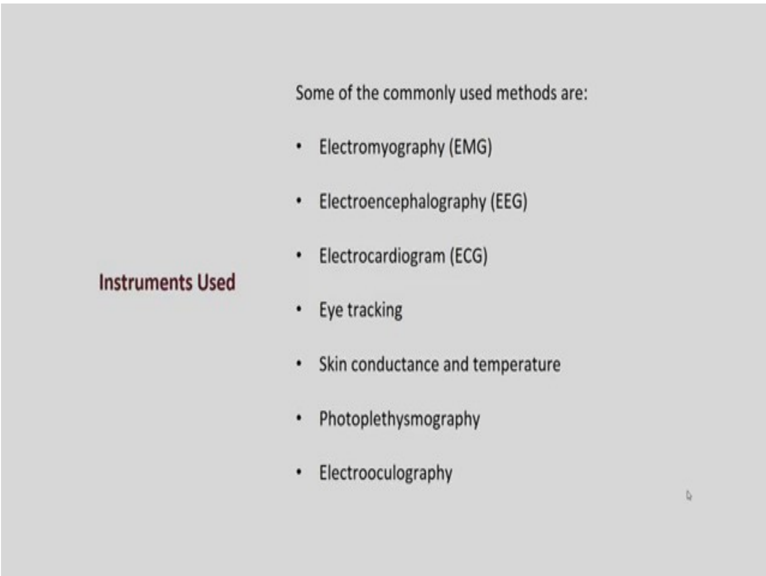

So, what we are going to do over here? Very important and commonly known measuring method is EMG which is normally in use whenever we are doing movement analysis. EMG is very popular of course. This is a purely medical instrument where we are recording the bio-signals and then we are trying to understand how the work place is interacting with the human being and what interacting methods are there and how those activity or work is affecting the physiological behavior.

So, we will be talking about EMG, we will be talking about EEG; also we have many others we will be naming few, but due to time constraint we may not elaborate on all these such as electrocardiogram, eye tracking, skin conductance and temperature all these. These are very much instrument specific measurement and method. We will explain some of these but due to time constraint.

EMG is very popular and commonly used. It is not about the popularity, it is very much useful in terms of data collection whenever the human body is active for a particular activity. Take example, suppose somebody is working in a shop floor using their forearm or trunk. So, how much force is required, how much they are getting exerted, if those group of muscles are developing fatigue etc.

How? What is the nature of that fatigue development or how the movement is happening? All these things when we want to learn, subjective response is definitely very important. Here we will be talking about instrumental measurement. So, numeric values of those potential generation and then how we are going to interpret that for understanding. So, suppose you developed a product where it needs to be held for some minute or some hours right to for that particular operation.

So, how you are going to analyze or tell or confirm that this particular instrument or this particular product actually reducing the physiological effort. Because what is the aim of this particular subject ergonomics? That reducing effort manual effort while doing the job on the same time we want to keep the productivity on the higher side. So, when we are talking about all those things, when we say that manual effort has been reduced or people are feeling less discomfort or less fatigue.

How you are going to prove it? Subjective response is one where we need this objective measurement. So, EMG is one of that which is very important.

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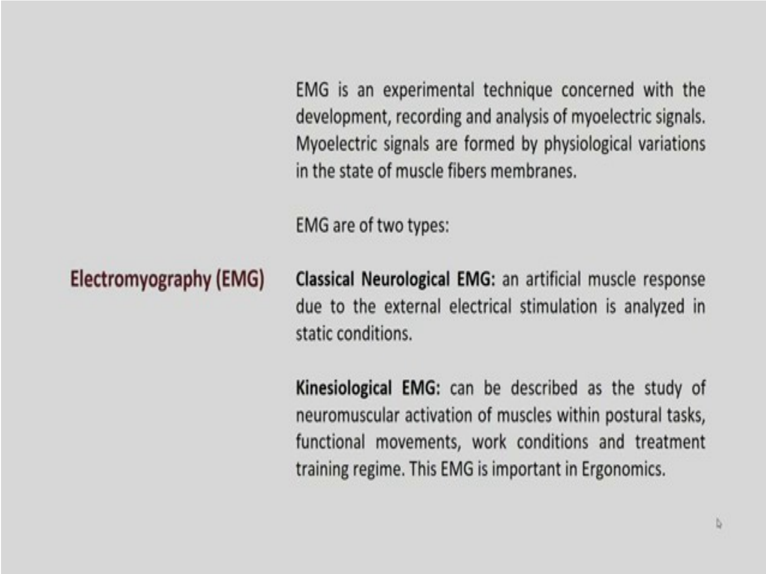

So, I will be taking you for EMG first and then slowly others. So, EMG is an experimental technique of course. It is an experimental technique concerned with the development recording analysis of myoelectric signal. So, what is myoelectric signal? In the muscle when the electrical potential is getting generated how we are going to measure those signal, we will be calling it is myoelectric signal.

So, what we are doing? We are trying to understand where it is getting developed, how it is getting recorded and analysis of those recording. So, myoelectric signals are formed by physiological variation in the state of muscle fibre membranes. So, if you really would like to do the EMG for your experiment, I would request you to go through the muscle physiology; we discussed it in very short in earlier slides.

But it will be very good that if you study in detail. So, mainly there are two types of EMG that we normally record: one is classical neurological EMG and another is kinesiological EMG. Kinesiological EMG is very important in terms of an ergonomic study. Classical neurological EMG normally we are using these type of facility or data for the medical purposes.

So, to understand the muscle movement of a particular injured muscle and how it is getting rehabilitated and all those things. For ergonomics kinesiological EMG will be very important and we will be practicing that.

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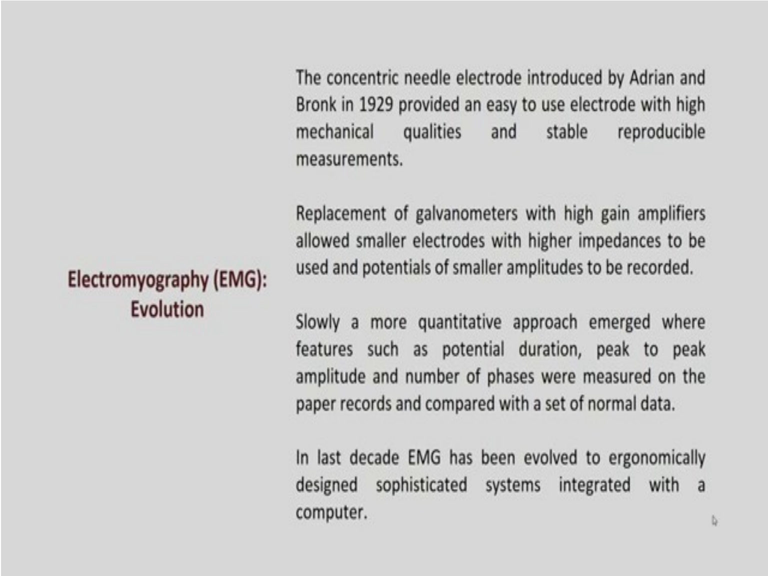

So, let us understand how it evolved and how we are using it. In 1929; so, it is you do understand, it is a very old method or old concept. In 1929 Bronk, he tried to understand the muscle activity with the concentric needle electrode. He only developed this one of course, Adrian also one of the author with him. So, he mentioned that he tried to understand the high mechanical qualities and stable reproducible measurement.

Suppose you are doing a particular movement closing a door. When you are closing a door how your biceps muscles are working. So, the same movement you can reproduce and you can reproduce the same kind of measurement through EMG. So, he developed this particular technique. Of course, the kind of instrument is required that also we can have in numbers. So, replacement of galvanometer with high gain amplifiers allowed, the smaller electrodes with higher impedance to be used and potential or smaller amplitude to be recorded.

So, this is the changes. So, in the beginning what used to happen; there used to be big galvanometer and then slowly it is being replaced by the all these high gain amplifiers. So, we have such recorders which can understand those recording and can amplify and it becomes very easy for the observer or the researcher to understand the nature frequency and other phenomena of that particular group of muscles when it is in working condition or in static condition.

So, slowly once that revolution happened that it became more quantitative in nature. Previously it was more of a qualitative analysis like nature, how it is working, is there any peak or not how long it is holding all those things but slowly it becomes very quantitative in nature. So, what it says that it came as a potential duration, peak to peak amplitude. So, these are the modification in the instruments. So, because of the development of various good mechanism instruments can really measure all these values.

What peak to peak amplitude, number of phases where measurement know those things we can measure. So, from last one decade what we are trying to do that, we have lot of ergonomically sophistically designed system. Even now-a-days we have some system which is wireless. So, you are putting the electrodes within a certain distance we can really measure how the muscle groups are or our target muscles are working.

So, we are actually not disturbing the person who is working on the field. So, these types of systems now are in market and people are using in various research laboratories.

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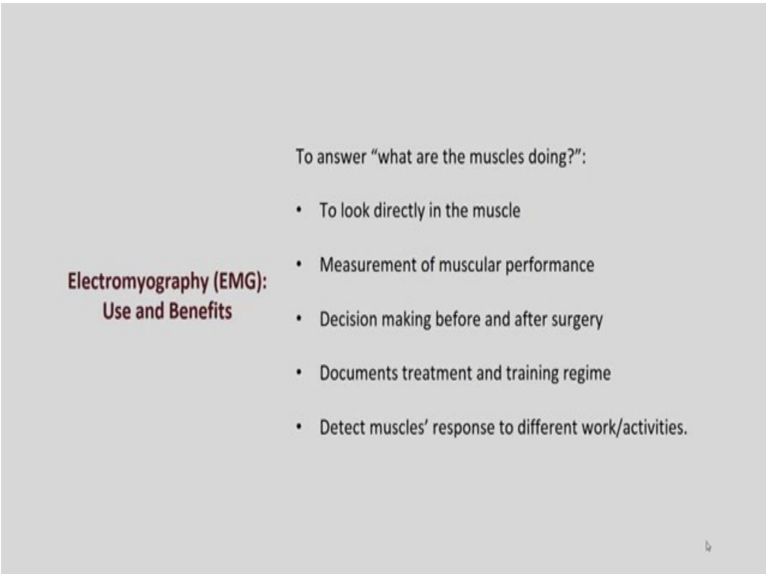

So, why we are using EMG as a measure system, what is the benefit of it? First we look directly into the muscle movement or muscle activity which is very important as far as ergonomics and physiological concepts are concerned.

So, when we are talking about physical movement; definitely physical movement is related to your muscle movement, motor movement. So, those cases you can directly see through the muscles. So, measurements of muscular performance; how good this muscle is, how strong this muscle is we can understand that muscular performance. Decision making before and after surgery- this is purely a medical thing. Suppose you would like to do a surgery for a particular group of muscle or particular area you would like to know how the strength is being changing.

It may reduce, it may enhance; our intention is to enhance it. So, document the treatment at training regime and like you know you are really calculating this was this on such and such date and then it has been changed to this to such and such date. So, it is a medical recording also we want to know the responses for different work and different activities. There are varieties of work. How that particular group of muscle which is our target maybe is responding for different varieties of work.

So, we can understand which one is strenuous job which one is not that much or moderate or those calculations. So, these are the purpose where you should do EMG study and you can find out your path. So, wherever you are right now if you have the availability of the instrument you always try to implement these measurements for your research purpose. This is very much quantitative in nature. So, it helps to make your statement more confirm. So, that is very important.

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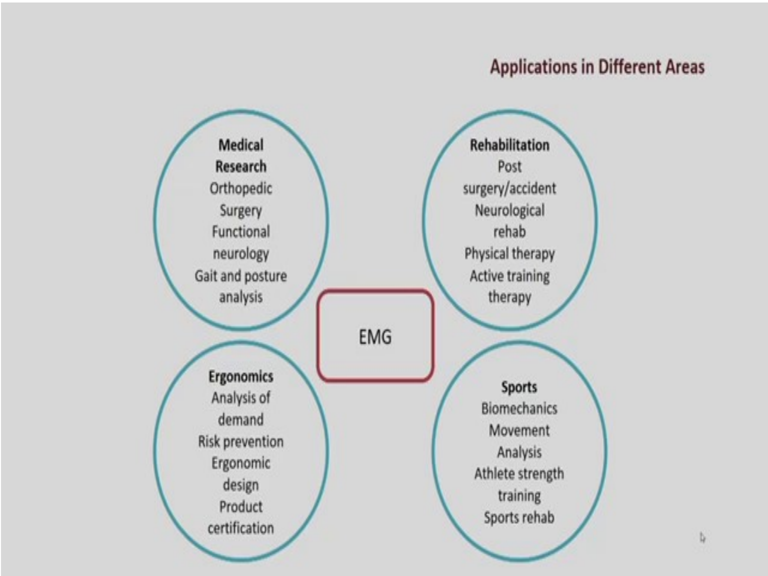

Now, as from the similar to the previous slide here we I tried to mention that how the EMG signals are being used. So, medical research, rehabilitation, sports and very important ergonomics field. So, we are going to analyze the demand, we try to prevent the risk, then ergonomic design when we are doing and we are trying to understand or we are confirming this product is better than earlier one, this product is more efficient to prove all those things we definitely need help of this EMG data.

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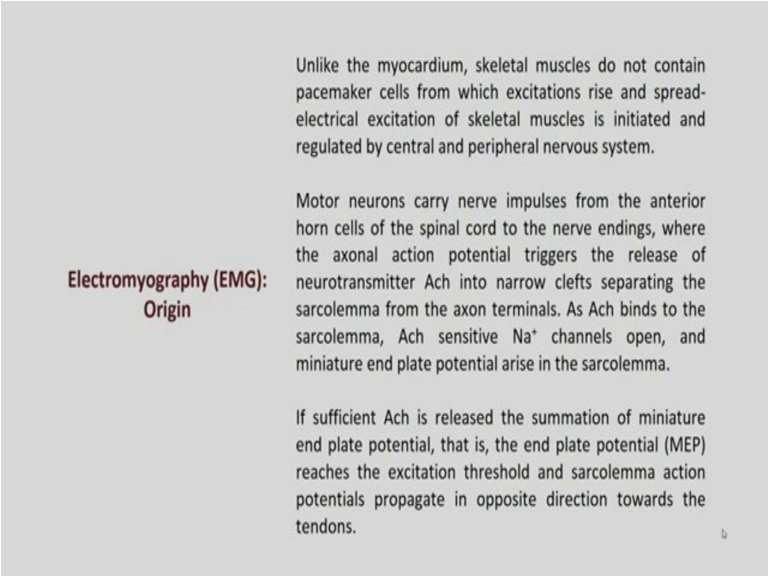

Let us understand that when we are talking about EMG analysis how is the origin of these signals. So, when we are talking about myocardium the signal generation is little different where as in the skeletal muscles. The difference between the types of muscles we discussed in previous presentations. So, in the skeletal muscles what happen; this it is the whole movement; whole control is regulated by the central and peripheral nervous system. So, there is an input, muscle contract and there is an output. This is the way how the signal process. So, what is the main component? Here the main component acetylcholine.

So, what it does? Motor neurons carry nerve impulses from the anterior horn cell of your spinal cord to the nerve ending. So, once it reaches the nerve ending there is an action potential trigger. So, these trigger what it does? It releases the acetylcholine into the sarcolemma. Once the acetylcholine binds to the sarcolemma; acetylcholine sensitive sodium channels open. Once sodium channel opens the miniature end plate potential arise in the sarcolemma and then the further process starts.

So, if sufficient acetylcholine is released the summation of miniature end plate potential arises the end plate potential. Normally we call it the excitation threshold. Suppose the threshold point is here and the level of acetylcholine is here then there will be no movement. So, threshold this release of acetylcholine should reach to this level. So, that should be across of the action potential.

So, once it crosses the action potential then the nerve impulses propagated in the direction towards the tendons. Crossing the threshold level is very important here. As I mentioned that when it reaches that particular threshold limit there is an influx of sodium. And, because there is an influx of sodium ion what happens? Depolarization happens. Depolarization causes action potential to quickly change the voltage.

So, it was before minus 80 millivolt. It becomes positive because positive ions are coming inside. So, what happens? It is a plus 30 millivolt. So, if that particular phenomenon occurs then these changes starts taking place. So, if it is a monopolar electrical burst and is immediately restored by the repolarization followed by an after hyperpolarization because automatically so many things are going on to do that all. First was the depolarization then repolarization.

So, when repolarization happens, lot of things goes out right. So, then what happens that is the imbalance. So, starting from MEP the action potential spreads along the muscle fibre through a tubercular system. This exciting leads to the release of now calcium ion and this cause the chemical process. We call it is excitation contraction coupling or EC coupling. So, this model of linking EC coupling represents a highly correlated relationship, it can be assumed that in a healthy skeletal muscle any form of muscular contraction is accompanied by this particular mechanism.

So, this is definitely will be there when there is a muscle contraction- this is the process. Now, signal is generated. How it will be processed or how did it will propagate? The EMG signal is based upon action potential at the muscle fibre membrane resulting from depolarization and repolarization process. The extent of the depolarization zone is described as approximately 1 to 3 millimetre square.

So, this is the value. There is a typing error. So, after initial excitation this zone travels along the muscle fibre at a velocity of 2 to 6 metre per second. So, this is the kind of velocity it maintains. Depending on the kind of movement we are doing this velocity can also change.

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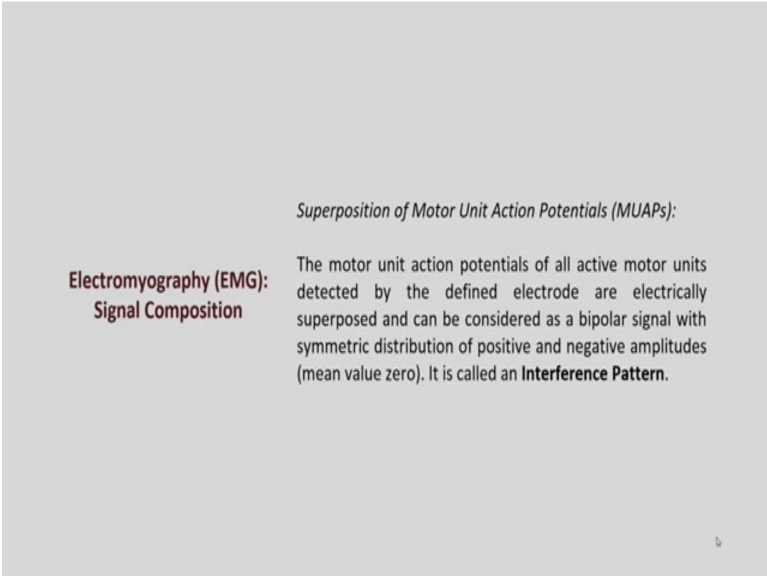

Now, when we are talking about all these signal propagation, signal origin and all, let us understand what are the varieties of signals are there and what is the composition of those signal. So, first is the motor unit action potential very important. So, what it is? Motor unit action potential of all active motor unit is detected by the defined electrode are electrically superposed and can be considered as a bipolar signals with symmetric distribution of positive and negative amplitude. It is called an interference pattern.

So, you need to understand this particular definition. Once you understand this definition of motor unit action potential whenever you are analyzing the EMG signals this unit is only you need to calculate and then further processed. So, from a particular active motor unit you will get this potential.

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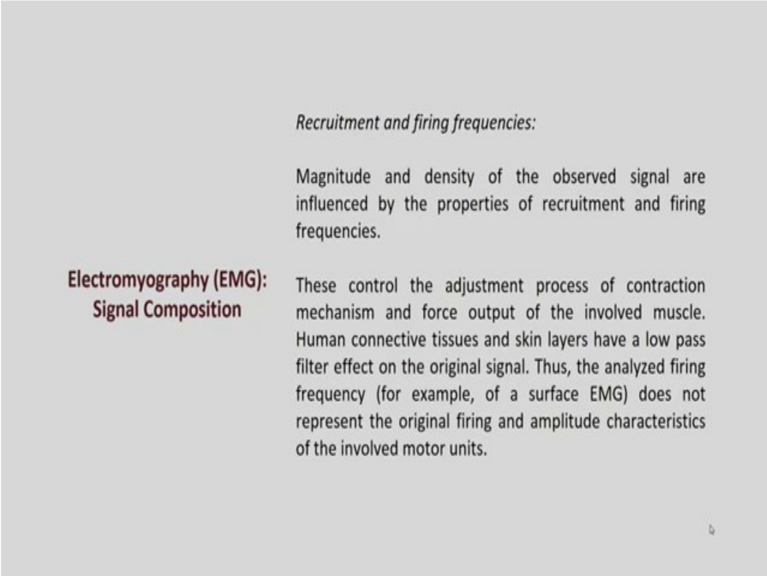

Next is recruitment and firing frequency. So, these are the composition of the signals. So, magnitude and density of the observed signals are influenced by the properties of recruitment and firing frequency. So, what is recruitment? What is firing frequency? You need to really understand these concepts. So, these control the adjustment process of contraction mechanism and before output of the involved muscles. So, once the force output happen then you need to really adjust the process of the contraction mechanism. So, here important thing is human connective tissues and skin layer have a very low pass filter effect. So, skin has its own resistance.

So, what happened if there is a signal generates in the muscle and we are trying to measure that using our surface electrode when it process it values are changed. The analyzed firing frequency is not exactly the same as we are recording as it is generated in the origin because if you have more subcutaneous fat you have that the signal that you are recording is less. So, you have to take care of this you have to understand these aspects when you are talking know measuring this thing.

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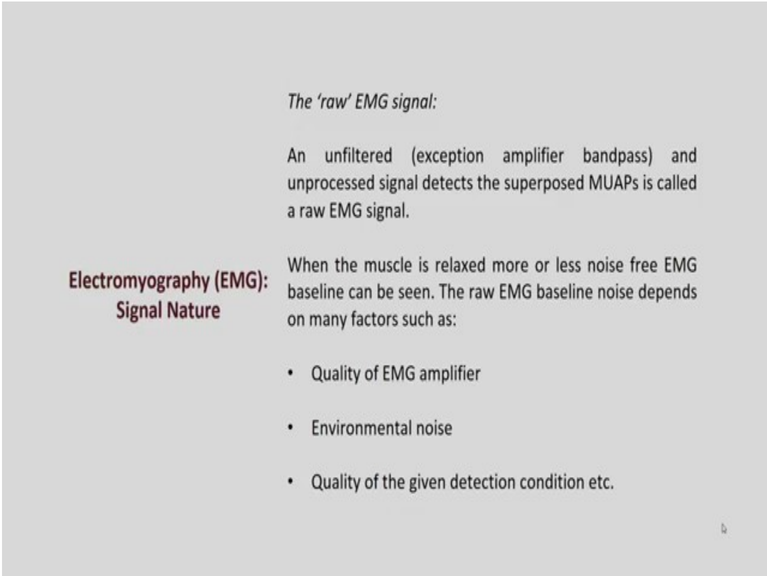

So, let us also understand the kind of nature we have in the EMG first is very important is the raw EMG signal. So, what it is by the name raw signals we can understand it is unfiltered we are not doing the filtration. So, unfiltered unprocessed signal detect the super superposed motor unit action potential we call it as raw EMG signal. So, when the muscle is relaxed, more or less noise free EMG base line can be seen. We will be talking about noise later. The raw EMG baseline noise depends on few factors: one is quality of EMG amplifier. We will talk about amplifier the kind of environmental noise we have and the quality of given detection condition. So, all these things we will be discussing in the next two slides.

So, these are the factors which actually affect the kind of raw signal we are getting.

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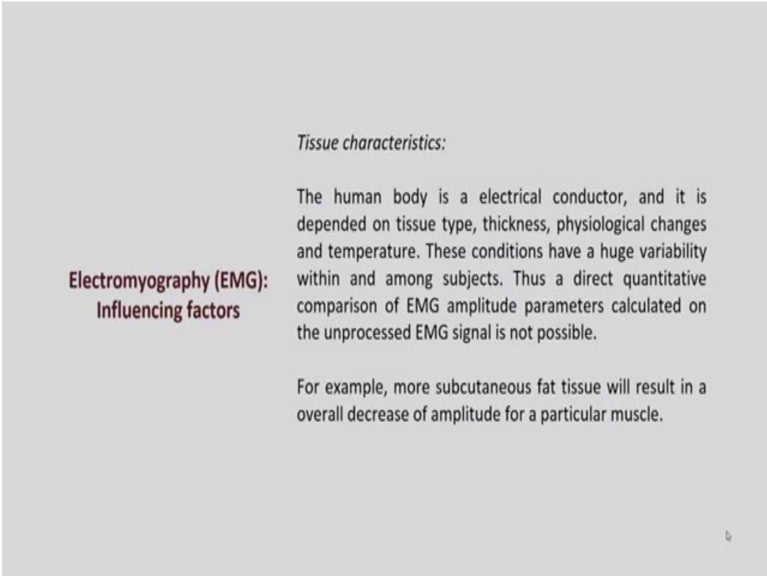

Here we seriously need to understand the kind of impact or influencing factor we have when we are recording EMG and we are analyzing it and when interpreting it. First is tissue characteristics because it is actually have lot of impact on when we are collecting the data. So, human body of course, it is an electrical conductor and it is dependent on the tissue type, thickness, physiological changes and the temperature of these are the major factors.

So, these conditions have a huge variability within and among the subject. So, maybe the same subject for morning and afternoon the type of tissue or the tissues physiology will be different on the same time a male and female tissue characteristics will be different. In the same gender or same muscle group the connectivity and all those things will be different. So, it is very important you should understand that and then you process your signal.

So, direct quantitative comparison of EMG amplitude parameters calculated on the unprocessed EMG signal is really not possible. So, always you need to do a proper processing. So, as I mentioned earlier if you have more subcutaneous fat you may you will not get the kind of amplitude you are getting with from a person who has less subcutaneous fat. So, then we really cannot compare this raw signal and the second raw signal. So, we need to really process it and then only we can interpret the data.

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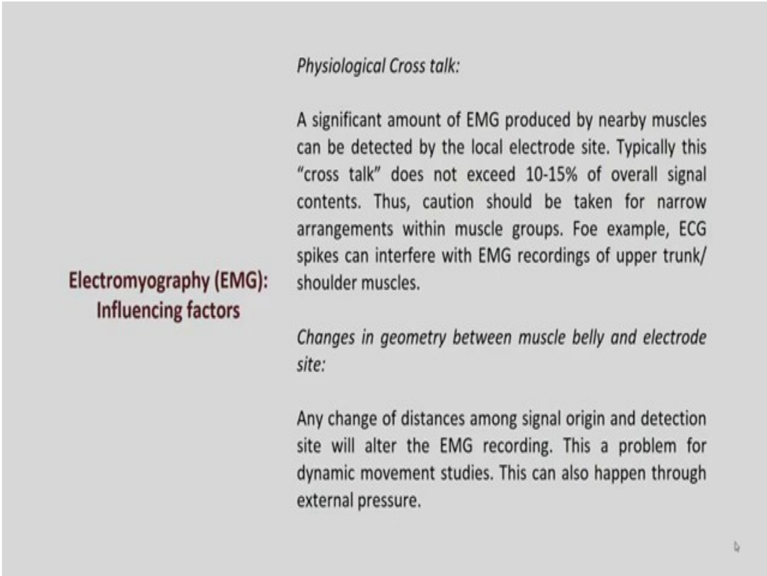

Here very important topic is physiological cross talk. What it is. Suppose there is another physiological signal you are recording, it may have cross discussion or cross noise. So, it is very important when we are talking about EMG signal. What it says? That a significant amount of EMG produced by nearby muscles can be detected. Suppose you are talking about recording of biceps muscles. In the arm biceps is not the only muscle you have surrounding other muscles. So, when you are doing a particular movement where bicep muscle is major you can definitely recording the raw signal for biceps muscle.

But the other surrounding muscles also have some effect on that particular signal. So, you really need to understand that you need to really eliminate that. So, the suggestion is it should not exceed ten to 15 percent of total or overall signal content. Precautions should be taken for narrow arrangement. So, when you are preparing the subject, when you are getting up the electrodes or you are arranging the whole process you should be very careful and clear what you would like to do. So, that is very important also sometimes it happens at ECG spikes has an impact with the EMG recording if you are doing it with the trunk or shoulder.

Because when you are talking about ECG it is placed on your left chest right various position of your left chest now the same kind of electrodes also you are using for your EMG maybe for shoulder and trunk. So, there may be a chance where these signals are getting a cross talk. So, definitely you should be very careful when you are doing this type of multiple arrangements. Next is change in geometry between muscle belly and electrode side.

So, how to place an electrode on the muscle belly how to identify that what is the actual geometrical location of it is very important. Because, if do that there will be an impact and you will not get a proper result or whatever result you are getting it may not give you a correct decision for this particular EMG analysis.

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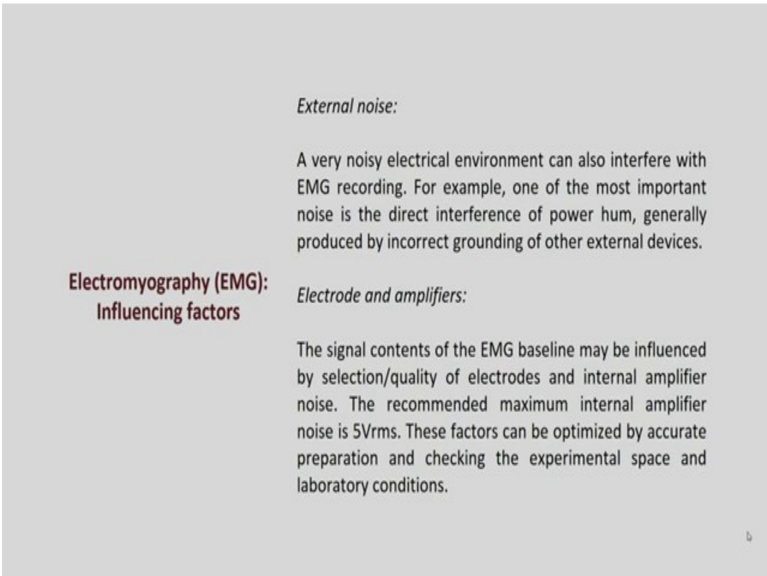

Very important is external noise. So, when we are talking about a particular this type of recording you have to have a environmental noise free setup where you have only the recording from your EMG electrodes not from the external processor or an external electrical influence. Another important factor is electrode and amplifier. So, the signal contents of the EMG baseline may be influenced by the selection of quality of the electrodes and the kind of internal amplifier your using because it may have extra noise which may affect your result.

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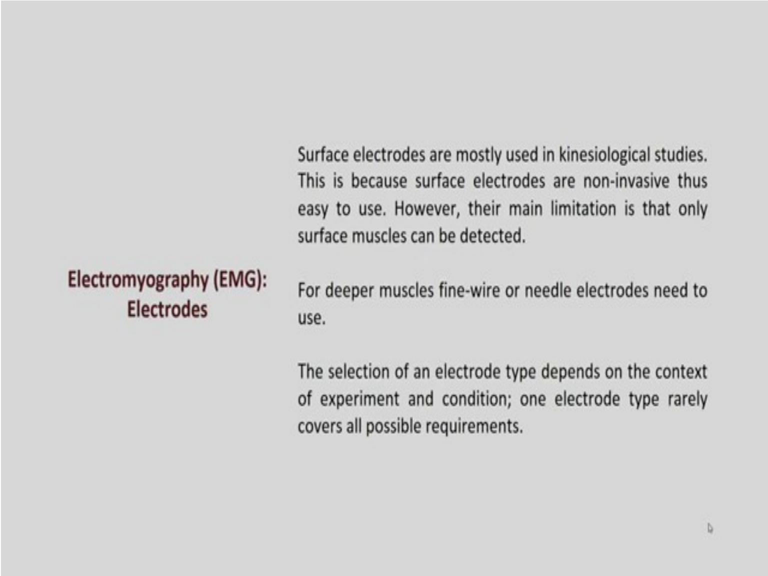

Now, when we are talking about all this we should also understand the kind of electrode we are going to use because this is the sensor through which we are going to collect our data very important here in ergonomics field normally we are using surface electrode. So, surface electrode normally used for kinesiological study that is the major interest for an ergonomist. However, it has a lot of limitations. Like as the name says that surface electrode, so, you cannot really take data for the deeper muscles. For that you need fine wire electrode for needle electrode which is an invasive method. This needs lot of medical supervision and many other issues such as ethical permission and all those things. It is very difficult and also it requires a lot of elaborate set up. So, normally we do not do it, we try to do the data collection through surface EMG. So, you need to be very careful about that.

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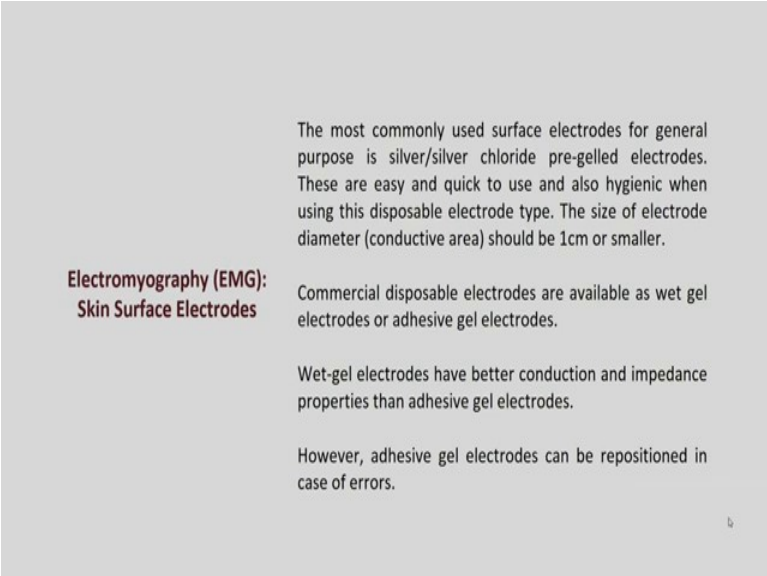

Now, when we are talking about the surface EMG we have few varieties. Mainly silver chloride pre gelled electrodes we normally use and the good feature of this particular electrode it is disposable. So, you are really maintaining your hygiene. You put a gel you collect your data you remove that electrode and throw it. There is no chance of further use. But we have something which is adhesive gel electrode which is again like you can reuse. But here the positive point is the position. Suppose you a placed a particular electrode on a particular muscle belly, but you found no this position is not correct.

So, you can remove and you can again replace it. So, it has that particular facility and it gives quite similar result. Of course, it is suggested you identify the belly first very carefully and then put your electrode. So, it will be easy for data collection and error free data collection. So, that is important.

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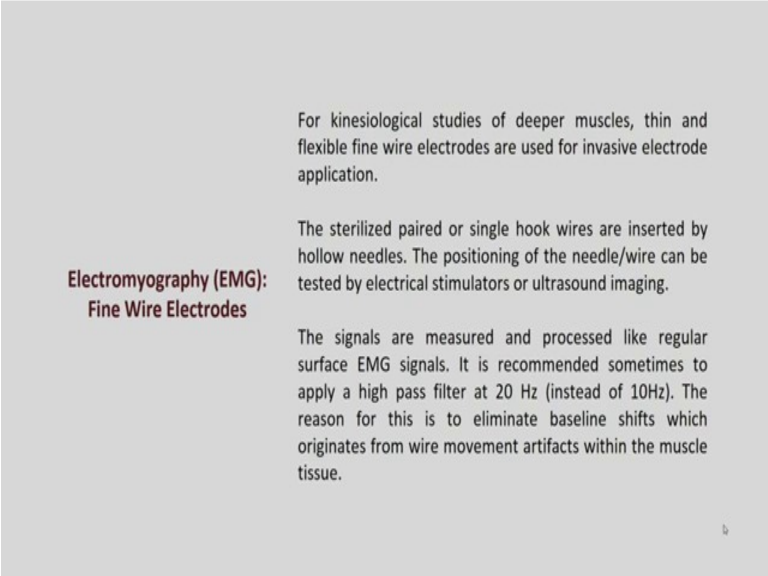

So, we have fine wire electrodes, but normally we try to avoid because as I mentioned earlier it is an invasive method, but of course, for a very specific type of experiment we may need it to use it. But definitely it needs a very different skill set. So, while using you should be very careful.

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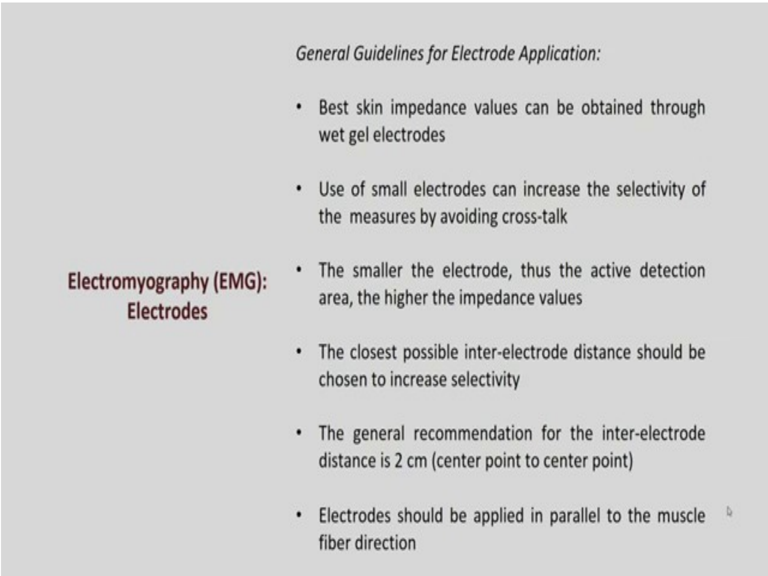

Now, when we are talking about electrodes let us have some guideline which is being quoted by various researchers and it is being published by different authors. So, what I tried to do or gather all the varieties of guidelines available for selection or use of electrodes. So, it will be useful when you are trying to use electrode and identify or record the EMG signal.

So, what it says? First important point is best skin impedance value can be obtained through wet gel electrode. So, they are suggesting that wet gel electrodes. So, use of small electrodes can increase the selectivity of measure by avoiding crosstalk. If the dimension or diameter of that particular electrode is very small, of course, it will collect data only for that particular muscle belly. It will not have a chance for a cross talk. So, it is suggested that always try to use small electrode. It gives better perfect result the smaller the electrode is the detection area is very easy and it has high impedance value.

Further it says the closest possible inter electrode distance should be chosen to increase the selectivity. So, the general recommendation for inter electrode distance is two centimeter. So, if you are doing this you should see that one point to another. Again it is a centre point. So, it should be two centimeter. So, electrodes are to be applied in parallel to the muscle fiber direction. So, if muscle fibers are lined like horizontally then you should put your electrodes like this not this or diagonal order. So, it should be parallel to the muscle fiber.

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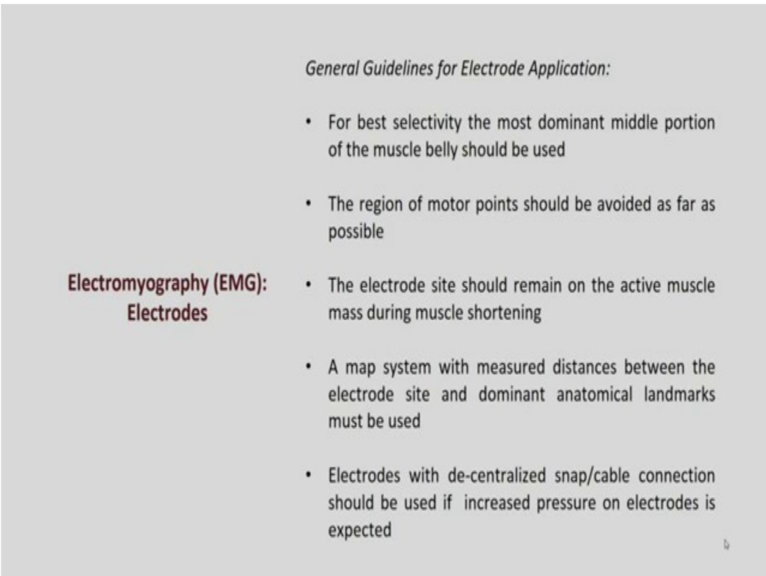

Best selectivity of the most dominant middle portion of the muscle belly should be used. What I am trying to mention from the beginning that muscle belly is the best position for positioning of your electrode. The region of motor point should be avoided as far as possible because motor point creates lot of other obstruction and noise. So, electrode side should remain on the active muscle during muscle shortening of muscle contraction. You should know how the muscle is actually having the orientation when the muscle is active.

So, once you understand that when place that electrode, a map system with measured distance between the electrode side and dominant anatomical landmark must be used. So, as I mentioned that you should see the muscle movement earlier you identify and you do a proper marking and then use it electrodes with decentralized snap or cable connection should be used if increased pressure on electrodes is expected. So, that is the recommendation. So, these are the normal general recommendations when you are placing your electrodes or you are using your electrode.

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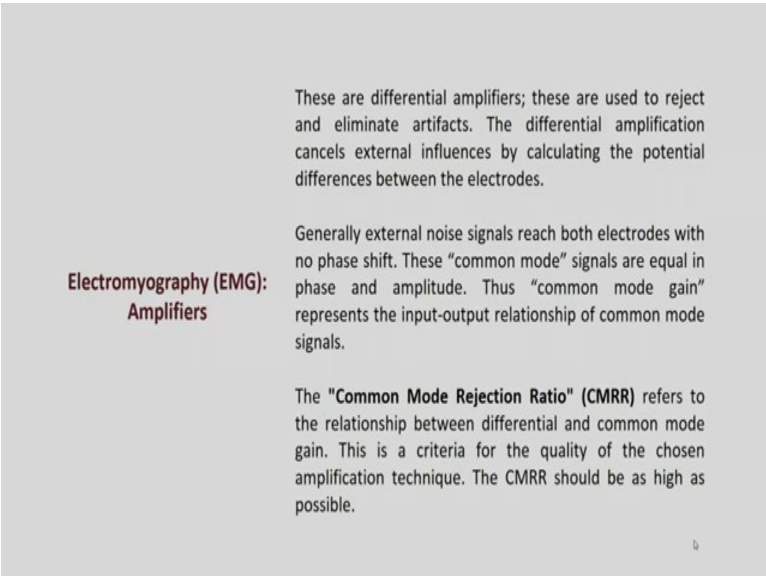

Now, when we are talking about electrodes we are collecting our data, let us understand how the signals are getting amplified. So, amplifier has a big role in this particular EMG signal processing assignments. So, the origin of these particular myosignals, when we record it, if you want to see it or visualize it or you want to interpret it you need to have a detailed description. If you really checking the amplitude frequency nature you should realize it you should understand it, but it is really not possible the nature is very small. So, for that that we have amplifiers and it help for analysis it only help for your analysis.

So, these are differential amplifiers normally we used for EMG signal these are used to visit and eliminate artifacts. So, differential amplification cancels external influences by calculating the potential differences between the electrodes. So, it is very important. Generally external noise signal reach both electrodes with no face shift these common mode signals are equal in phase and amplitude. So, common mode signals are equal in phase and amplitude thus common mode gain represents the input output relationship of that particular common mode signal.

So, when we are using this we need to understand these amplifiers and based on that we are going to use it. So, EMG preamplifier is very common term and we are using it.

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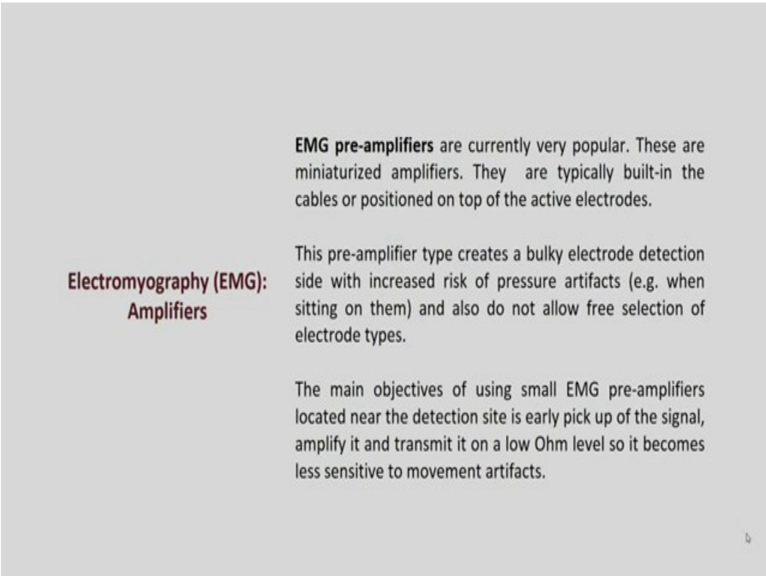

Very frequently we say that this type of EMG preamplifiers if we are using we will get a better result. So, it is these are typically inbuilt the cables and it is positioned on the top of the active electrode. So, whatever the electrodes you are there which one is the active one it is placed just top of it. So, what it does this preamplifier types create a bulky electrode detection side with increased risk of pressure. Here again a problem like as it is placed on the top of the electrode it creates a pressure and also do not allow free selection of electrodes side.

So, but still we prefer to use the EMG preamplifier that is very important. Now here one major objective what we consider is that when we are using small EMG preamplifier which is located near the detection side is early pickup of the signal and transmit it on a low ohm level. So, it becomes less sensitive to the movement artifact. So, this way we rectify it and we use this one.

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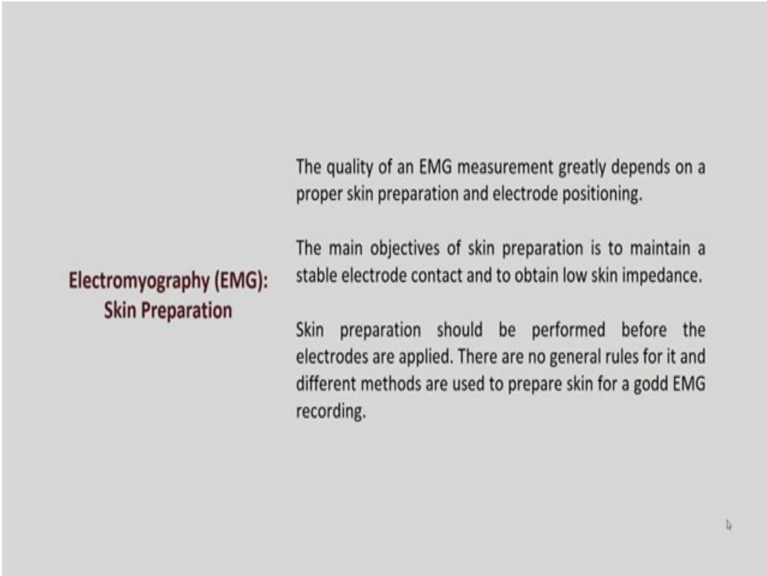

Now, when we are talking about surface EMG we are not talking about needle electrodes we are talking about EMG recording is the using surface electrode and you are going to place that electrode on your skin surface.

So, how you are going to prepare that particular skin because if there is a lot of obstruction, there is lot of noise then you will not get a proper result. So, skin preparation is very important for the quality EMG. So, let us understand what are the types or varieties are available and how you should do it.

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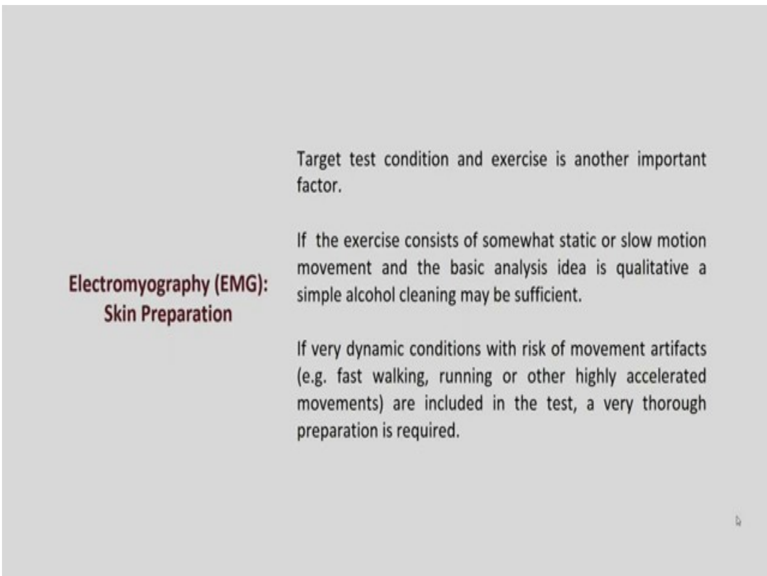

So, target test condition and exercise is another important factor. So, when we are talking about that particular group of muscle or particular muscle where you are going to do the testing you should do the proper exercise you should understand that which movement you are going to collect.

So, if this exercise consists of somewhat static or low motion movement and the basic analysis idea is qualitative in nature a simple alcohol cleaning may be sufficient. So, if you want to say it has been increased, it is good or it is more than previous one this type of qualitative analysis if you would like to do here the frequency is going to hold for sometimes.

So, this type of analysis if you are doing to do in that case normal alcohol cleaning is sufficient. But if you are doing it in very dynamic condition suppose somebody is running somebody is playing and you would like to understand the muscle activity. Then cleaning is very important because, then your electrode should be placed properly and it should not have any disturbance because it has lot this will any way other noises are involved already as it is dynamic in nature.

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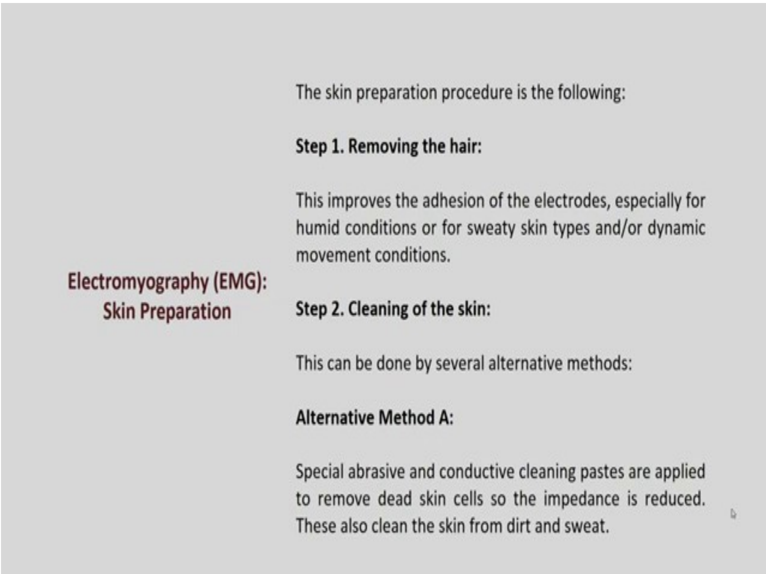

So, that is important. So, first step always is removing the hair normally we have that extra thing which we can remove and then we can have better conductivity. So, it in like what it does like you know it this sweat it goes off then definitely for dynamic movement it is very important if you have hair cells then this hair follicle actually effect conductance.

So, that is important now you have different cleaning alternative. So, first method is special abrasive and conductive cleaning paste that is available you can apply on the skin and you can remove the dead skin. So, it improves the conductor and it reduces the impedance and it cleans the dirt and sweat of that particular surface.

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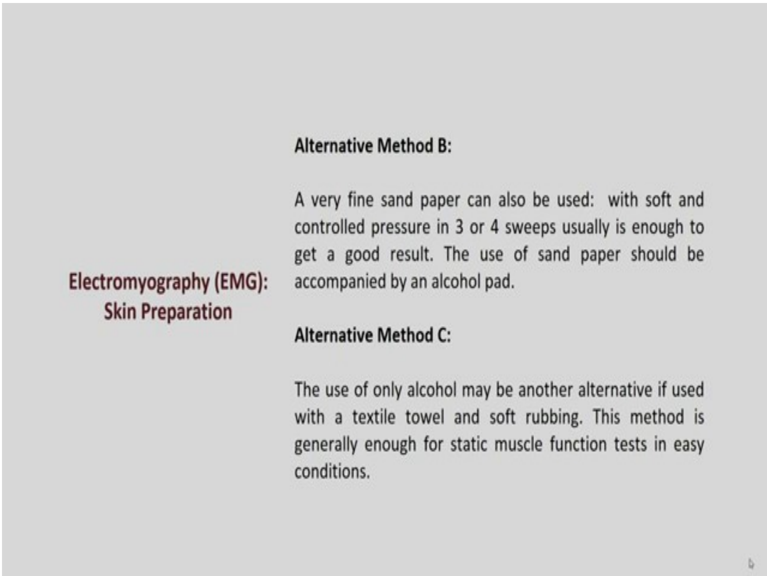

So, that is one. The second is very fine sand papers are available. So, with soft and controlled pressure if you rub it on the particular area for 3 to 4 times and followed by alcohol cleaning will be good. So, you can do that also. Another thing is if you have some textile or kind of cotton. So, you can put alcohol which is little rough and with the control pressure as previous one.

You can rub on the skin and then you can clean your skin now here all this method for skill based. So, whenever doing all this may be first time you are not perfect. So, you have to keep on practicing. When you are going for your own actual data collection what is the suggestion you practice this particular process cleaning placing of electrode identifying that particular muscle. And, all those things you practice it 4-5 times at your laboratory and then only you go for your actual data collection because once you collect your actual data there is no chance for repeat right.

This is very much skill based job. So, as many times you will be practicing you will master on that particular process.

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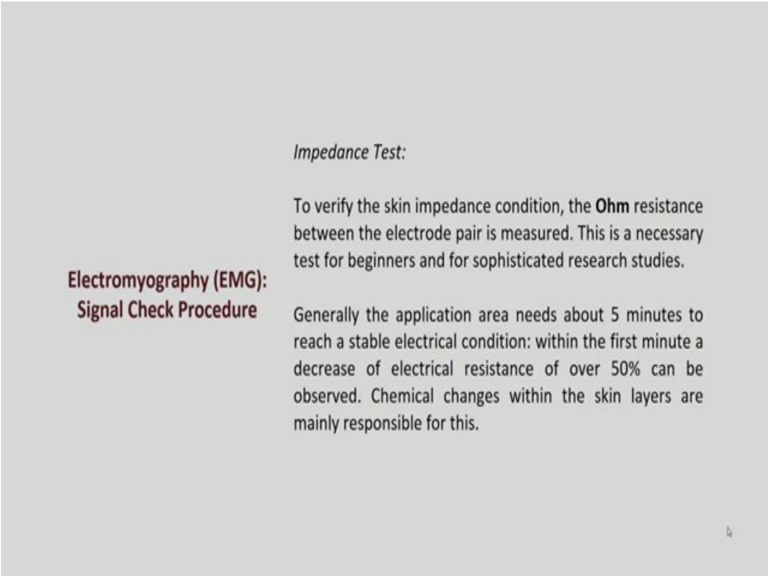

So, what are the signal check procedures we have? We can do impedance test. So, what it says to verify this skin impedance condition the Ohm resistance between the electrode where we are going to measure. So, this is an unnecessary test for beginners and required for sophisticated research study. What does it mean sophisticated research studies? It means that when you have lot of comparison, lot of analytical data for your study there you may really need this type of test impedance test.

So, generally the application area needs about 5 minutes to reach a stable electrical condition. So, as soon as you put your electrode you should not start the data collection you wait, you see how the impedance happens, is there any change or not. Once it is stable you start your date collections. So, this is very important. Further there is a recommendation that within the first minute a decrease of electrical resistance over 50 percent can be observed.

So, once that 50 percent decrement happened then you can say fine it is going to start, now your prepare yourself and you start your data collection.

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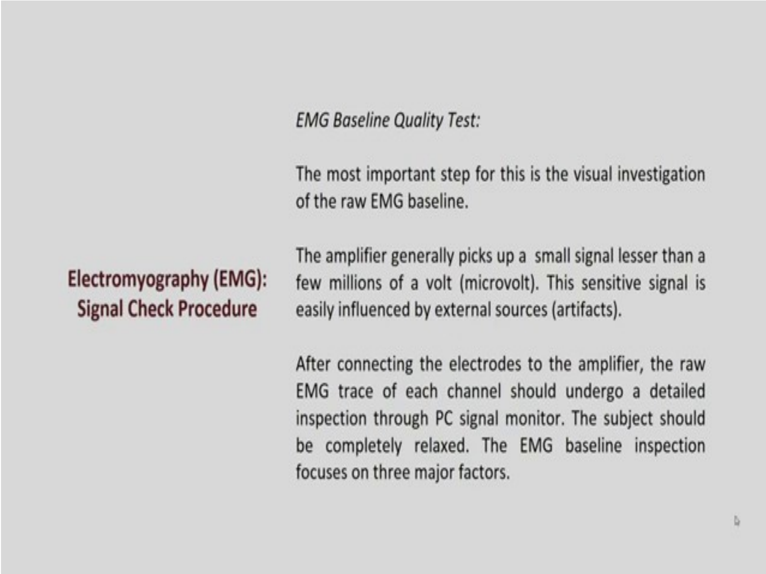

Then also you should check the EMG baseline quality. So, if the baseline quality is not properly as per the standard then you should do all the arrangements and you can restart your process. So, most important step for this is visual investigation of the raw EMG baseline. So, again it is a skill, it is an experience. At first time you will not be able to understand. So, with consultation of your the experts you can understand which one is correct, which one is not correct and as long you will continue the data collection you will be expert yourself.

So, again visual understanding of the raw EMG signal is very important. So, the amplifier generally picks up a smaller signal lesser than a few millions of a volt or microvolt. So, this sensitive signal is easily influenced by the external source because we have lot of artifact. So, you should understand what is there any artifact or not, if it is there how to eliminate it.

So, after connecting the electrodes to the preamplifier the raw EMG trace is of each channel should undergo a detailed inspection when it is visualized or when it is imposed on the computer; you check it and then you take a decision yes we are going to start our data collection. So, baseline inspection is very important.

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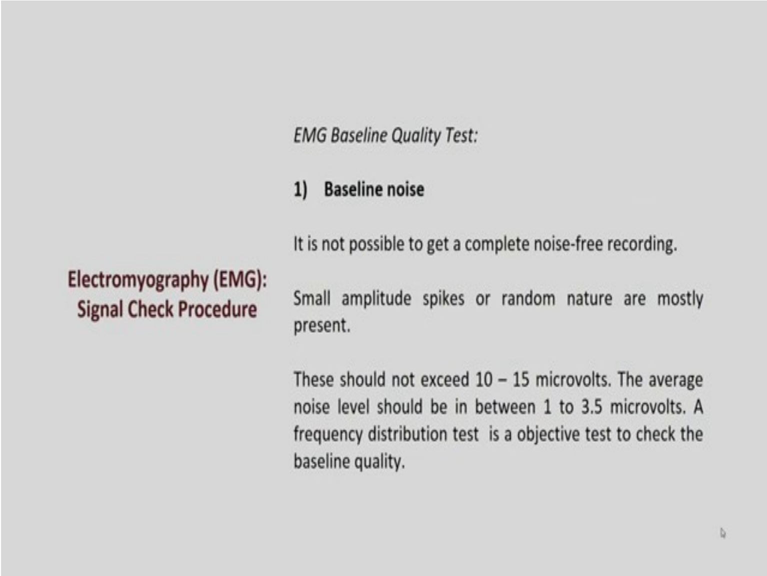

Now, how you are going to do the test? First one is baseline noise. It is not possible to get a complete noise free recording because it is just not possible. But if it is very high you have to find how you can remove that extra noise. So, some amount of noise is always acceptable, but you have to understand what the limit of it is. Based on your research objective, based on the kind of data you are looking for you are the decision maker how much is acceptable, how much is not.

Of course, there is a specific guideline that this much is really not acceptable that you have to understand. So, what it says that 10 to 15 microvolts it should not exceed. So, it is acceptable that average 1 to 3.5 microvolts is inacceptable range.

So, you should check that and you can start your data collection.

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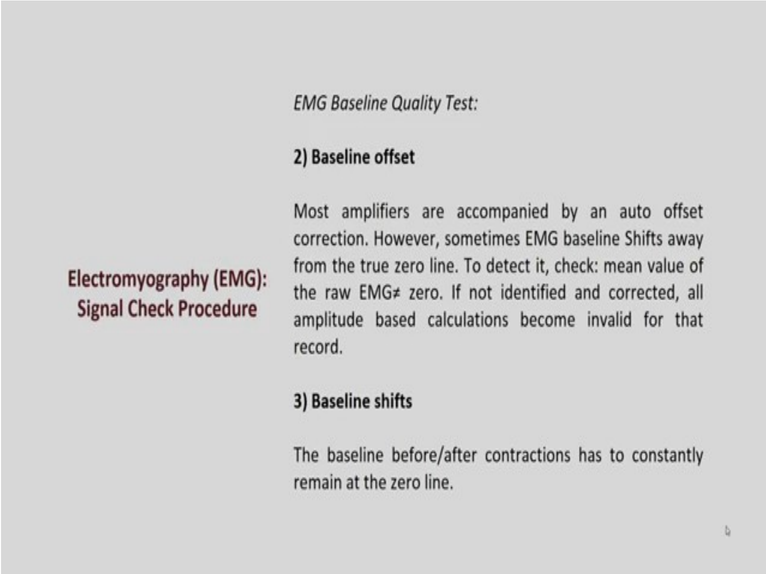

Another point is baseline offset. So, first one is baseline noise then baseline offset. So, most amplifiers are accompanied by an auto offset correction. However, sometimes EMG baseline shifts away from true zero line. So, then you have to do that check and you have to come back to the zero where EMG raw EMG signal is equal to almost zero that you have to identify. Third one is baseline shift the baseline before and after contraction has to constantly remain at zero. So, before and after it should come to the zero so, that you have to check.

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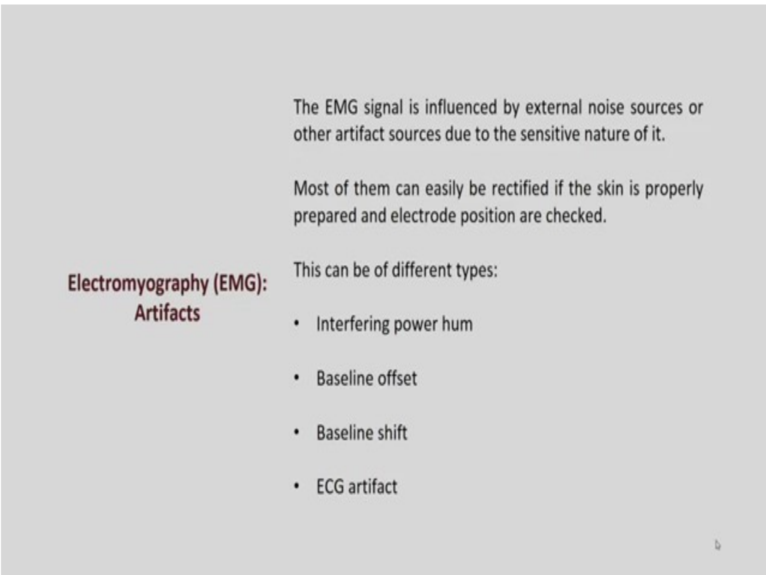

Now, there are lots of artifacts you should understand; first one is interfering the power hum, baseline offset, baseline shift and ECG artifact. As I mentioned earlier also ECG artifact is very important many times for trunk and shoulder muscle group or nearby muscle group.

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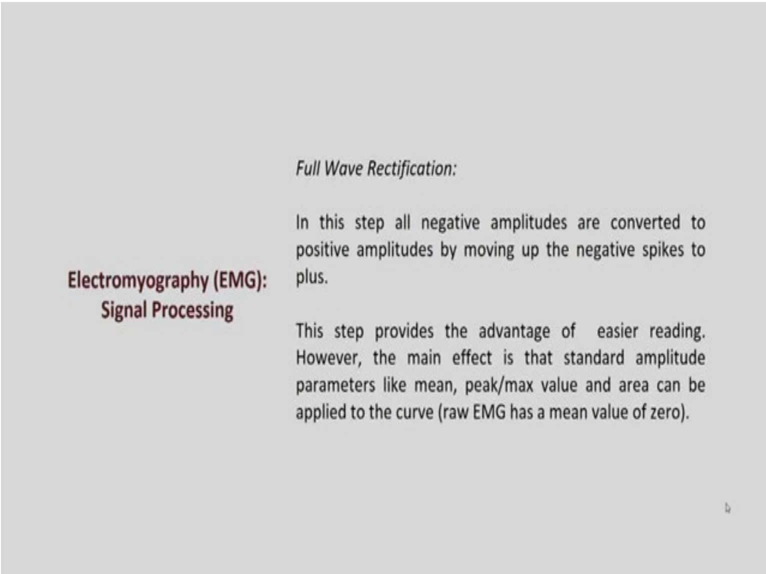

So, full wave rectification. So, let us understand the processing. When we gathered our data how we are going to process. So, how the processing happens, how we are going to interpret it. So, in this particular step all negative amplitudes are converted to positive amplitude by moving up the negatives spike to plus. So, this is the zero line we have these values, we are shifting from this lower value to up. So, this is way how we are converting the negative values to the positive.

So, this step provides the advantages of easier reading like you can read it easily; however, the main effect is that standard amplitude parameters like mean, peak, max value and the kind of area you are covering can be applied to a particular curve. So, that is very important.

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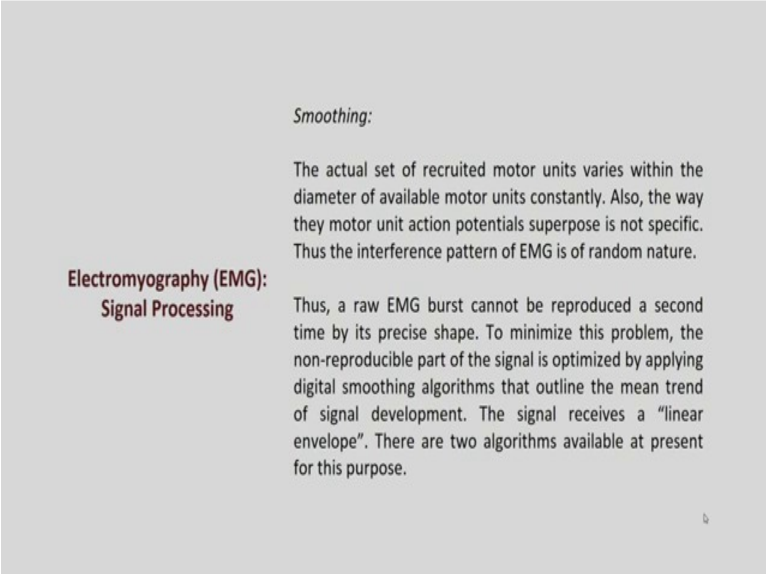

Then next processing is smoothing. So, these are lot of things are available: lot of peak lot of disturbance and lot the raw signal, but you need to keep a smoothing nature. What it does? So, the actual set of recruited motor unit where is within the diameter of available motor unit constantly. Also, the way the motor unit is motor unit action potential super posed is not very specific. Thus, the interference pattern of EMG is of random nature. So, when we are talking about all this signals whatever we are receiving as a linear envelope. So, there are two algorithms available at present for this particular purpose you should follow that and you should use that for you smoothening of the thing.

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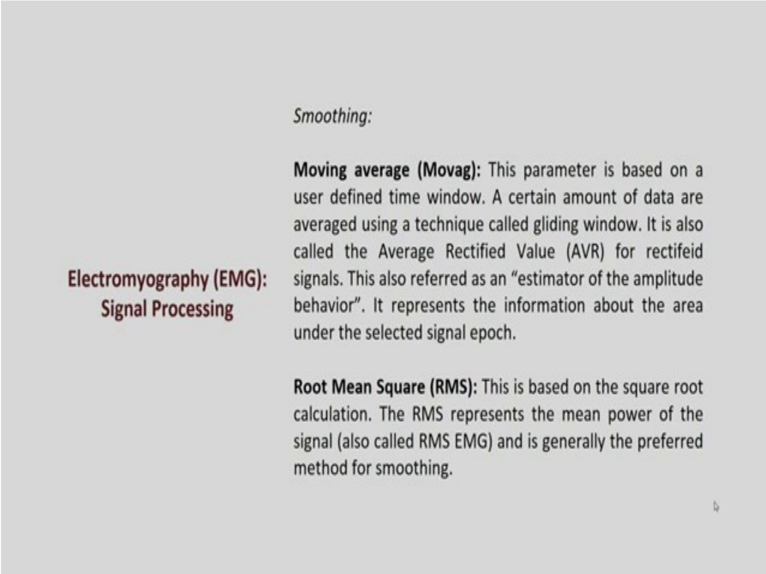

So, first one is moving average and another is root mean square. So, these are the two parameter or variable that you are going to use for your smoothing of data. So, what it says that this particular parameter that moving average or Movag we call it is based on a user defined time window. Certain amounts of data are averaged using a technique called gliding window. It is also called as average rectified value AVR. So, many times in EMG data analysis when you are publishing data AVR is a very frequently used variable and you are comparing that. So, this you are using for rectifying this particular signal.

So, this also referred as an estimator of the amplitude behaviour. The second one is root mean square. This is based on the square root of root calculation. So, root means square represents the mean power of the signal and is generally the preferred method of smoothing. So, root mean square if you open up any particular journal papers especially in the field of ergonomics you will find RMS value to compare or to explain the nature of the EMG signal. So, this is also very frequently used variable.

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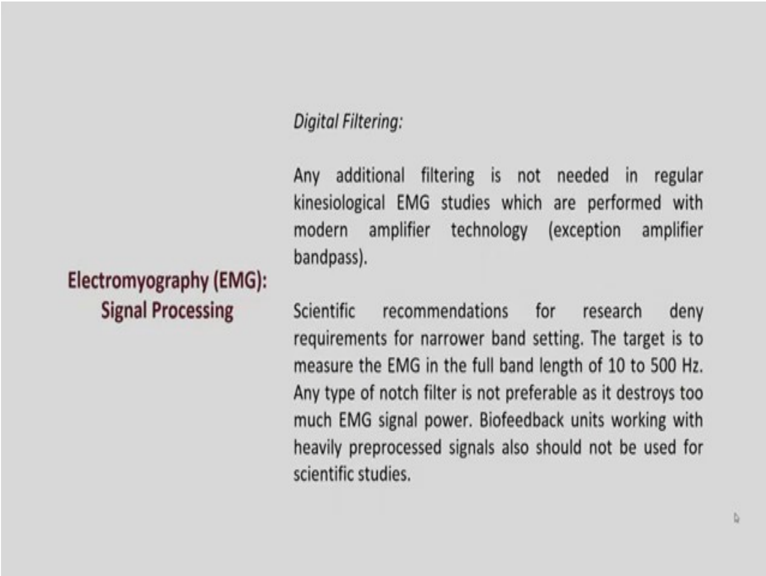

Now, next is digital filtering. So, after smoothing you have digital filtering. What it does? So, any additional filtering is not needed in regular kinesiological EMG studies which are performed with modern amplifier technology, we have that particular system inbuilt; only for the bandpass amplifier we do not have this particular facility. So, when you are going to use your instrument, please confirm how these filters are and how these amplifiers are; so, based on that you need to do.

So, scientific recommendation for research deny the requirements of narrow band setting, they do not say that you set the band in narrow set the target is to measure. The EMG in a full band length that is 10 to 500 Hertz any type of notch filter is not preferable as it destroy too much of EMG signal power.

So, always you should accept the other. Biofeedback unit is working with heavily preprocessed signal also should not be used for scientific studies because, once you are free processing it too much then you are actually losing the originality or original nature of the particular signal or particular data. So, it is not recommended. So, you should remember all those thing.

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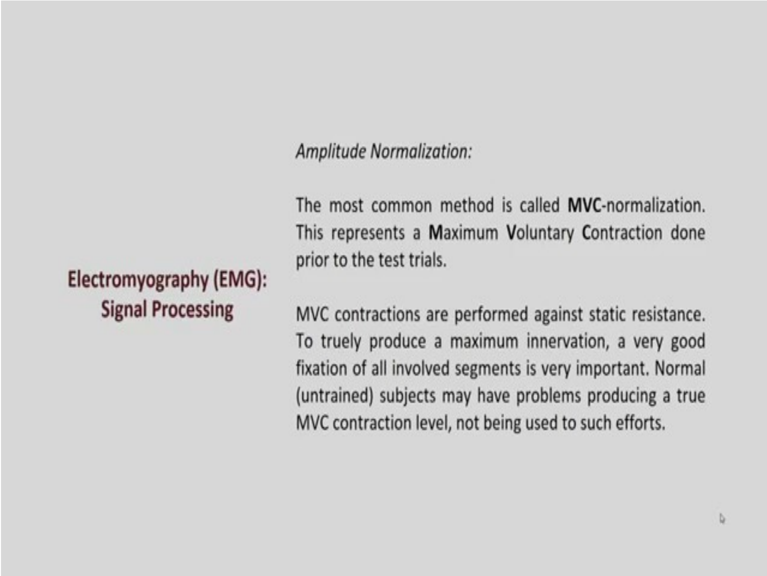

Amplitude normalization; so, here maximum voluntary contraction is very important. What it says that when your muscle you are contracting how much maximum contraction you can do. So, that is maximum voluntary contraction, you should understand that you should record it and that you can compare with your percentage value of the working one. So, MVC contractions are performed against static resistance to truly produce a maximum in innervations, a very good fixation of all involved signal is very important ok.

So, when you are talking about MVC recruitment of other muscle group is strictly prohibited. So, you should arrange the setup in such a way that, that particular group of muscles only you are recording. So, normal subjects may have problems producing a true MVC contraction level not being used to such efforts.

So, if you are not having that kind of subject, subject means participants or voluntary you should not use it; one more thing is to enable the average curves. It is recommended to perform the amplitude normalization based on smooth rectified EMG to mean value found within each test, exercise or trial.

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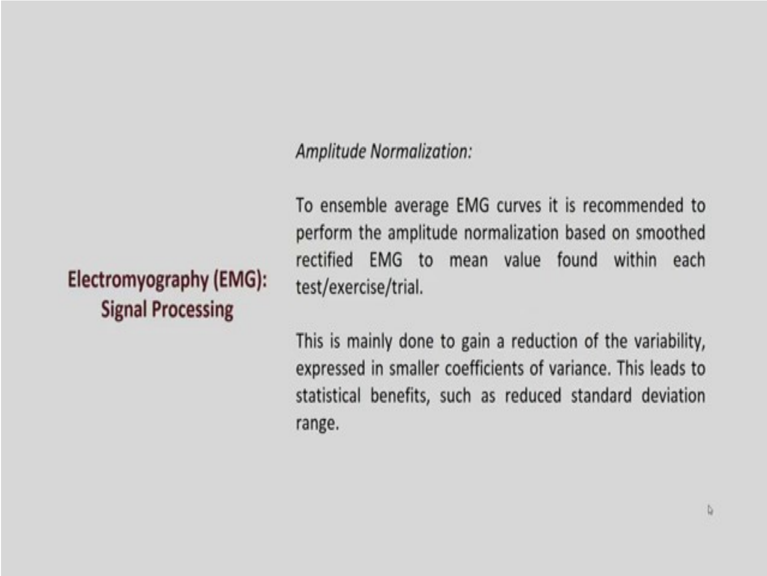

So, for that particular case you should process it. So, this is mainly done to gain a reduction of variability expressed in smaller coefficient of variance. This leads to statistical benefit because finally, what we do? Once we collect our data we process our data, we identify our data we are going to do statistical treatment.

So, this is suggested if we do all these then only you will be able to process our data through statistical treatment. So, reduce standard deviation range is required. So, for that we need to follow this.

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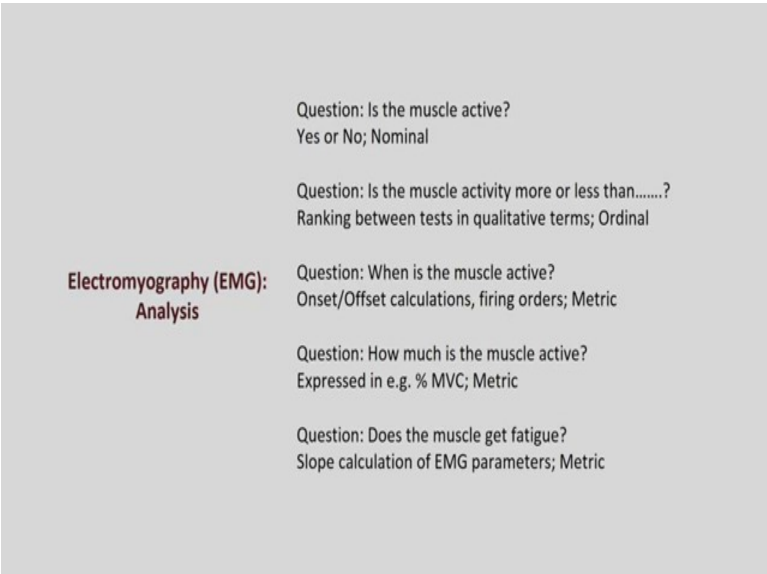

Now, when we are done with our whole recording processing, we need to understand what it is so analysis. Few questions I have jotted down here apart from that based on your requirement you can quantify and you can do your further processing. So, first thing what you try to understand is the muscle active or not, is the muscle activity more or less than previous or than intervention program than before or those entire things? When is the muscle is active, how much is the muscle activity or how much is the percentage, how what is the percentage of activity of total MVC?

Does the muscle get fatigue or not? So, all these are the types of analysis we normally do, but these are only few. Apart from that you have many more for when you are analyzing EMG. So, of course, you are going to collect your data, process your data, process your EMG signal and then finally, analyze your data based on your research question.

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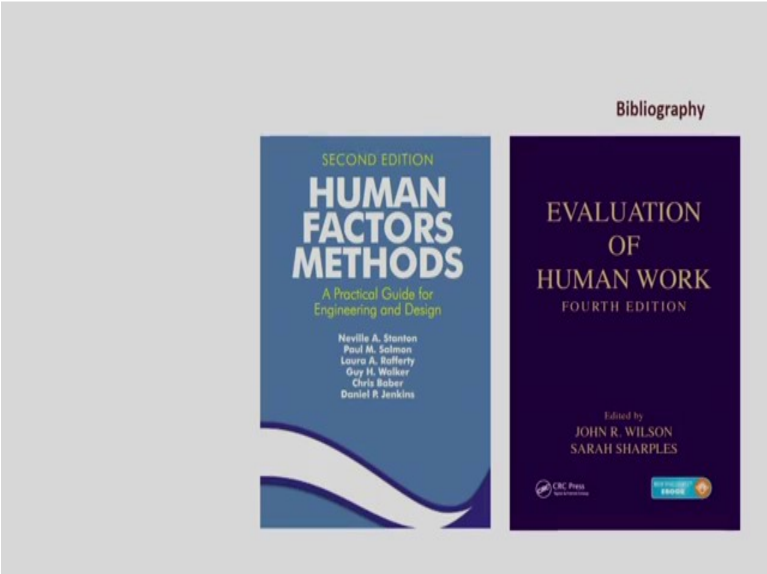

So, for today this is and these are the books again I followed for this particular lecture you can refer; apart from that many other books are available that also you can refer; of course, this is not easy job. Whenever you are trying to do EMG analysis, EMG data collection it needs lot of skill set, lot of experience. So, many more trials are important whenever you are doing the EMG data collection or EMG studies. So, prepare yourself based on this particular lecture, I will take you to the lab and then we will see how the normal process happens. Of course, that keeps on changing based on the types of instrument you are using, types of electrodes you are using and the situation or context you are using that particular method right. So, please follow and if you have any doubt come back to us for your query.

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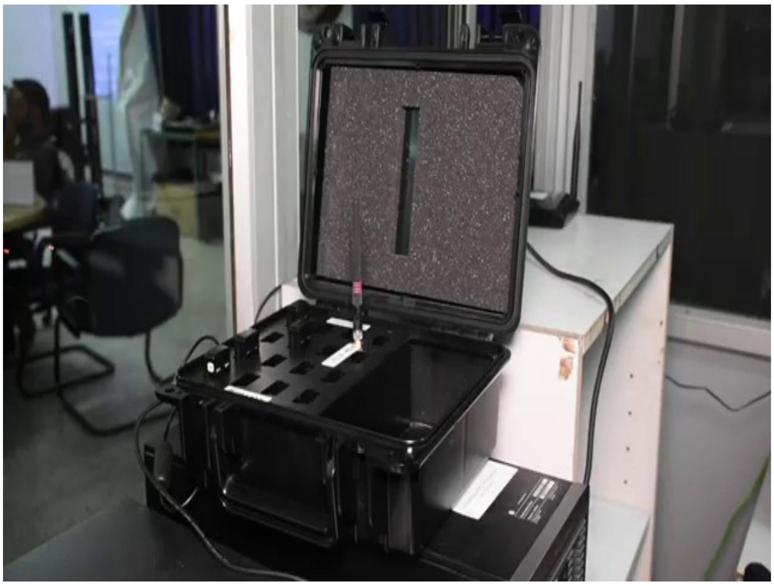

Welcome everyone to the lab session of ergonomic workplace evaluation, today we will show you one of the important instrument that is called EMG. This particular module is (Refer Time: 59:32) Trigno wireless EMG. The benefit of the wireless EMG is the sensors which can be taken away from the instrument. Other than these instruments consists of a charging system and USB to connect with the computer.

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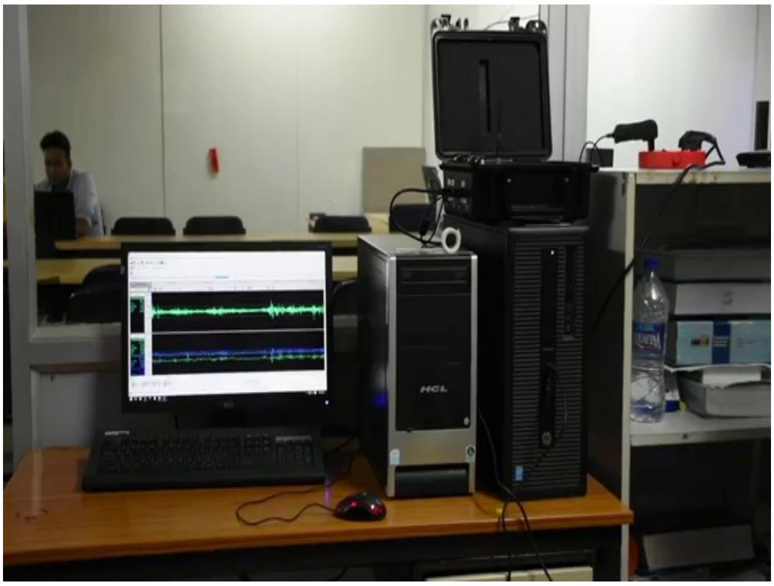

And there is a dedicated software system. Another thing is required that is the skin preparation tool, but for our demonstration we are not showing that. So, to start the EMG analysis we have to first identify the muscles. For identifying muscles there are muscle maps available. Otherwise there is simple process from which we can identify the muscle for example, here we are doing a biceps.

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So, for that, as we know the biceps constricts when we flex our forearms. So, when a forearm is flex, you can see the bicep muscle and we can feel the belly of the muscle. So, along the axis of the muscle you have to place the sensor and keep it tight with the tape. And, then there is an arrow (Refer Time: 60:39) in the sensor which will be along the muscle axis then you can switch on the sensor.

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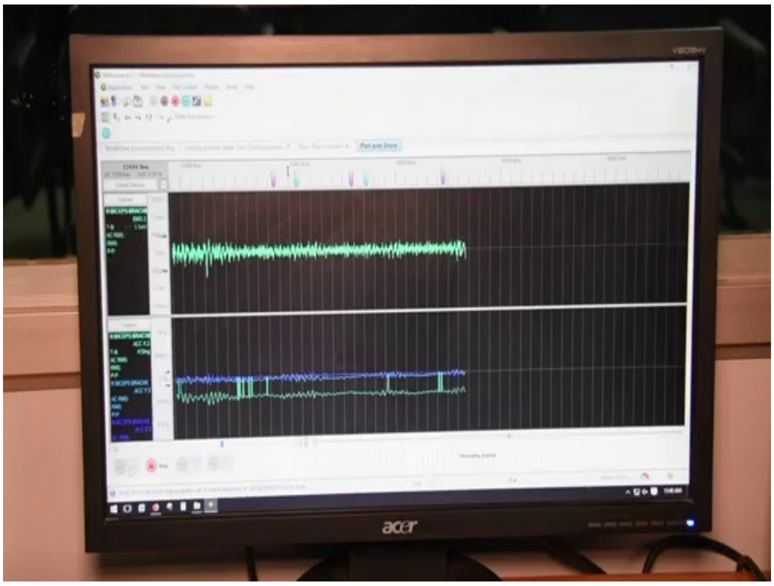

And do the required steps in the software and then you can run this test. You can see the reading of the muscle.

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See the activity of the load. So, run time depending on your work you can fix separately you can keep it 20 second, 30 second anything you want. So, that is for a singular run time you can and you can save it for later application. And, there is analysis option, you can analyze it later according to your research topic.