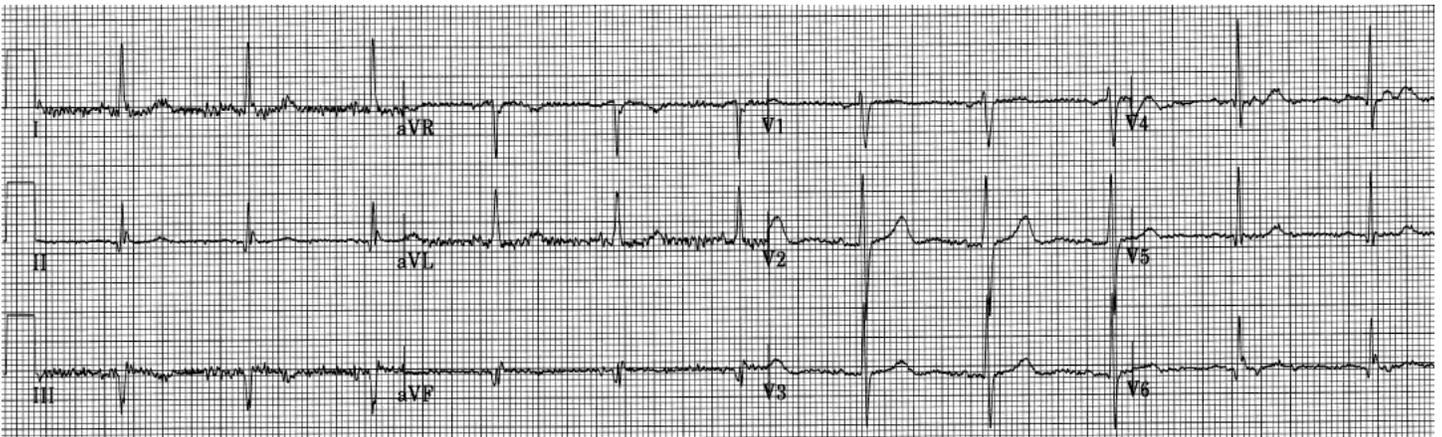


# Which Electrode Is Causing the Artifact?



*This section is for those of you just beginning your study of electrocardiography...*

**ECG ARTIFACT** – An irregularity of the ECG tracing that is caused by the machine, the machine’s electrical connections, implanted devices or by patient movement – but NOT by a problem with the heart itself.

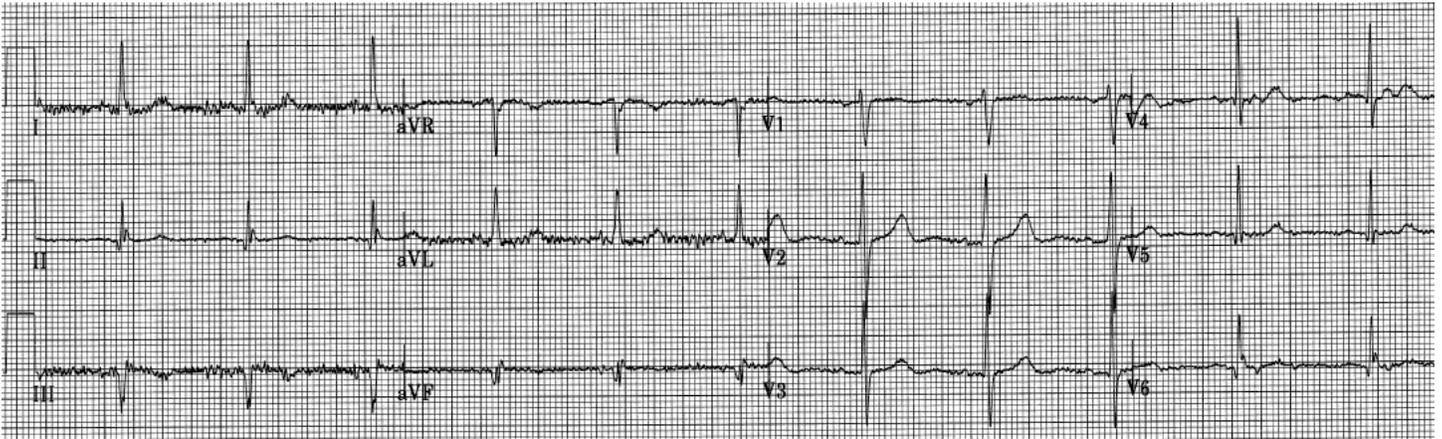
Someone hands you an ECG to read. You immediately notice the ragged baselines in Leads I, III and aVL. You even notice a much lesser degree of a ragged baseline in Leads II, aVR and aVF – but *not* to the degree that is seen in Lead aVL. Even the precordial leads appear to show inscriptions that are not as clear as they should be. You realize that there is a problem with an electrode, and you would like the ECG repeated. But which electrode is creating the artifact?

How would you like to amaze your colleagues by immediately indicating which electrode is the culprit causing the baseline artifact? Well, you can – and it’s so simple that it’s almost like a parlor magic trick!

You’ve already noted the more obvious baseline irregularity in Leads I, III and aVL. What do all three of those leads have in common? *They all share a common electrode – the left arm (LA) electrode.* Simple – but it still requires a lot of brain power. You have to know which electrode combinations result in which leads and then you have to compare them to determine which electrode is common to all of them. Not too difficult for an experienced electrocardiographer, but perhaps a bit of a challenge for someone new to ECG interpretation. Not to worry – *there’s an even faster and simpler method!*

You know that Leads I, II and III are created by the difference in electrical charge between two of three limb lead electrodes: the *left arm*, the *right arm*, and the *left leg* (LA, RA, and LL). But the augmented leads consist only of the electrode (and when I say *electrode*, I mean those little “stick-on” tabs to which the ECG lead wires are connected) which acts as the positive pole for that lead and a *virtual negative pole which is calculated by the ECG machine*. So essentially, what I am telling you is that **aVL is the LA electrode, aVR is the RA electrode and aVF is the LL electrode.**

So, here’s the beauty of this electrocardiographic “magic trick:” all you have to do is note which of the augmented leads (aVL, aVR or aVF) is affected by the artifact and THAT will be the electrode causing the problem. When I first saw this ECG and noted the three limb leads with obvious artifacts, I immediately looked to see which of the affected leads was an *augmented* lead – in this case, aVL – and I immediately knew that the LA electrode was the culprit (probably not securely applied to the patient’s skin).



***This next section is for the more advanced ECG “nerds” (but you “newbies” are very welcome to follow)...***

If you look closely, you will notice that it is not only Leads I, III and aVL that are affected by the faulty application of the LA electrode, but all the other limb leads demonstrate a bit of irregularity, also – just not to the same extent as Leads I, III and aVL. And even the inscriptions of the precordial leads could be a little clearer. Why?

**Regarding the *limb leads*...**

You must realize that we now live in the digital age. That was not the case when I was a medical student and resident. Computers were very rudimentary machines, only used by the government and large companies and institutions. Heck, they hadn’t even invented Pac-Man yet! So when we recorded an ECG, we used an *analog* machine that actually recorded every one of the 12 leads individually.

That’s no longer the case. When you record the limb leads of a 12-lead ECG today, you are only recording TWO leads – Leads I and II. All the OTHER limb leads – Leads III, aVR, aVL and aVF – are calculated by the ECG machine as graphs (which is what an ECG actually is – a *graph of voltage versus time*) from the information in Leads I and II, and then inscribed on the ECG paper. And, since Leads I and II share the RA electrode, you can see how ALL the limb leads are based on the information from Leads I and II. Even *Wilson’s Central Terminal* – which is calculated for each lead by using the information from the other two leads – is a part of this process.

Well, the ragged baseline in Leads aVL, I and III happens to be information that is included in the calculations of the remaining three leads; so, they also show some of the ragged baseline artifact but *not to the same degree* as the three leads that use the information from the LA electrode directly in their own measurement.

**Regarding the *precordial leads*...**

But if you look even more closely, you can see a very minimal – *but similar* – baseline artifact in *all* the *precordial leads*. How can that be? Even today we use different sets of lead wires for the limb leads and the precordial leads.

The connection here is, again, *Wilson’s Central Terminal* – the virtual negative pole for Leads aVR, aVL, aVF and V1 – V6. That’s how the precordial leads are directly related to the augmented limb leads and distantly related to Leads I, II and III. Leads V1 – V6 also use the same virtual negative pole as Leads aVR, aVL and aVF.