How to Get ***GREAT DATA: ECG***

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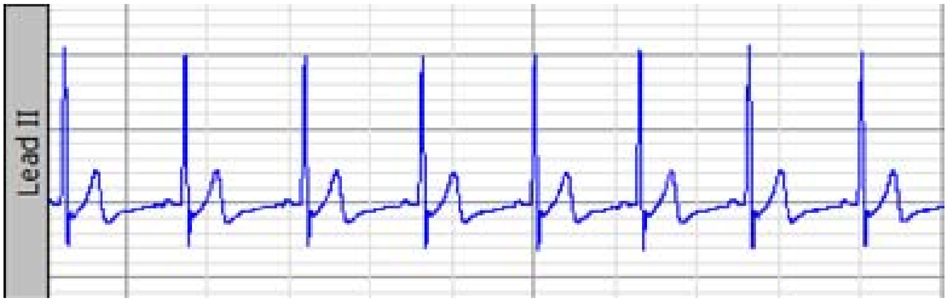
Useful tips for recording quality ECG data in your lab every time, compliments of BIOPAC life science hardware and software solutions.



An electrocardiogram (ECG) is a graphic recording of the changes occurring in electrical potentials as a result of cardiac activity.

Depolarization of the cardiac cells is the central electrical event of the heart. This occurs when the cardiac cells, which are electrically polarized, lose their internal negativity. Depolarization is propagated from cell to cell, producing a wave of depolarization that can be transmitted across the entire heart. This wave represents a flow of electricity that can be detected by electrodes placed on the surface of the body. Once depolarization is complete, the cardiac cells are able to restore their resting polarity through a process called ***repolarization***. Similarly, this flow of electricity can also be sensed using the same recording electrodes.

Reducing Impedance

Obtaining accurate data from an electrocardiogram depends partially on the specific electrode placement and site preparation. One of the most important considerations in site preparation is reducing the amount of impedance between the electrode and the skin surface. ***Impedance*** is the measure of restriction to the applied current in an electrical circuit.

Mathematically Expressed: ***Impedance = Voltage/Current***

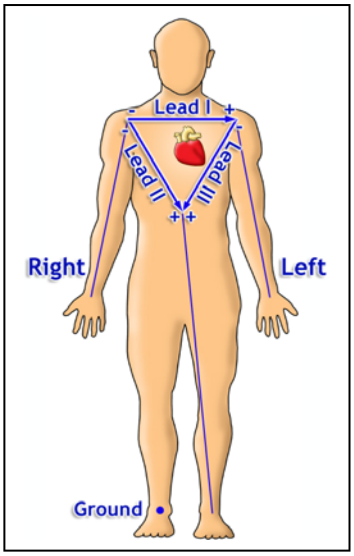
High electrode/skin impedance can be caused by dry skin, hair, calluses, scar tissue, and insufficient electrode gel or skin preparation. High electrode/skin impedance can also have the detrimental effect of adding noise to the biopotential signal of interest. There are four types of noisy artifact associated with high electrode/skin impedance:

1) Thermal noise, from real part of electrode/skin impedance
2) Amplifier current noise multiplied by electrode/skin impedance
3) Interference, imbalance in differential source impedances reduces amplifier common mode rejection ratio
4) Baseline drift, inconsistent ion transfer at electrode/skin junction influences half cell potentials

Preparing the Skin Site

Potential noise sources can be simultaneously reduced by properly preparing the skin electrode site, resulting in low skin/electrode impedance and optimal skin/electrode contact.

- Use BIOPAC's ELPAD to lightly abrade the skin site to remove the top layer of dead skin cells. This layer is highly resistive.
- Rub in a small amount of BIOPAC's ELPREP gel to increase the conductivity between skin and electrode. Remove excess gel and clean and dry the skin.



Einthoven's Triangle

Electrode Placement

One commonly-used ECG electrode placement is based on Einthoven's triangle, which is an imaginary triangle drawn around the volume of the heart (see diagram). Each apex of the triangle represents where the body's composition around the heart connects electrically with the limbs. Einthoven's law states that if the values for any two points of the triangle are known, the third can be computed.

Mathematically Expressed: ***LEAD II - LEAD I = LEAD III***

Place one electrode (such as BIOPAC's EL503) at the Right Leg "Ground" location and then place two electrodes at the below indicated locations for the desired LEAD, as illustrated in Figure 1:

For LEAD I: Right Arm (RA = Vin-) and Left Arm (LA = Vin+)

For LEAD II: Left Leg (LL = Vin+) and Right Arm (RA = Vin-)

For LEAD III: Left Leg (LL = Vin+) and Left Arm (LA = Vin-)

TIP: For an alternate LEAD II configuration offering maximum EMG artifact reduction, place the electrodes as follows: Right Collarbone = VIN-, Lower Left Abdomen (against rib) = VIN+, Lower Right Abdomen (against rib) = Ground.

IMPORTANT: Make certain that the electrode gel cavity (or holding sponge) has sufficient electrode gel in the application area. If the electrode is dry, add more electrode gel (GEL100) to the cavity or sponge.

Once electrodes are placed on the skin, an impedance check (also called a "resistance" check) should be made to determine the resistance between all the applied electrodes. Resistance checking, with BIOPAC's ELCHECK, should be performed between Vin+ and GND, Vin- and GND and Vin+ to Vin-. For best electrode-based measurement performance, resistance levels should be 5 Kohms or less. Note that impedance levels will improve over time as the electrode conductivity gel fully migrates between the skin surface layers and surface electrode.

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