Modification of Electrode in Dermatosensory Evoked Potential

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Abstract

Somatosensory evoked potential (SSEP) usually done using bipolar surface stimulator of peripheral nerve and recorded by cortical surface or subdermal needle electrodes, in this study we modify an adhesive large surface area, surface stimulator using the same montage and method then compare the result between them. We took nineteen patients of median nerve SSEP, locate and identify the shape of dermatom assigned according to text using large square adhesive surface electrode. The same as the shape of dermatom, this is the cathode electrode, for the anode, a strip has the same length of the cathode with a width of two centimetres placed beneath the cathode, the circular ground band between stimulated and recording electrode. The subjects In this study prepared for routine SSEP study the result obtained of both study compared using statistical method and we found there was a significant different between two method and the modified as higher amplitude using lesser stimulated threshold but not significant different between latency. That's happened because we increased the surface area of stimulation which means more the motor nerve was stimulated.

Keyword: *Somatosensory, evoked potential, electrode, electrical charge.*

Introduction

Definition and review: The electrical signals were a response by evoked potentials that formed by nerves that work as receiver for stimulation.(1). Nerves disorder was diagnosed by computer testes, site and type of nerve damage, and provided a clear view about patient's condition after and during the surgery, wherever several types of evoked potential tests that used for that purpose. The all used to induce mild stimulation the nerves to receive and send the impulse to and from the brain. The electrodes polar put on several sites on the skin for recording the work nature of the brain and spinal cord. Type and degree the responses are recorded and analyzed by specialized computer software and the results are printed on paper as a chart. (2,3)

Prior to the production of muscle force, ion exchange across muscle fiber membranes, results in production of small electrical currents, which is generated by muscle fibers to produce muscle action. These currents represent the main part of the signaling process for the muscle fiber contraction. EMG can be measured by using specific elements to conduct the signals either superficially by applying electrodes to the skin or invasive intramuscular elements. Surface EMG method of measurement are the most common method, It is non-invasive, and it doesn't need medical heath professional to conduct it. Surface EMG measurement, depending on many factors including UV and low mV range (5). The properties of the sEMG are affected by many factors such as(4,5)

- The time needs for muscle contraction
- The strength of muscle contraction
- The space between the electrode and the active muscle area

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- The elements of the underlying tissue (e.g. thickness of underlying skin and adipose tissue)
- The character of electrode and amplifier
- The electrode and skin connection quality

In many situations the data of the time and muscle contraction strength is required, the other factors increased the variation in the EMG records, which is makes the result analysis more complicated process. However, the influence of the non-muscular factors on the sEMG can be reduced by:

- Using the same parameters (electrodes and amplifier)
- Maintain consistency of the electrodes- skin contact

The Importance of Skin – Electrode Impedance: The constant impedance is very important factor for the EMG measurement accuracy. Recent design of the pre-amplifier has minimized the importance of EMG measuring with low level of electrode –skin impedance. The level of muscle impedance is not a significant factor, while the impedance stability with the time and the impedance balance between electrode sites has a significant effect on the signal to noise ratio of the sEMG measurement. To minimize the noise components, it is very important to ensure the balance in impedance between electrodes sites. The perfect balance of the impedance at each site doesn't require, but the relative similarity is required. The impedance balance level is not arbitrary it depends on the pre-amplifier. The energy levels of the electrical signals determine by the impedance at each electrode sites. The signal strength gets in the process of differential amplification, as a consequence of the impedance differences between electrode sites. The common signal components canceled by differential amplification. In a similar way the D/C voltage potential will not be cancelled. Pre-amplifier instability and inaccuracy occurs when the pre- amplifier doesn't have sufficient D/C noise suppression in the residual D/C component.

Skin Preparation: The electrode – skin bind results in a D/C voltage potential, generated by impedance increment from the outermost layer of skin, including dead skin material and

Oil secretions. This D/C potential, common to all electrodes, can be minimized with proper skin preparation [7].

Types of Electrodes: The most common surface electrodes include:

- Dry electrodes in direct contact with the skin
- Gelled electrodes using an electrolytic gel as a chemical interface between the skin and the metallic part of the electrode Recommendations for Bipolar sEMG Electrodes has recommendations for construction of bipolar EMG electrodes (sensors) including:
- Electrode form
- Electrode size
- Inter-electrode dimension
- Electrode components
- Electrode structure

Electrode Shape:

- The "electrode shape is defined as the shape of the conductive area". There are different shapes of electrodes, varies as circular, square, and bar shaped electrodes. Each electrode site must have the same surface area.

Electrode Size:

- Electrode size is defined as the size of the surface of a conductive area of a sEMG electrode, Upon an increase of the size perpendicular to the muscle fibers (bar electrodes perpendicular to the muscle fibers), it is expected that the view of the electrodes

Increases. No quantitative data on the extent of this effect on the EMG characteristics is available at the moment. For bipolar sensors, in general, the size of the electrodes should be large enough to record a reasonable pool of motor units, but small enough to avoid crosstalk from other muscles."

Material and Method

During eleven months (10th January 2018 till 19th of December 2018), twenty five cases of the median nerve, located and identified the shaped of dermatom assigned according to text using large square adhesive surface electrode the shape of dermatom. This is the cathode electrode for the anode a strip has the same length of the cathode with a width of two centimetres placed beneath the cathode, the circular ground band between the stimulated and recording electrode; the study was conducted at Erbil teaching hospital. The data collected was from random simple cases fulfilling the above

criteria SSEP, with a comparison groups analysis data done based on the reading of old and modified method for the median nerve.[8] SSEPs are usually used electrical stimulations into either dermatomes or significant nerve trunks. dermatomal SSEPs (DSSEPs) are meaning responses that done by dermatomal stimulation.

DSSEPs are used needle electrodes in the dermal and subdermal surface. Theoretically, the sites that stimulated by electrodes will produce responses into a nerve root. The responses are done medically in more than one nerve root. Dermatomal maps are included the best location for the best dermatomal responses [9]

Stimulating of the median nerve in the wrist is done for recording the response electricity by two polar the anode in proximal of the palmar, and the cathode set at three cm proximal to the anode polar, between the tendons of muscle.

Stimulating the median nerve is at the wrist region by placing the cathode pair at (2-4) centimetres of the wrist between the muscle of flexor carpi radialis and the palmaris longus. The used current uses square wave has 20 mA- 5.1 Hz and during 200 msec. Stimulation and recording are done by using a disposable intradermal needle. The reading starts and recorded gradually, and the stimulation increases to reach simple twitching in the muscle. (Macdonald DB, 2006) CPz, CP1, CPE are the location of the active electrodes at FPz depend on the international 10-20 system as figure (1). While on the forehead, the ground electrode was put between the recording sites and stimulating. The electrodes stayed less than five KOhm and required time is (50-100) msec[11].

Stimulation of nerves is done by using monophasic square pulses for (0.1-0.3) seconds. The stimulus is done either by steady constant current or constant voltage. See Figure 1

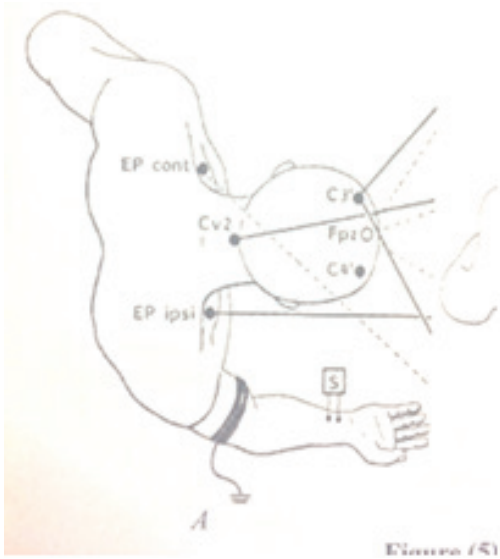
The contact should be without resistance for following causes:

- For decrease patient discomfort.
- The nerve become effective when the voltage constant.
- To decreasing the electrical stimulus in the recorded information.

The stimuli should be high in the intensity at accepted ranged where the patient should be anesthetized during making the process. The high intensity stimulus is favorite advisable for giving safety margin in decreasing nerve stimulation during operation surgery. Ischemia of the nerves and limb edema are Factors results in reducing the efficacy of nerve stimulation.

Stimulus Rate: Avoiding rapid stimulus delivery rates, wherever, the normal rate is (3-6) stimuli each second. And should avoid low rates such as frequency (5.0) Hz, the signal decrease the noise. If the stimulus ratio is under harmonic of the recurrence, the frequency noise must be same phase in each data time.

The characteristics of SEPs that should detected such as component amplitudes, peak latencies and waveform morphology. Wherever, component amplitudes are status during several tests of SEP recordings. Peak latencies are consistent across subjects, while the amplitudes demonstrate great contrast. Therefore, analysis of SEP diagnostic studies is based on peak latencies and measures derived from them.



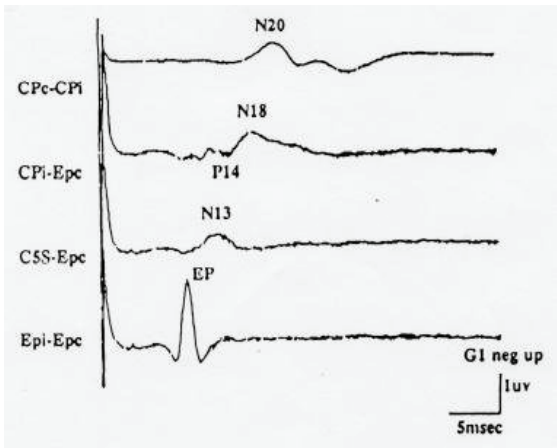


Figure 1: Median nerve SSEP recorded

Result and Discussion

A total of 15 cases were meeting the inclusion criteria between two kinds of electrodes, no studies involved randomized comparisons, and all were simple case series .patient age are (20-63) years, and the ratio was 2.12:1 and we excluded the value in the table 1 because we take the normal cases .

Table 1: Value of latency and amplitude don't including in this study

Cortex	P14	N20	P25
Latency (msec)	14.8±1.2	18.9±o.4	23.6±0.32
Amplitude (uV)	3.0±1.4	2.8±0.3	1.85±0.69

For most techniques, an acute 50% amplitude drop or 5% to 10% latency increase is considered clinically significant .smaller degrees of backgrounded variability in latency and amplitude are common but not generally of clinical significant

That is the main problem in all patients, the traditionally used test is very painful, and in most cases the pain is unbearable, To solve this problem the area of the examination was expanded which in return reduce electrical charge and reduce the level of pain for the patients.

Statistically when increased the area that is mean decreased the electrical charge and the pain with less time.

In this study we are changed in the electrode from 1 cm in the old electrode and to modified electrode to 7 cm and then increased the stimulated with low electricity and stimulated the same region in the brain by nerve or by skin, and we found the decreased of pain when increased the surface is that mean more area was stimulated.

Advantages of the new method:

1. The traditional procedure is extremely painful causing the patient to move to make the results more valid.
2. The new test is available on the market at reasonable prices.

Charge density is the amount of electric charge per unit length, surface area, or volume at any point in a volume. Surface charge density is the quantity of charge per unit area, measured in coulombs per square meter ($C \cdot m^{-2}$).

Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field.

Charge density (C/m^{-2}) = current/Area: In brief, figure (2) shows a scatter plot XY, in which the Y axis shows the difference between the two paired measurements (Old electrode – modified electrode) and the X axis represents the average of these measures ((Old electrode + modified electrode/2). In other words, the difference of the two paired measurements is plotted against the mean of the two measurements. B & A recommended that 95% of the data points should lie within ± 2SD.

The figure shows that the average discrepancy between two method is not large enough to be important which support that there is a good agreement between the two used method. Thus, we can say that there is a clear relationship between Old electrode and modified electrode.

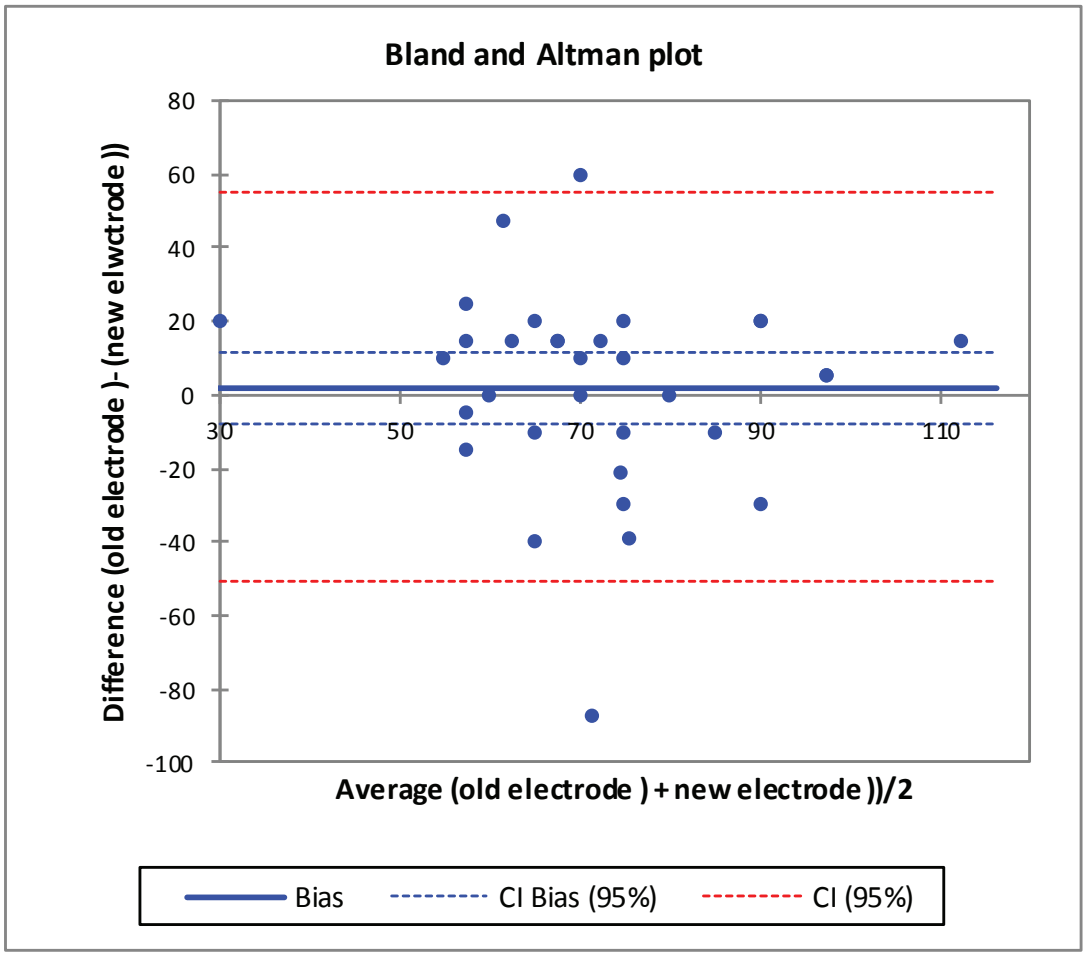


Figure 2: The correlation between pressures estimated by Old electrode and modified electrode, the blue line is mean, the red line is + 2SD

Conclusion

This study has investigated the difference in results between applying Old electrode and modified electrode in patients with different neurosurgery exam .it has shown some aspects that must be considered during doing the exam . I recommended studying the difference between the two techniques in other diseses to know the effect of the nerve which is obviously has an important effect. We also recommend to give more attention to the type and size of electrode depended on the different area investigation.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq

Conflict of Interest: Non

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