

ECG Lead Misplacement Significance

Proper ECG recording facilitates appropriate interpretation and diagnosis. Electrode misplacements can lead to morphological changes on ECG that could potentially be interpreted as ischemic or arrhythmogenic in origin. Therefore, recognition of the patterns seen in improper lead positioning is essential to avoid incorrect diagnoses and unnecessary treatments.

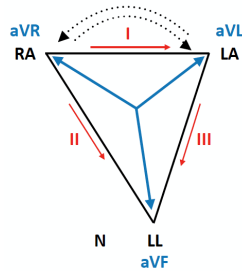
Electrode misplacements are a relatively frequent finding, in 0.4% of ECGs done in outpatient clinics, and even more common at 4% in intensive care units. Several key findings on an ECG can help clinicians identify potential signs of electrode misplacements.

When the limb electrodes (LA, RA, LL) are exchanged without disturbing the neutral electrode (RL/N), Einthoven's triangle is "flipped" 180 degrees or rotated, resulting in leads that switch positions, become inverted or remain unchanged (depending on their initial position and vector).

Exchanging one of the limb electrodes with the neutral electrode (RL/N) disrupts Einthoven's triangle and distorts the zero-signal received from Wilson's central terminal, altering the appearance of both limb and precordial leads. Limb leads may be grossly affected, taking on the appearance of other leads or being reduced to a flat line.

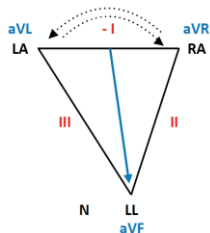
Einthoven Triangle

The relationship between the limb leads and electrodes is described by [Einthoven triangle](#).



LA/RA reversal

With reversal of the LA and RA electrodes, Einthoven's triangle flips 180 degrees horizontally around an axis formed by lead aVF.

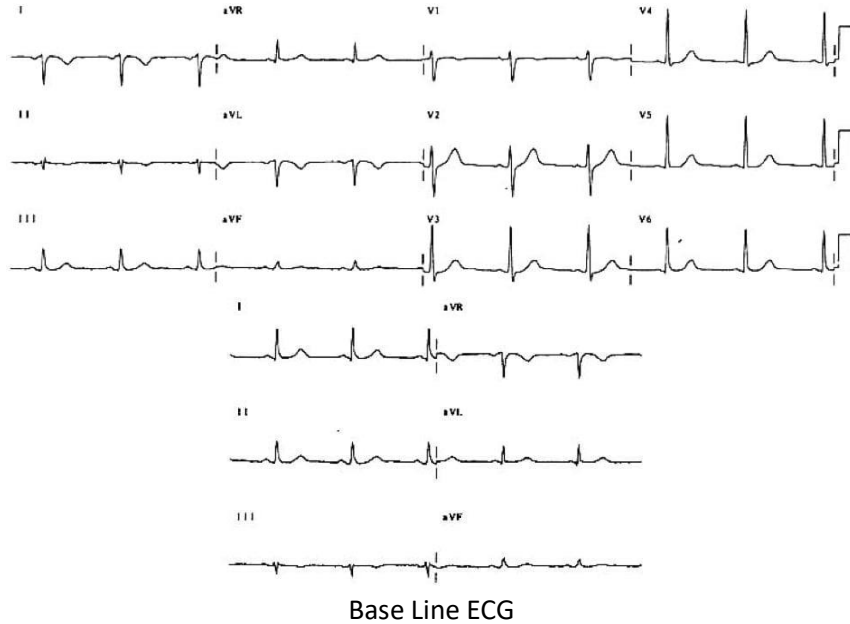


Quick guide to spotting LA/RA reversal

- Lead I is completely inverted (P wave, QRS complex and T wave).

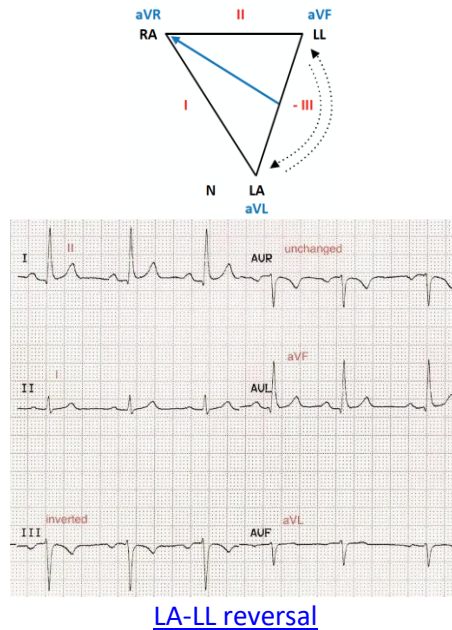
- Lead aVR often becomes positive.
- There may be marked right axis deviation.

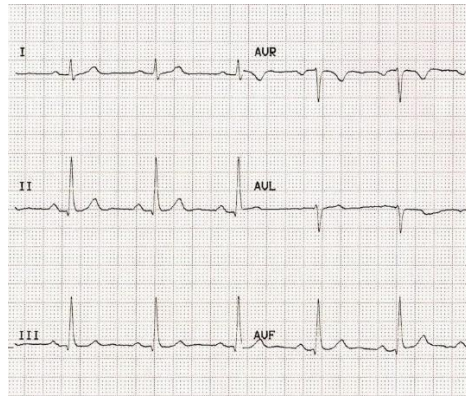
LA/RA reversal may simulate [dextrocardia](#). However, in contrast to dextrocardia there is normal R wave progression in the precordial leads.



LA/LL reversal

With reversal of the LA and LL electrodes, Einthoven's triangle rotates 180 degrees vertically around an axis formed by aVR.





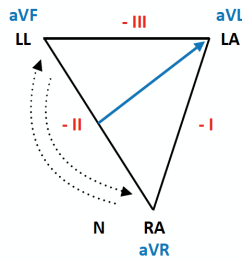
Baseline ECG

Quick guide to spotting LA/LL reversal

- Lead III is completely inverted (P wave, QRS complex and T wave)
- The P-wave is unexpectedly larger in lead I than lead II (it is usually the other way around).

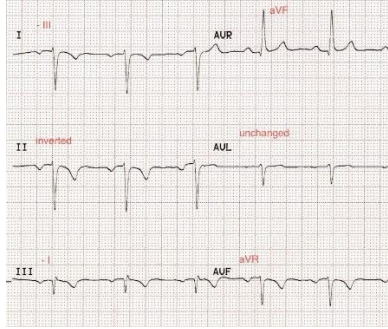
RA/LL reversal

With reversal of the RA and LL electrodes, Einthoven's triangle rotates 180 degrees vertically around an axis formed by aVL.

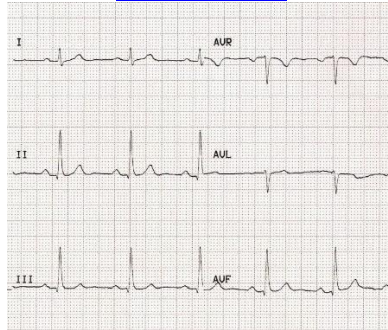


This has the following effects on the ECG:

- Lead II becomes inverted.
- Leads I and III become inverted and switch places.
- Leads aVR and aVF switch places.
- Lead aVL is unchanged.



[RA/LL reversal](#)

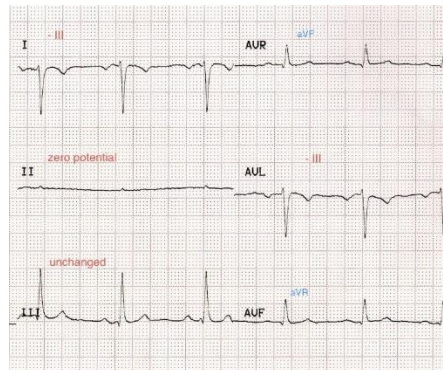
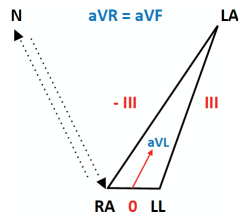


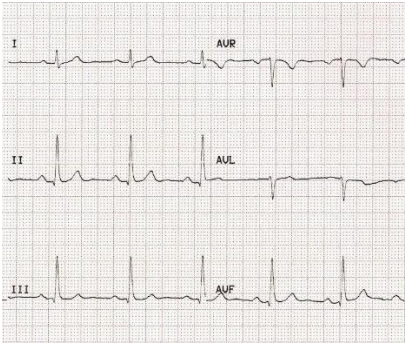
[Baseline ECG](#)

Quick guide to spotting RA/LL reversal

- Leads I, II, III and aVF are all completely inverted (P wave, QRS complex and T wave).
- Lead aVR is upright.

RA/RL(N) reversal



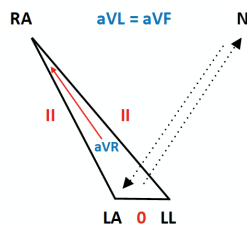


Baseline ECG

Quick guide to spotting RA/RL(N) reversal

- Lead II is a flat line.

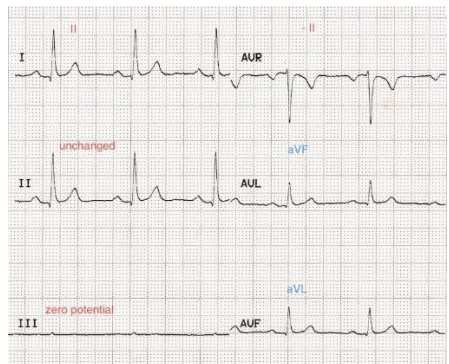
LA/RL(N) reversal



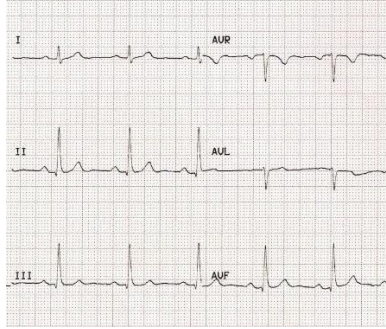
LA/RL(N) lead reversal has the following ECG features:

- Lead I becomes identical to lead II.
- Lead II is unchanged.
- Lead III records a flat line (zero potential).
- Lead aVR approximates to an inverted lead II.
- Leads aVL and aVF become identical.

As the neutral electrode has been moved, the precordial voltages may also be distorted.



LA/RL(N) reversal

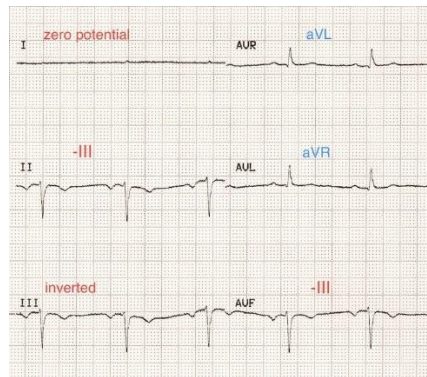
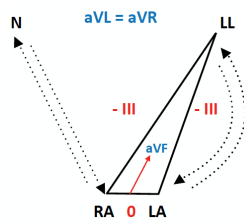


[Baseline ECG](#)

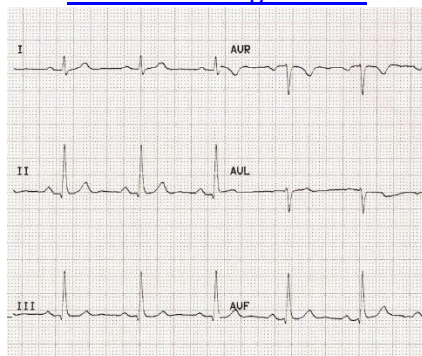
Quick guide to spotting LA/RL(N) reversal

- Lead III is a flat line.

Bilateral Arm-Leg Reversal (LA-LL plus RA-RL)



[Bilateral arm-leg reversal](#)



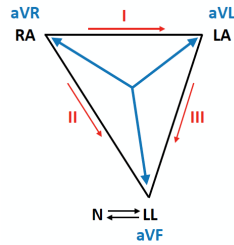
[Baseline ECG](#)

Quick Guide To Spotting Bilateral Arm-Leg Reversal

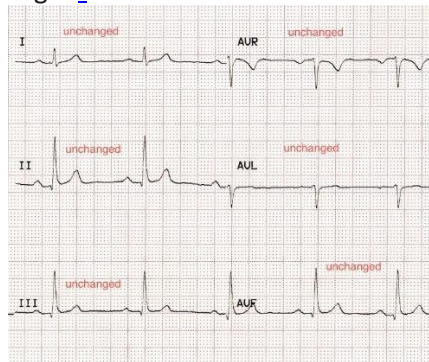
- Lead I is a flat line.

LL/RL(N) reversal

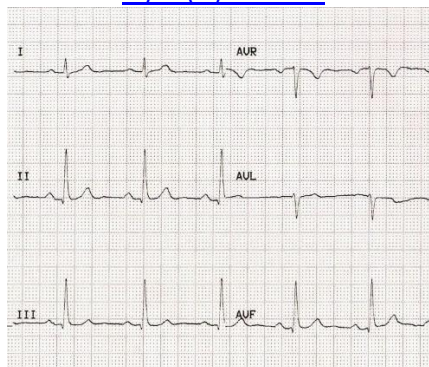
- With reversal of the lower limb electrodes, Einthoven's triangle is preserved as the electrical signals from each leg are virtually identical.



- The ECG is therefore unchanged.



LL/RL(N) reversal



Baseline ECG

How to spot LL/RL(N) reversal

- You won't!

But don't worry, it won't make any difference to your ECG interpretation.

Summary – The KISS Principle

“True” lead	I	II	III	aVR	aVL	aVF	V1– V6
Reversal							
LA / RA	- I	III	II	aVL	aVR	aVF	No change
LA / LL	II	I	- III	aVR	aVF	aVL	No change
RA / LL	- III	- II	- I	aVF	aVL	aVR	No change
Clockwise	III	- I	- II	aVL	aVF	aVR	No change
Anti-Clockwise	- II	- III	I	aVF	aVR	aVL	No change

- RA—right arm; LA—left arm; LL—left leg;
- Clockwise rotation: RA→LA→LL→RA;
- Anti-clockwise rotation: RA→LL→LA→RA.
- The (-) sign signifies that the respective lead is inverted