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Research Article

Simple Method to Determine the Normal Cardiac Axis with I (D1) and aVF

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Abstract

Background: A recently published paper argues that calculating the mean electrical axis of the heart in the frontal plane may lead to inaccuracies when using leads I (also known as lead D1) and aVF when the axis is within the range of -30° to 0° or between 90° and 110°.

Methods: Based on our previous reports we present counterarguments and demonstrate there is no compelling reason to avoid using the combination of leads I (D1) and aVF within these ranges.

Results: In cases where the value of aVF is negative and less than half (precisely 50.00%) of the value of I (D1), which is positive, the axis is between -30° and 0°. Similarly, when the value of I (D1) is negative and less than a third (precisely 31.52%) of the value of aVF, which is positive, the axis is between 90° and 110°. When both the I (D1) and aVF values are positive, the axis is between 0° and 90°. Therefore, we assert that there are no mathematical limitations preventing the use of leads I (D1) and aVF within the axis range of -30° to 110°.

Interpretation: In aligning with the currently valid criteria for the "normal axis values", which are for adults according to the American Heart Association between -30° and 90°, we described two rules to determine it as follows: (1) The value of the I (D1) is positive. (2) The value of the aVF is positive, or the value of the negative aVF is less than half the I (D1) value.

Keywords: Electrical Heart Axis; Electrocardiography; Novosel Formula

Introduction

The determination of the mean electrical axis of the heart is a challenging subject to various approaches [1-4]. In a recent publication [5], HPD Lopez proposed a method to determine an axis within the range of -30 to 110 degrees, which he considered as the normal range. He argues that the most popular method, which uses leads I (also known as D1) and aVF, is sufficient when the axis is between 0 and 90 degrees but lacks utility when the axis is within the range of -30 to 0 degrees or 90 to 110 degrees. Consequently, he suggests using a combination of leads I (D1) and III (D3) for axes within these ranges. However, as described elsewhere [6-8], the axis can be calculated from combination of any limb leads [6,9], and the choice of lead pairs may be based more on the ability to estimate voltage precisely (or personal preferences) than on the theoretical background.

There is a distinction between visually determining the axis and its mathematical value. In short, the visual method is swift and used in daily routine work, emergencies, or any situation where the exact value holds no significance. The arithmetic method, used to calculate the axis from measured values, is slower (unless automatically done by the ECG device) but more accurate.

In our paper, we confine ourselves to methodological viewpoints and do not delve into discussions regarding clinical relevance.

Methods

For the purpose of this study we use the formula described elsewhere [6, 8, 9] which was entitled as „Novosel formula“ by Dahl and Berg [7].

Electrical Axis = +/- Arctan ((2*aVF)/(Sqr(3)*I))

Results

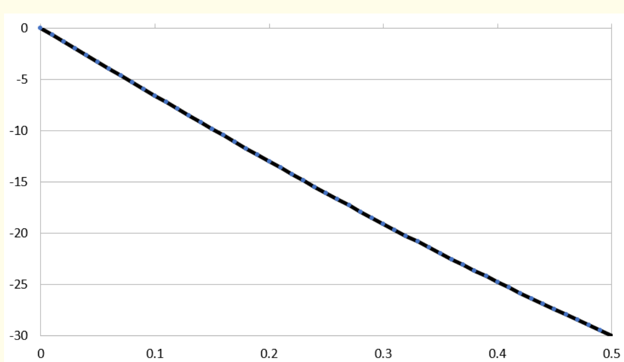

Figure 1

Figure 1 displays the axis values (vertical axis) determined through the quotient (horizontal axis) of the negative value of aVF lead and the value of I (D1) . The threshold point is reached when the negative value of aVF is half that of the I (D1) value. A range of quotient below 0.5 indicates that the axis is between 0 and -30 degrees.

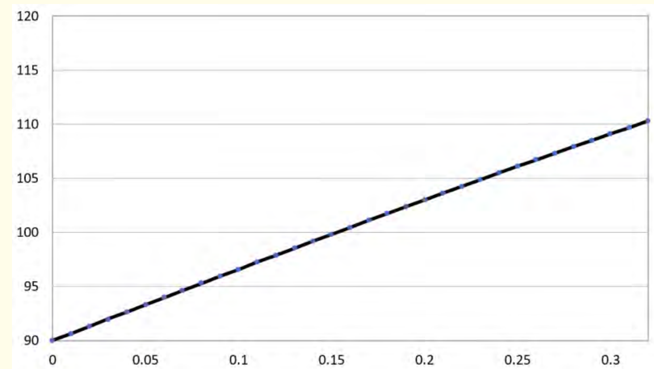

Figure 2

Figure 2 depicts the axis values (vertical axis) determined by the quotient (horizontal axis) of the negative value of lead I (D1) and the value of aVF. The threshold point is reached when the negative value of I (D1) is a third of the aVF value. A range below 0.3152 indicates that the axis is between 90 and -110 degrees.

Discussion and Conclusion

There is no doubt that the mean electrical axis of the heart in the frontal plane can be visually estimated and calculated in various ways, with some methods being more accurate than others. However, when the numerical values of any two lead combinations are known, there is no mathematical explanation why the one combination should be inherently superior to another. It is possible that amplitude values could influence the choice of different lead combinations, especially if the amplitudes in certain leads are very low or challenging to measure manually.

When the combination of one of the (unipolar) augmented leads (aVR, aVL, aVF) and one of bipolar leads (I, II, III = D1, D2, D3) are used a correction should be performed. When using a combination with only augmented leads (aVR, aVL, aVF) or only with bipolar leads (I, II, III = D1, D2, D3) no correction is needed as both groups of leads have the same amplification of the signal. It is noteworthy that the word “augmented” is misleading and that the overall amplitudes of the leads aVR/aVL/aVR are lower then those of I/II/III (D1/D2/D3) [9].

Visual determination, involving a quick scan to decide whether a more precise analysis is necessary, can also be done visually. In this context, we propose the following approach:

- **Rule 1:** If both I (D1) and aVF values are positive, the axis is between 0 and 90 degrees.
- **Rule 2:** If the value of aVF is negative and is less than a half (exact value: 50.00%) of the positive value of I (D1), the axis is between -30 and 0 degrees.
- **Rule 3:** If the value of I (D1) is negative and is less than a third (exact value: 31.52%) of the value of aVF, which is positive, the axis is between 90 and 110 degrees.

However, according to the currently valid standards for the interpretation of the ECG the normal electrical axis in adults is defined as in the range of -30 and 90 degrees [10]. It is noteworthy to mention that the axis value of 0 degrees means that the I (D1) is positive and the aVF value is zero and the value of 90 degrees means that the value of I (D1) is zero and the value of aVF is positive. For the axis value between 0 and -30 degrees the value of I (D1) must be positive and the value of aVF should be less than the half of the I (D1) value. Conclusively, to interpret the value of the axis an "normal", the value of the I (D1) must be positive in any case. If the value of the aVF is positive or negative, but less than half of the I (D1) the axis should be considered as normal. Therefore a simplified rules for the determination of the normal electrical axis of the heart in the frontal plane are:

- **Condition 1:** The value of the I (D1) is positive;
- **Condition 2:** The value of the aVF is positive or the value of aVF is negative and less than the half of the I (D1) value.

If both conditions are fulfilled, the heart axis should be considered as in the normal range.

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Conflict of Interests

Nothing to declare.

Ethical Considerations

Not applicable.

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