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ONE-TWO Criteria: Improving the Approach to Electrocardiogram

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Abstract

The electrocardiogram (EKG) is one of the major Para-clinic exams for evaluating patients suspected to cardiac or non-cardiac disease which could be very informative especially when assessed by experienced clinicians. To improve and accelerate the approach to EKG interpretation, simple and accurate criteria are useful and save the physician's time especially in emergent situations.

In this article, we introduce our criteria which determine whether the electrical axis of heart is normal or not and if abnormal, what kind of deviation it has. These criteria say that "if the mean QRS complex in leads I and II are positive, the axis will be accurately in the normal range (-30 to +90); unless, the axis is abnormal necessitating a more complex evaluation". These criteria could simplify the first step of the approach to EKG interpretation especially in emergent situations. They can also be proper substitute for current methods of heart axis determination in clinical practice and for educational goals.

Keywords
Heat axis, Electrocardiogram, Criteria, Heart leads

Introduction

Recording electrical activity of heart as EKG and its interpretation is one of the first approaches to a patient with cardiovascular disorder. Interpretation of EKG can begin with determination of heart axis. This action not only makes an image of the heart anatomical structure, but also helps to detect some of the cardiac functional abnormality (1). Available methods of heart axis determination help to calculate the heart axis and make a differentiation between normal and abnormal ones. But these methods

are not definitely accurate, leading to false results in some cases.

The normal range of heart axis is between -30 to +90 degree and an axis more negative than -30 degree is referred to as left axis deviation(2).The current methods (using I and aVF(3) or I and III) can only determine that the axis is between 0 and +90 or not; But in some cases that the axis is between 0 and -30 degree, a more complete attention is needed, because the axis is normal but is not matched with the normal range of these methods. An example of such cases is shown in figure 1. In this figure, the mean QRS complex is positive in I and negative in aVF, suggesting a left axis deviation; but in fact, the axis is normal locating between 0 and -30 degree.

In this article, we developed novel ONE-TWO criteria, which solve this problem and determine the normal axis (between -30 to +90 degree) that is accurately matched with the normal range mentioned in related text books.

Hypotheses

The electrocardiogram is a recording of cardiac electrical activity by skin electrodes. Although the technique is easy and fast, its pattern should be interpreted to solve many problems and clarify lots of important clinical conditions. The EKG is indicated for detection of cardiac arrhythmias, myocardial infarction, hyperkalemia, hypokalemia, bundle branch block, ischemic heart disease, stress test, pulmonary embolism and hypothermia (4). When being read and interpreted by a highly skilled and experienced physician, an EKG is considered one of the most useful records of heart function. The first approach to EKG is determination of the heart axis.

The normal heart axis ranges from -30 to +90 degree. An axis more negative than -30 degree is defined as left axis deviation and an axis more positive than +90 degree is referred to as right axis deviation (5). Some of the most common cases that may be associated with the axis deviation are summarized in table 1 (6).

The heart axis is determined using the mean QRS in two heart leads, mostly I and aVF (7, 8) or I and III (4, 7). To determine the axis of total QRS, we draw perpendicular lines from the apices of two leads (e.g. I and III). The point of intersection of these two perpendicular lines represents the apex of the mean QRS axis in ventricles. The point of intersection of two leads is the negative end of the QRS axis. Therefore, the mean QRS axis is drawn between these two points.

The aforementioned method is summarized as following:

1) Plot the net deflection of QRS complex (mean QRS) for both leads I and aVF along each lead. According to the sum of deflection, plot toward the positive or negative pole of the relevant lead;

2) Run perpendicular lines from each of the plotted points for these two leads;

3) The point of intersection of perpendicular lines represents the apex of the mean QRS axis in ventricles;

4) Draw a vector from the intersection of leads I and II and the intersection of the perpendicular lines (vector tip). The angel between the vector and the lead I is heart

Electrical axis angel

The average electrical potential generated by the ventricles during depolarization is represented by the length of this axis (7). Positive QRS complexes in leads I and aVF suggest an axis between 0 and 90 degree(4), but if the QRS complex is negative in aVF and positive in I, then determining the normal axis will face a problem because it is not clear that the axis is less or more than -30 degrees.

For example, figure 1 shows an EKG in which the mean QRS complexes in leads aVF and I are negative and positive, respectively. In this case, determination of this fact that the heart axis is in the normal range or there is a left deviation is difficult and even impossible without using exact geometric methods, and here is where a need for exact and fast criteria is sensed.

We have developed novel criteria that not only solve the aforementioned problem, but also have other benefits. The criteria which are called ONE-TWO, uses the mean QRS complex in leads I and II which is defined as below: " if the mean QRS complexes in leads I and II are positive, the axis will be accurately in the normal range (-30 to 90 degrees); unless, the axis is abnormal necessitating a more complete evaluation.

In abnormal cases, we have two conditions:
If QRSI> QRSII, then it is left axis deviation
If QRSII> QRSI, then it is right axis deviation."

The criteria are originated from these two facts:
If the mean QRS complex is positive in lead I, the axis ranges between -90 to +90 degrees.
If the mean QRS complex is positive in lead II, the axis rang is between -30 to +120 degrees.

Merging these two points conclude axis range between -30 to +90 which is matched with the normal axis of heart (figure 2).

Each electrocardiogram that fulfills these criteria has normal axis and each one that has normal axis fulfills these criteria. We think that using these criteria is easy and fast (important especially in emergent conditions) and could be an appropriate substitute for current methods of heart axis determination (I and aVF or I and III) for educational goals.

Evaluation of the hypotheses

This method can be assessed clinically by comparing the EKG of patients in normal and abnormal ranges of heart axis with other practical tests like

echocardiography, exercise test, and if indicated angiography. We should choose two groups of individuals; the first group consists of persons with abnormal cardiac electrical axis (less than -30 or more than +90) and the second one contains persons with normal axis. These two groups should be matched for age, sex, ethnicity, etc. Then, they should be evaluated for cardiac and non-cardiac diseases, performing more exact paraclinical studies such as angiography of heart vessels, exercise test, heart perfusion scan, echocardiography and nuclear imaging. By analyzing the data using ANOVA and Student t-test, it will be evident that how a normal range of EKG can conclude the absence of cardiac disorders, and how an abnormal one can predict the presence of such diseases in the heart.

Results of such study, if confirms efficacy of these criteria will be useful in fields of emergency medicine, education, and following up of patients for heart disease.

Discussion

The main investigatory techniques in cardiovascular disorders are EKG, chest x ray, echocardiography, etc (9). Interpretation of signs and symptoms of patients, making differential diagnosis and thus treating them should be fast and without any time wasting. This fact is more evident in the emergent condition especially in old patients with cardiovascular disorders. So, the clinicians should do their best to avoid time wasting to improve the patient's conditions. Every minute that heart continues to fibrillate (for example, after a heart attack), the chance of heart rhythm recovery decreases by about 10% (10, 11).

Because ONE-TWO criteria are exact, fast and easy in axis determination and differentiation between the normal axis and the abnormal ones, they could simplify the approach to EKG in emergent conditions. Besides, these criteria are easy to be used by the health care staffs who may not be expert in interpreting EKG. Because these criteria could simply determine whether the axis is normal or not, they could be used as useful and practical general screening criteria for some cardiac and non-cardiac diseases. Avoiding of time wasting in advanced cardiac life support(ACLS) and having appropriate features to be included in heart axis issues in related textbooks are some other benefits.

Conclusion

Eventually, we recommend using these criteria as faster, easier, and more accurate approach in the first step of going to the EKG interpretation. It can be used in emergency settings and for rapid initial evaluation of one's EKG; being abnormal, other accurate diagnostic tests should be performed to detect or confirm exact diagnosis. For example, a 55 years old lady who is admitted to the orthopedic surgery ward with femoral neck fracture 7 days ago is now complaining of sudden onset dyspnea. The night shift resident visits the patient and after ordering the EKG, he finds positive QRS in leads aVF and negative one in lead I; the right axis deviation is confirmed. Being suggested for acute pulmonary emboli, chest CT angiography is ordered. Considering this hypothesis in educational fields can have important application for training electrophysiology, because it is easy and reliable.

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Overview Box

What do we already know about the subject?
Determination of heart electrical axis was always limited to methods which ignored some errors, and we just bring out a concept as new criteria.

What does your proposed theory add to the current knowledge available, and what benefits does it have?
This hypothetic paper expresses a new approach to heart axis determination using another leads among the previous ones. We discovered accurate criteria which is easy and fast for determination of heart electrical axis.

Among numerous available studies, what special further study do you propose for testing the idea?
We recommend performing a case-control study to assess the hypotheses. Two groups of individuals (having normal versus abnormal heart axis according to new criteria) should be evaluated for cardiac and non-cardiac diseases. The results should be assessed statistically. This will verify the efficacy of the criteria.

Table 1. The major causes for deviation of heart axis

Right axis deviation	Left axis deviation
Right ventricular overload Left posterior fascicular block Lateral wall MI Left ventricular dextrocrdia Left side pneumothorax	Left ventricular hypertrophy Block in the anterior fascicle of The left bundle system Inferior wall MI

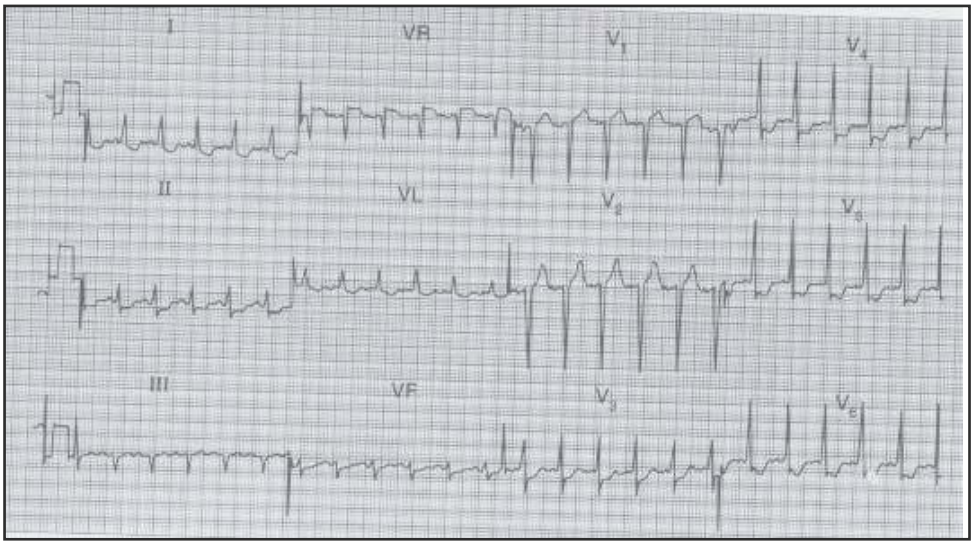

Figure 1. An example of a little complicated EKG in heart axis determination (1)

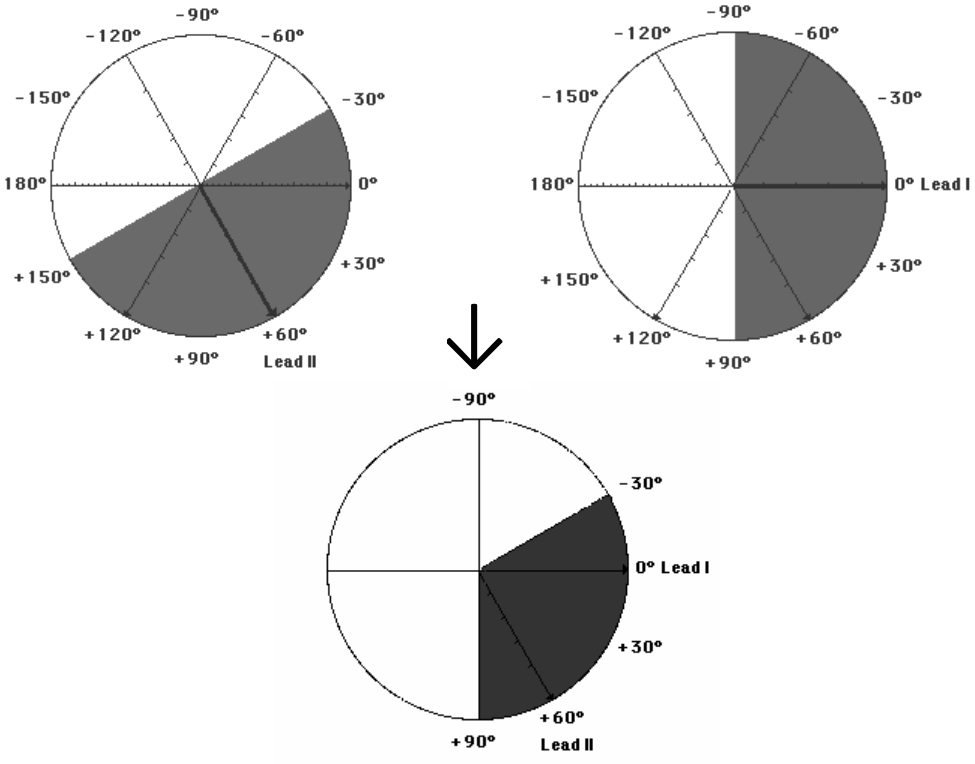

Figure 2. Determination of normal range of Heart axis

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