The Meaning of Axis Deviation

M. Irene Ferrer, M.D.
Cardiologist, Metropolitan Life Insurance Company
Professor of Clinical Medicine, College of Physicians and Surgeons, Columbia University
Director, Electrocardiographic Laboratory, Columbia-Presbyterian Medical Center, New York, N.Y.

From the earliest days of the clinical interpretation of electrocardiograms the concept of axis deviation has been part of an electrocardiogram evaluation. Simple inspection of the tracing was originally used, — with the term "left axis deviation" applying when R is greater than S in lead I and S is greater than R in III, and "right axis" was diagnosed when S was greater than R in I and R was greater than S in III. Today the use of axis deviation as an electrocardiographic finding has changed considerably and certain types of QRS axis deviation even allow specific anatomic diagnoses (e.g. left anterior fascicular block, left posterior fascicular block). A review of this interesting electrocardiographic finding is, therefore, useful.

The concept of electrical axis is a simple one since, when it is expressed as the mean electrical axis of the QRS, it indicates the average pathway in space taken by the activation through all the ventricular myocardium. The frame of reference within which this pathway is oriented is, of course, Einthoven's triangle. By the method indicated in the attached charts an exact figure in terms of an angle subtended from the horizontal can be ascribed to this electrical axis or to the position of the pathway in space. Ordinarily in the adult the electrical axis lies between +30° and +90° (Fig. 1) with the average position at +60°. This normal segment of the circle in Fig. 1 is called no axis deviation (NAD). At birth the electrical axis is much more to the right, generally occupying a position around +90° to +110° and occasionally even further to the right (Fig. 2). As the child grows and the body shape and heart shape both change, the electrical axis moves leftward until about 6-8 months of age when the normal adult position of the electrical axis is usually established. Left axis deviation (LAD) exists when the electrical axis lies between +29° and −44°. Right axis deviation (RAD) lies between +91° and +119°. Left anterior fascicular block (LAFB) exists when the axis is between −45° and −120° and left posterior fascicular block (LPFB) exists when the axis is +120° to −180° (Fig. 1). The segment between −121° and −179° represents an area of undeterminate axis. This latter term merely indicates it might be a very marked left or a very marked right axis deviation and which one of these two possibilities cannot be determined.

The factors which control the electrical axis are those which relate to the position of the cardiac mass in the bony thorax and not to hypertrophy and/or dilatation of any cardiac chambers. When one bears this fact in mind one can understand that deviations away from the normal to the left (left axis deviation or LAD) or to the right (right axis deviation or RAD) need not necessarily imply any ventricular hypertrophy of the left or right side. Any factors which, for example, place the heart 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 bony thorax will produce deviations of the electrical axis to the right. Noncardiac conditions which illustrate the former (horizontal positions) are obesity, intestinal obstruction with abdominal distention and rise in the diaphragm, and a rising diaphragm due to pregnancy, ascites, or

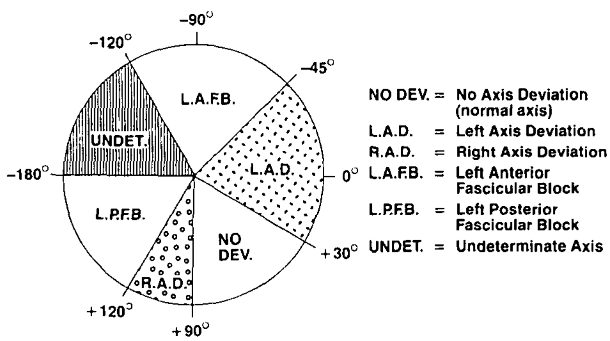

Figure 1. Location of mean electrical axis of the QRS in various conditions.

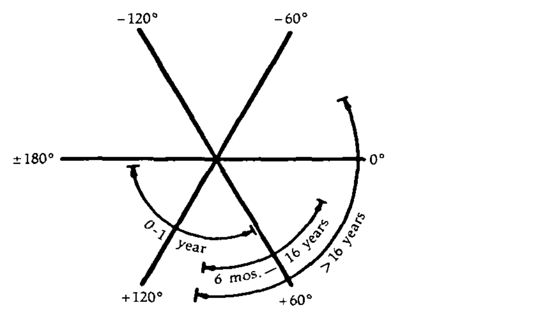

Figure 2. Location of mean electrical axis of the QRS at different ages. Reprinted by permission from Ferrer, M.I. Electrocardiographic Notebook, 4th edition. Futura Publishing Co. 1973.

diaphragmatic paralysis. Examples of the latter (vertical positions) are loss of body weight, the normal tall, thin body habitus, and most important of all, a lowering of the diaphragm in such conditions as emphysema or chest deformities.

Deviations of the electrical axis to the left are, of course, well known to occur when enlargement of the left ventricle also occur. It should, however, be remembered that this is not necessarily due to hypertrophy. Thus, left ventricular dilatation alone can produce left deviation of the electrical axis. When the left ventricle enlarges, either due to hypertrophy or to dilatation, or to both processes, the ventricle tends to rotate and move to the patient's left in the chest, because this is the path of least resistance for this chamber. This tends to make the heart as a whole assume a more horizontal position and, hence, the electrical axis shifts towards the left. When the right ventricle enlarges it rotates into a vertical position as a rule and the net result of this alteration of its location within the bony thorax is a right deviation of the electrical axis. However, there may be enlargements of either of these chambers separately with little rotation and, hence, no deviation of the electrical 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 bony thorax and, therefore, no change in the electrical axis even though cardiomegaly has occurred. Sudden deviation to the left of the electrical axis can be seen in sudden dilatation of the left ventricle, as in left ventricular failure of an acute nature. Similarly, sudden hypertension of the right ventricular chambers, as seen in acute cor pulmonale due to pulmonary embolism may induce a sudden appearance of RAD. These sudden shifts in the electrical axis may subside when the inciting cause has also disappeared.

Precise identification of fascicular disease (LAFB, LPFB) is now accepted on the basis of measurement of the axis deviation and this specification of conduction system disease, — i.e., blockage of one or the other of the two peripheral divisions of the main left bundle — is a real advance in our knowledge of the meaning of axis deviation.

Thus simple LAD and RAD (Fig. 1) should not be considered a real abnormality, as discussed above, but as positional variants. Their greatest value, now that actual numbers (in degrees) can be assigned to them, lies in following any changes in axis with respect to such things as changing level of the diaphragm (as in intestinal obstruction, ascites, emphysema, preganancy), acute changes in heart size (as with acute dilatation of a ventricle). Of course, changes in bodily position (sitting or standing versus lying down) will also shift the axis, — hence the importance of noting on the tracing itself the position of the patient when the electrocardiogram was taken. The standard position of the patient having an electrocardiogram is always lying down. The Tables on the following pages can be used to measure (in precise degrees) the electrical axis. The current and increasing use of computerized analysis of the electrocardiogram offers the advantage of precise measurement (in degrees) of the QRS axis.

TABLES FOR DETERMINATION OF ELECTRICAL AXIS (IN DEGREES).

Instructions for use:

1. Using amplitudes of deflections, calculate algebraic sum of positive and negative waves in lead I. If sum is positive, use Table 1, if negative, use Table 2.

2. Determine algebraic sum of positive and negative waves in lead III.

3. Plot values obtained under appropriate headings. Point of intersection of lead I and lead III columns gives electrical axis in degrees. Electrical axis is expressed as angle alpha and represents the angle (in degrees) subtended from the horizontal by QRS or P vector. Angles above horizontal are defined as negative, those below as positive.

See Tables pages 4 and 5.

Lead III Positive	Lead I Positive 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	20.0
0.0		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
0.5	90	60	49	44	41	39	38	37	36	35	35	34	33	33	33	32	32	32	32	32	32	31
1.0	90	71	60	53	49	46	44	42	41	40	39	38	37	36	35	35	34	34	34	33	33	32
1.5	90	76	67	60	55	52	49	47	45	44	43	41	39	38	38	37	36	36	36	35	35	33
2.0	90	79	71	65	60	56	53	51	49	47	46	44	42	41	40	39	38	38	37	37	36	35
2.5	90	81	74	68	64	60	57	54	52	51	49	47	45	43	42	41	40	39	39	38	38	36
3.0	90	82	76	71	67	63	60	57	55	53	52	49	47	45	44	43	42	41	40	39	39	37
3.5	90	83	78	73	69	66	63	60	58	56	54	51	49	47	46	44	43	42	42	41	40	38
4.0	90	84	79	75	71	68	65	62	60	58	56	53	51	49	47	46	45	44	43	42	42	39
4.5	90	85	80	76	73	69	67	64	62	60	58	55	53	51	49	48	47	45	44	43	43	40
5.0	90	85	81	77	74	71	68	66	64	62	60	57	55	52	51	49	48	47	46	45	44	41
6.0	90	86	82	79	76	73	71	69	67	65	63	60	57	55	53	52	50	49	48	47	46	43
7.0	90	87	83	81	78	75	73	71	69	67	65	63	60	58	56	54	53	51	50	49	48	44
8.0	90	87	84	82	79	77	75	73	71	69	68	65	62	60	58	56	55	53	52	51	50	46
9.0	90	87	85	82	80	78	76	74	73	71	69	67	64	62	60	58	57	55	54	53	52	48
10.0	90	88	85	83	81	79	77	76	74	72	71	68	66	64	62	60	58	57	56	54	53	49
11.0	90	88	86	84	82	80	78	77	75	73	72	70	67	65	63	62	60	59	57	56	55	50
12.0	90	88	86	84	82	81	79	78	76	75	73	71	69	67	65	63	61	60	59	57	56	52
13.0	90	88	86	84	83	81	80	78	77	76	74	72	70	68	66	64	63	61	60	59	58	53
14.0	90	88	87	85	83	82	80	79	78	77	75	73	71	69	67	66	64	63	61	60	59	55
15.0	90	88	87	85	84	82	81	80	78	77	76	74	72	70	68	67	65	64	62	61	60	55
20.0	90	89	88	87	85	84	83	82	81	80	79	77	76	74	72	71	70	68	67	65	65	60

Lead III Negative	Lead I Negative 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	20.0
0.0	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150
0.5	−90	−120	−131	−136	−139	−141	−142	−143	−144	−145	−145	−146	−147	−147	−147	−148	−148	−148	−148	−148	−148	−149
1.0	−90	−109	−120	−127	−131	−134	−136	−138	−139	−140	−141	−142	−143	−144	−145	−145	−146	−146	−146	−147	−147	−148
1.5	−90	−104	−113	−120	−125	−128	−131	−133	−135	−136	−137	−139	−141	−142	−142	−143	−144	−144	−144	−145	−145	−147
2.0	−90	−101	−109	−115	−120	−124	−127	−129	−131	−133	−134	−136	−138	−139	−140	−141	−142	−142	−143	−143	−144	−145
2.5	−90	−99	−106	−112	−116	−120	−123	−126	−128	−129	−131	−133	−135	−137	−138	−139	−140	−141	−141	−142	−142	−144
3.0	−90	−98	−104	−109	−113	−117	−120	−123	−125	−127	−128	−131	−133	−135	−136	−137	−138	−139	−140	−141	−141	−143
3.5	−90	−97	−102	−107	−111	−114	−117	−120	−122	−124	−124	−129	−131	−133	−134	−136	−137	−138	−138	−139	−140	−142
4.0	−90	−96	−101	−105	−109	−112	−115	−118	−120	−122	−124	−127	−129	−131	−133	−134	−135	−136	−137	−138	−138	−141
4.5	−90	−95	−100	−104	−107	−111	−113	−116	−118	−120	−122	−125	−127	−129	−131	−132	−133	−135	−136	−137	−137	−140
5.0	−90	−95	−99	−103	−106	−109	−112	−114	−116	−118	−120	−123	−125	−128	−129	−131	−132	−133	−134	−135	−136	−139
6.0	−90	−94	−98	−101	−104	−107	−109	−111	−113	−115	−117	−120	−123	−125	−127	−128	−130	−131	−132	−133	−134	−137
7.0	−90	−93	−97	−99	−102	−105	−107	−109	−111	−113	−115	−117	−120	−122	−124	−126	−127	−129	−130	−131	−132	−136
8.0	−90	−93	−96	−98	−101	−103	−105	−107	−109	−111	−112	−115	−118	−120	−122	−124	−125	−127	−128	−129	−130	−134
9.0	−90	−93	−95	−98	−100	−102	−104	−106	−107	−109	−111	−113	−116	−118	−120	−122	−123	−125	−126	−127	−128	−132
10.0	−90	−92	−95	−97	−99	−101	−103	−104	−106	−108	−109	−112	−114	−116	−118	−120	−122	−123	−124	−126	−127	−131
11.0	−90	−92	−94	−96	−98	−100	−102	−103	−105	−107	−108	−110	−113	−115	−117	−118	−120	−121	−123	−124	−125	−130
12.0	−90	−92	−94	−96	−98	−99	−101	−102	−104	−105	−107	−109	−111	−113	−115	−117	−119	−120	−121	−123	−124	−128
13.0	−90	−92	−94	−96	−97	−99	−100	−102	−103	−104	−106	−108	−110	−112	−114	−116	−117	−119	−120	−121	−122	−127
14.0	−90	−92	−93	−95	−97	−98	−100	−101	−102	−103	−105	−107	−109	−111	−113	−114	−116	−117	−119	−120	−121	−125
15.0	−90	−92	−93	−95	−96	−98	−99	−100	−102	−103	−104	−106	−108	−110	−112	−113	−115	−116	−118	−119	−120	−125
20.0	−90	−91	−92	−93	−95	−96	−97	−98	−99	−100	−101	−103	−104	−106	−108	−109	−110	−112	−113	−115	−115	−102

Lead III Negative	Lead I Positive 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	20.0
0.0		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
0.5	−90	−30	0	11	16	19	21	22	23	24	25	26	26	27	27	27	28	28	28	28	28	29
1.0	−90	−60	−30	−11	0	7	11	14	16	18	19	21	22	23	24	25	25	26	26	26	27	27
1.5	−90	−71	−49	−30	−16	−7	0	5	7	11	13	16	18	20	21	22	23	23	24	24	25	26
2.0	−90	−76	−60	−44	−30	−19	−11	−5	0	4	7	11	14	16	18	19	20	21	22	22	23	25
2.5	−90	−79	−67	−53	−41	−30	−21	−14	−8	−4	0	6	9	12	14	16	17	19	20	20	21	23
3.0	−90	−81	−71	−60	−49	−39	−30	−22	−16	−11	−7	0	5	8	11	13	15	16	17	18	19	22
3.5	−90	−82	−74	−65	−55	−46	−38	−30	−23	−18	−13	−6	0	4	7	10	12	14	15	16	17	21
4.0	−90	−83	−76	−68	−60	−52	−44	−37	−30	−24	−19	−11	−5	0	4	7	9	11	13	14	15	19
4.5	−90	−84	−78	−71	−64	−56	−49	−42	−36	−30	−25	−16	−9	−4	0	3	6	8	10	12	13	18
5.0	−90	−85	−79	−73	−67	−60	−53	−47	−41	−35	−30	−21	−14	−8	−4	0	3	6	8	9	11	16
6.0	−90	−86	−81	−76	−71	−66	−60	−54	−49	−44	−39	−30	−22	−16	−11	−7	−3	0	3	5	7	13
7.0	−90	−86	−82	−78	−74	−69	−65	−60	−55	−51	−46	−38	−30	−23	−18	−13	−9	−6	−3	0	2	10
8.0	−90	−87	−83	−80	−76	−72	−68	−64	−60	−56	−52	−44	−37	−30	−24	−19	−15	−11	−8	−5	−2	7
9.0	−90	−87	−84	−81	−78	−74	−71	−67	−64	−60	−56	−49	−42	−36	−30	−25	−20	−16	−13	−9	−7	3
10.0	−90	−87	−85	−82	−79	−76	−73	−70	−67	−63	−60	−53	−47	−41	−35	−30	−25	−21	−17	−14	−11	0
11.0	−90	−88	−85	−83	−80	−77	−75	−72	−69	−66	−63	−57	−51	−45	−40	−35	−30	−26	−22	−18	−15	−3
12.0	−90	−88	−86	−83	−81	−79	−76	−74	−71	−68	−66	−60	−54	−49	−44	−39	−34	−30	−26	−22	−19	−7
13.0	−90	−88	−86	−84	−82	−80	−77	−75	−73	−70	−68	−63	−57	−52	−47	−43	−38	−34	−30	−26	−23	−10
14.0	−90	−88	−86	−84	−82	−80	−78	−76	−74	−72	−69	−65	−60	−55	−51	−46	−42	−38	−34	−30	−27	−13
15.0	−90	−88	−87	−85	−83	−81	−79	−77	−75	−73	−71	−67	−62	−58	−53	−49	−45	−41	−37	−33	−30	−16
20.0	−90	−89	−87	−86	−85	−83	−82	−81	−79	−78	−76	−73	−70	−67	−63	−60	−57	−53	−50	−47	−44	−30

Lead III Positive	Lead I Negative 0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5 0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	20.0
0.0		−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150	−150
0.5	90	150	180	−169	−164	−161	−159	−158	−157	−156	−155	−154	−154	−153	−153	−153	−152	−152	−152	−152	−152	−151
1.0	90	120	150	169	180	−173	−169	−166	−164	−162	−161	−159	−158	−157	−156	−155	−155	−154	−154	−154	−153	−153
1.5	90	109	131	150	164	173	180	−175	−172	−169	−167	−164	−162	−160	−159	−158	−157	−157	−156	−156	−155	−154
2.0	90	104	120	136	150	161	169	175	180	−176	−173	−169	−166	−164	−162	−161	−160	−159	−158	−158	−157	−155
2.5	90	101	113	127	139	150	159	166	172	176	180	−174	−171	−168	−166	−164	−163	−161	−160	−160	−159	−157
3.0	90	99	109	120	131	141	150	158	164	169	173	180	−175	−172	−169	−167	−165	−164	−163	−162	−161	−158
3.5	90	98	106	115	125	134	142	150	157	162	167	174	180	−176	−173	−170	−168	−166	−165	−164	−163	−159
4.0	90	97	104	112	120	128	136	143	150	156	161	169	175	180	−176	−173	−171	−169	−167	−166	−165	−161
4.5	90	96	102	109	116	124	131	138	144	150	155	164	171	176	180	−177	−174	−172	−170	−168	−167	−162
5.0	90	95	101	107	113	120	127	133	139	145	150	159	166	172	176	180	−177	−174	−172	−171	−169	−164
6.0	90	94	99	104	109	114	120	126	131	136	141	150	158	164	169	173	177	180	−177	−175	−173	−167
7.0	90	94	98	102	106	111	115	120	125	129	134	142	150	157	162	167	171	174	177	180	−178	−170
8.0	90	93	97	100	104	108	112	116	120	124	128	136	143	150	156	161	165	169	172	175	178	−173
9.0	90	93	96	99	102	106	109	113	116	120	124	131	138	144	150	155	160	164	167	171	173	−177
10.0	90	93	95	98	101	104	107	110	113	117	120	127	133	139	145	150	155	159	163	166	169	180
11.0	90	92	95	97	100	103	105	108	111	114	117	123	129	135	140	145	150	154	158	162	165	177
12.0	90	92	94	97	99	101	104	106	109	112	114	120	126	131	136	141	146	150	154	158	161	173
13.0	90	92	94	96	98	100	103	105	107	110	112	117	123	128	133	137	142	146	150	154	157	170
14.0	90	92	94	96	98	100	102	104	106	108	111	115	120	125	129	134	138	142	146	150	153	167
15.0	90	92	93	95	97	99	101	103	105	107	109	113	118	122	127	131	135	139	143	147	150	164
20.0	90	91	93	94	95	97	98	99	101	102	104	107	110	113	117	120	123	127	130	133	136	150