

The Meaning of Axis Deviation in Insurance Medicine

by

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INTRODUCTION

Throughout the history of electrocardiography there has always been keen interest in the concept of electrical axis and in the deviations from the normal axis. The mean electrical axis of the QRS has been the prime concern and is usually quoted as part of every ECG interpretation. The axis of the P wave is used only in rhythm analysis. The frontal plane electrical axis of the QRS indicates the average pathway in space taken by the electrical activation waves through all the ventricular myocardium. The space referred to, of course, is the thorax and the frame of reference within which the pathway is traveled and measured is Einthoven's Triangle. The latter, bounded by the right arm, left arm and left leg, is composed of the three limb

or standard leads. Figure 1 represents a diagram of the orientation of the electrical axis and the classical manner of its expression with reference to locations on a circle. These locations are defined as angles (in degrees) away from the horizontal plane, marked zero degrees. Above the horizontal the axis is marked negative and below it is positive. The segments of this circle are assigned certain areas. No deviation indicates the normal axis location (note the average normal axis at 60 and the normal range of +30 to +90). Left axis deviation (L.A.D.) exists when the axis lies to the left of normal and between +29 and -90, and right axis deviation (R.A.D.) lies to the right of the normal between +91 and -91. These values apply to the adult.

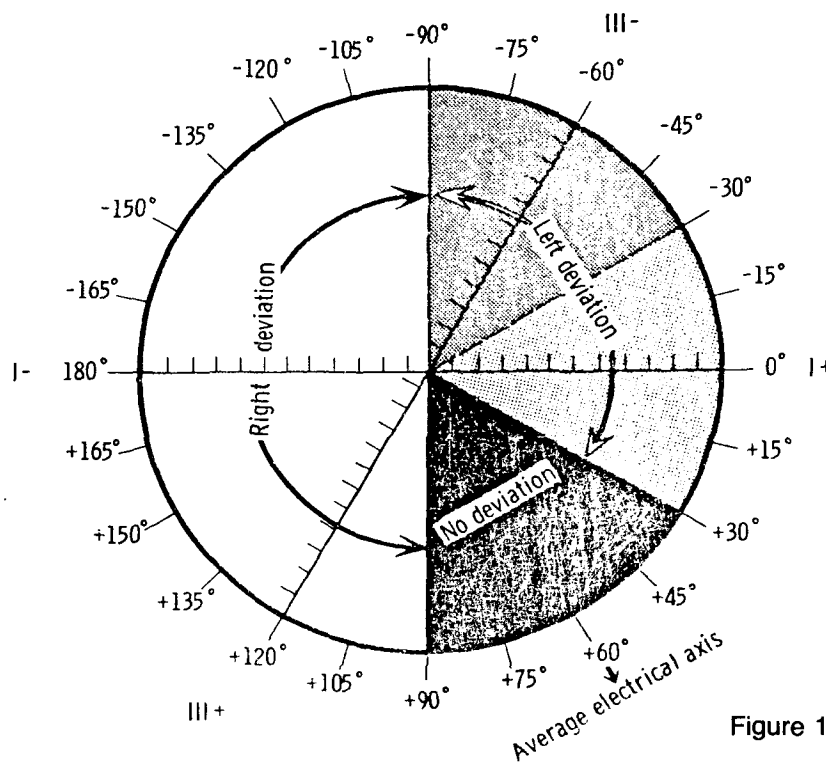


Figure 1

LOCATION OF THE QRS AXIS AT DIFFERENT AGES

Figure 2 demonstrates the location of the QRS axis at different ages. At birth, the axis is considerably to the right, averaging +90 to +110 and even, occasionally, lies even further to the right. As the child grows and the body shape and heart shape both change, the axis moves leftward until about 6 to 8 months of age at which time the normal adult position of the axis is usually established. Occasionally some right axis deviation persists into later years. It is also evident in Figure 2 that some degree of left axis deviation is seen in normal individuals, reading -30 at times.

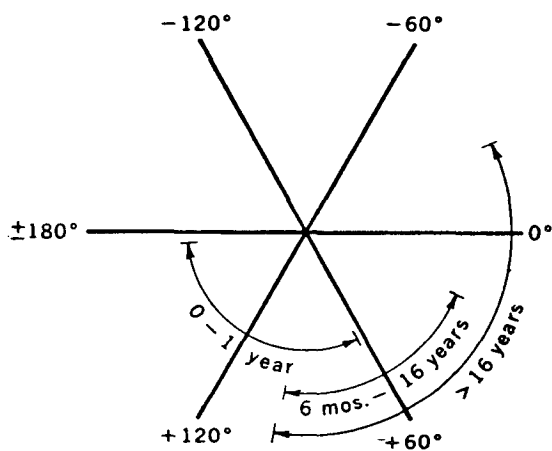


Figure 2

FACTORS CONTROLLING ELECTRICAL AXIS

The factors which control the position of the electrical axis of the QRS are those which relate to the position of the cardiac mass in the bony thorax and not to hypertrophy and/or dilation of any cardiac chambers. Misconceptions concerning a primary relationship between axis deviation and intracardiac abnormalities such as size of ventricles and thickness of ventricular walls have led to serious errors of interpretation in clinical medicine. Deviations of QRS axis away from the normal - leftward or rightward - need not necessarily imply any ventricular hypertrophy of the left or right heart. Any factors which, for example, place the heart as a whole in a more horizontal position in the bony thorax will produce a deviation to the left of the electrical axis, whereas factors which place the cardiac mass in a more vertical position in the thorax will produce a deviation of the electrical axis to the right. *Non-cardiac conditions* which illustrate the former (horizontal position) are obesity or intestinal obstruction with rise in the diaphragm, and a rising diaphragm due to pregnancy, ascites or diaphragmatic

paralysis. Examples of the latter (vertical position) are loss of body weight with a drop in diaphragmatic level, the normal, tall thin narrow body habitus with low diaphragm and, most important of all, lowering of the diaphragm in such conditions as emphysema or certain chest deformities. The cardiac mass is pulled out cephalo-candally into a more tubular or vertical orientation as the diaphragm goes down. Diaphragmatic position can also alter with deep breathing and axis shifts with a deep breath or change in bodily position from lying to sitting are often seen.

Deviations of the electrical axis to the left are, of course, well known to occur when enlargements of the left ventricle occur. Enlargement, it should be emphasized, is not necessarily due to hypertrophy; left ventricular dilatation alone can cause enlargement and left axis deviation. When left ventricle enlarges, - either as a result of dilatation or hypertrophy, or both processes - the ventricle tends to rotate in the chest and escape to the patient's left because this is the path of least resistance for this chamber. This makes the heart as a whole assume a more horizontal position and hence the QRS axis usually shifts to the left. When the right ventricle enlarges it moves anteriorly and rotates the heart into a vertical position as a rule, pushing the left ventricle toward the spine and more posteriorly. The vertical position results in right axis deviation. However, there may be enlargement of either the left or the right chambers separately with little resultant rotation and hence no deviation of the QRS axis. Secondly, if both chambers are enlarging at approximately the same rate there may, of course, be no over-all shift in the position of the heart in the thorax and no change in electrical (QRS) axis even though cardiomegaly has occurred. Sudden deviation to the left of the axis can be seen in sudden dilatation of the left ventricle such as occurs in acute left ventricular failure. Similarly, sudden hypertension of the pulmonary circulation with acute dilatation of the right ventricle, as seen in acute cor pulmonale due to pulmonary embolism or recent respiratory insufficiency in obstructive lung disease, may induce the sudden appearance of right axis deviation. These acute shifts in electrical axis may subside when the inciting causes have disappeared.

To summarize the factors controlling electrical axis of the QRS, it must be emphasized that the basic mechanisms are those of rotation of the ventricular mass and not ventricular enlargement or hypertrophy per se. Horizontal positions induce left axis deviation and vertical ones right axis deviation. Under most clinical circumstances, therefore, the mere presence of axis deviation from the normal does not permit a diagnosis electrocardiographically of cardiac disease.

There are three exceptions to this last statement, however. Firstly, in infants and children under the age of six months the mere presence of left axis deviation, or an axis of +29 or more leftward (see Figure 1) should cause concern and generate investigation for congenital heart disease. In adults left axis deviation which is more negative than -44 and right axis

deviation which is more rightward than +110 are in themselves clearly abnormal. It is these areas of axis deviation which are of importance in insurance medicine.

MEASUREMENT OF ELECTRICAL AXIS AND AXIS DEVIATIONS

There are three methods in clinical use at present for exact calculation of the QRS axis in degrees, the first two of these being well known: (1) the diagram in Figure 1 (see instructions in the Legend) and (2) the table in the Criteria of the New York Heart Association.*

A third method had just become available with introduction of some new electrocardiographic equipment. These new electrocardiographic machines, each of which contains its own minicomputer, generate an immediate interpretation print-out at the bedside using computer analysis and the interpretation is printed along with, and at the top of the tracing. The analysis includes an exact calculation of QRS (and P)

axis in degrees. This has a great advantage in evaluation of the meaning of the exact degree of abnormality of the QRS axis, (see below).

Of course, on simple inspection of the three standard leads (I,II,III), one can observe whether there is any deviation from normal to the left or to the right without an exact calculation of degrees.

Left deviation (L.A.D.) exists whenever the S wave is greater than the R wave in Lead III and the R wave is larger than the S Wave in Lead I. When L.A.D. is more than slight or moderate - i.e. above the horizontal or zero point on the circle in Figure 1 - one can make the estimate of this more severe degree of L.A.D. (called Marked L.A.D.) on observing that the S wave in lead II is greater than the R wave in Lead II. This implies an axis deviation which lies somewhere between -30 to -90. It is in this segment of the circle that true abnormality is found. This will be discussed further below.

Right deviation (R.A.D.) is established when the S wave is greater than the R wave in lead I and in lead III

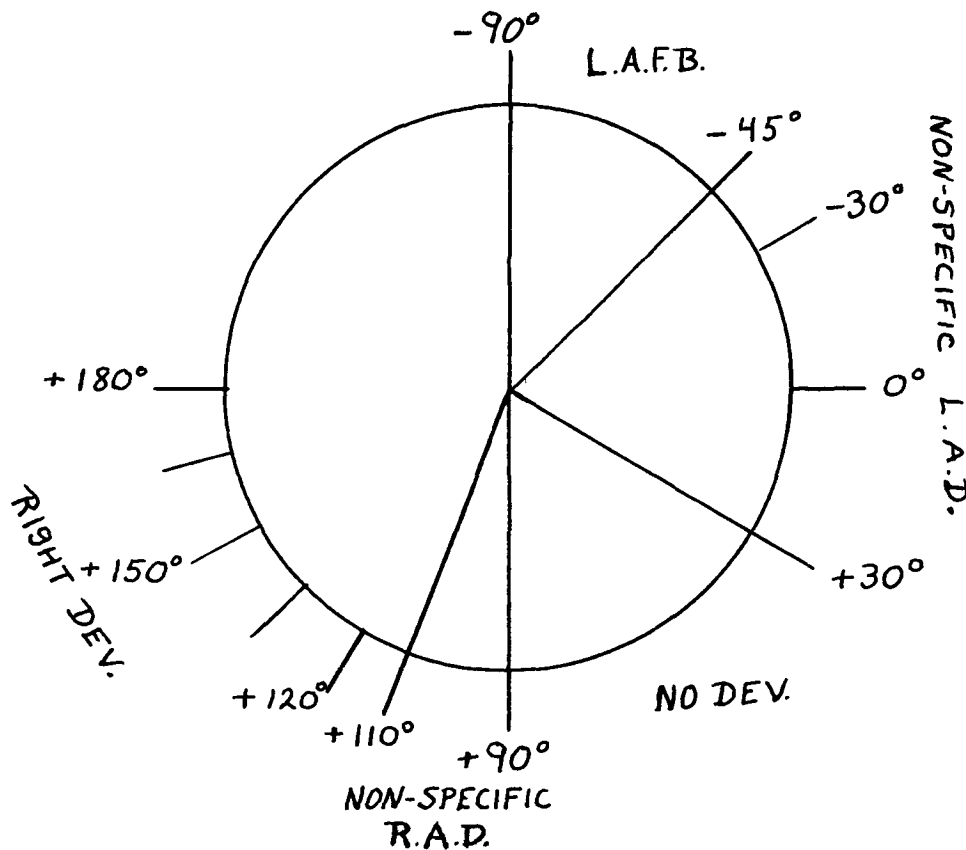


Figure 3

*Table F for Determination of the frontal plane axis on pages 307 - 310 of Nomenclature & Criteria for Diagnosis of Diseases of the Heart by the Criteria Committee of the New York Heart Association, 8th Edition, 1979.

the R wave exceeds the S wave in size. When R.A.D. is marked (M.R.A.D.) the S wave will exceed the R wave in lead II. These axes lie between -179 and -91 in the upper left quadrant of Figure 1.

Superior Axis: Rarely, one sees axis deviation which falls in the region close to, or on either side of, -91 degrees at the top of the circle. Some call this particular area superior axis (S.A.D.) because it is difficult to determine at times whether this orientation has been reached by means of a severe deviation of the axis to the left or to the right. Clinically this superior axis is most frequently seen in combined (left and right) ventricular hypertrophy, particularly in congenital heart disease.

AXIS DEVIATION IN INSURANCE MEDICINE

As clinical information has accumulated it has become quite clear that the electrocardiographic finding of axis deviation of the QRS as an isolated finding deserves further scrutiny. This is especially true in insurance medicine where ratings may depend to some degree upon electrocardiographic interpretation. It is, therefore, no longer enough to state that the ECG shows left or right axis deviation. The actual degrees of these deviations should be measured and then evaluated. Figure 3 demonstrates the different categories of axis shift according to their importance in insurance medicine. In the sectors bounded by -45 and -90 , where there is marked left axis deviation, the abnormality of axis should be identified as due to left anterior fascicular block (L.A.F.B.), an intraventricular conduction defect, and an impairment which is clearly the product of cardiac disease. This is usually a chronic fibrotic pathologic process and not necessarily due to coronary disease. It has a long natural history and should be followed carefully.

When this monofascicular block changes to bifascicular with the appearance of right bundle branch block as well, the outlook is less sanguine. The sectors bounded by +110 to +180 define marked right axis deviation. In these areas a number of cardiac abnormalities are found, - notably left posterior fascicular block and right ventricular hypertrophy, particularly in congenital heart disease.

Outside these abnormal sectors there are areas of non-specific left axis deviation (L.A.D.) and non-specific right axis deviation (R.A.D.). These may be non-cardiac in origin, reflecting only a horizontal or vertical heart. Exact measurement of the axis in degrees is, therefore, most important if ECG interpretations are to be used in a rational fashion. Less accurate appraisal will generate unjust ratings.

It is now a well accepted ECG principle that axis shifts must be accompanied by increased QRS voltage and/or ST-T abnormalities before being explained as due to ventricular enlargement (dilatation or hypertrophy). Indeed ventricular hypertrophy (left or right) can exist without any QRS axis shift. Finally, the ECG as a means of diagnosing hypertrophy can be disappointing as it may not signal increased ventricular mass in as much as 35 - 45 percent of cases.

CONCLUSION

A review of the basis mechanisms producing axis deviation of the QRS reveals the important conclusion that this electrocardiographic abnormality should be accurately measured in degrees and not just estimated, as left or right, in order to offer meaningful information as to risk appraisals in insurance medicine.