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Prognostic implications of shift in electrical axis in acute anterior wall myocardial infarction

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Abstract

Introduction: The long term and short term prognosis of a patient presenting with acute myocardial infarction depends on many factors. The established prognostic markers include clinical, biochemical, electrocardiographic, echocardiographic and various types of imaging modalities. The existing prognostic indicators have some limitations. So there is always a search for simpler and more reliable methods for diagnosis and prognostication of acute myocardial infarction.

Clinical markers include age of the patient, previous history of myocardial infarction, hemodynamic complications like congestive heart failure, new mitral regurgitation or hypotension and Left ventricular dysfunction.

Serum markers of cardiac damage like Creatine kinase (CK), CK isoenzymes (CK MB) are important biomarkers of myocardial necrosis. Myoglobin and cardiac troponins are other useful markers for prognostication.

In patients with chest pain compatible with myocardial infarction, echocardiography is a useful diagnostic tool to quantify the area of infarction.

Electrocardiogram (ECG) provides critical information for both diagnosis and prognosis after acute myocardial infarction.

During an episode of acute myocardial infarction, there can be shift in mean QRS electrical axis due to various reasons with or without fascicular blocks. The aim of the study was to find out whether there is any correlation between the shift in mean QRS electrical axis and inhospital outcome in patients with first ST elevation anterior wall myocardial infarction.

Methods: A total of 180 patients with first acute anterior ST elevation myocardial infarction (STEMI) were included in the study. ECG was taken at admission, 90 minutes, 12 hours, 24 hours and 48 hours post thrombolysis. QRS axis was determined by bedside method and graph paper method.

Results: It was found that there is a shift in mean QRS axis from baseline ECG in a large proportion of patients with acute anterior Myocardial infarction. There was an increase in incidence of major arrhythmias in patients with leftward axis shift. There was an insignificant increase in the primary and secondary endpoints in the group with leftward axis shift compared to those with rightward axis shift.

Keywords: Anterior myocardial infarction, ECG, axis shift

Introduction

The long term and short term prognosis of apatient presenting with acute myocardial infarction depends on many factors. The established prognostic matters include clinical, biochemical (serum markers), electrocardiographic and various types of imaging modalities. The existing prognostic indicators have many limitations. So there is always a search for simpler and more reliable methods for diagnosis and prognostication of acute myocardial infarction.

Electrocardiogram

12 lead ECG provides critical information for both diagnosis and prognosis after acute myocardial infarction. [1, 2]. patients with multiple lead showing ST elevation and high sum of ST segment deviation have increased mortality rate especially if the infarction is anterior in location [3]. ±Àimilarly patients whose ECG demonstrates persistent advancsed heart block (eg. Type ll second degree or third degree AV block) or new intraventricular conduction abnormalities (bifascicular or trifascicular block) in the course of STEMI have a worse prognosis than do patients without these abnormalities [4]. Other ECG findings with poor prognosis are Q waves in multiple leads and atrial fibrillation [5].

Axis shift after myocardial infarction

During an episode of acute myocardial infarction there can be shift of mean QRS electrical axis due to various reasons. Bundle branch block is an important cause of axis shift [6]. Before the thrombolytic era nearly upto 8% of patients with acute myocardial infarction presented to hospitals with bundle branch blocks or developed it after admission (Keith *et al.*). these patients have an unfavourable short term and long term prognosis with in hospital mortality rate up to 30%. With the advent of reperfusion therapy, resolution of bundle branch blocks have been reported after Percutaneous coronary interventions and thrombolysis [7].

Left Bundle Branch Block (LBBB)

The incidence of LBBB ranges 4-7% in various studies [8]. In LBBB the QRS electrical axis is usually within normal limits. Sometimes the LBBB is associated with Left Axis Deviation (LAD). Shift of QRS axis to left is usually associated with more extensive disease of the conduction system, which may involve the left Anterior Fascicle and the left main bundle. It is reported that LBBB with LAD has higher mortality rate compared with normal axis 25 – 61% [8, 9]. Right Axis Deviation (RAD) can also occur with LBBB [10].

Right Bundle Branch Block (RBBB)
The incidence of RBBB in acute myocardial infarction is 3.2 – 7% [8, 9]. The QRS axis in RBBB is usually within normal limits. But LAD also can occur associated with RBBB. When RAD or LAD occur, it will be associated with block of one of the divisions of the left bundle.
Patients with RBBB with STEMI is associated with high adverse in hospital morbidity and mortality. Mortality in various studies range from 12% to 61% [9, 11].

Hemi blocks
Fascicular blocks are reported to occur in 2 – 50% of patients with STEMI. Left Anterior Hemi Block (LAHB) is associated with marked shift of QRS axis to left (-45 to -90 degrees) due to delayed activation of antero superior left ventricular myocardium. The ECG will be characterised by initial r waves followed by deep S waves in the inferior leads and qR pattern in aVL, and V5 – V6 with normal QRS duration. Jaques. Coll *et al.* reported the incidence of LAHB in acute myocardial infarction as 4.3% with a mortality of 25% [8].

Left Posterior Hemi Block (LPHB)
Conduction block in left posterior fascicle results in delayed activation of inferoposterior aspect of Left Ventricle (LV). ECG is characterised by Right Axis Deviation (RAD) with rS patterns in leads I, aVL, and qR complexes in the inferior leads with RAD (> +120 degrees). There is no QRS prolongation. incidence of isolated LPHB in Acute Myocardial Infarction (AMI) is less compared with LAHB (<1%). It can occur in association with RBBB (bifascicular block) [8].
During AMI, axis shift can also occur without demonstrable fascicular blocks. When the infarction is massive and involves largeareas of the anterior wall of the LV, there is total loss of the anteriorly oriented electrical forces. The remaining electrical forces will be directed to the left and posterior. When there is loss of R wave height in lead l and aVL, the QRS axis may shift to right. So the shift in QRS electrical axis relates to size and location of infarction. Is there any prognostic significance for the shift in these electrical axes, which cannot be explained by fascicular blocks ? This aspect was not studied previously. So it was decided to study whether there is any correlation between the shift in mean QRS axis and inhospital outcome in patients with first ST elevation anterior wall myocardial infarction.

Aim of the study
To compare the QRS electrical axis determined by bedside method and by using graph paper, in patients with first acute anterior wall myocardial infarction.
To study the shift in electrical axis if any during the initial 48 hours and to correlate the data with in hospital course and outcome.

Materials and Methods
Data of patients admitted in the intensive care unit with first episode of acute ST segment elevation myocardial infarction (STEMI) during an 18 month period.

Inclusion criteria
Patients admitted with diagnosis of acute anterior wall myocardial infarction, who were eligible for thrombolysis (ST elevation of >1mm in atleast 2 contiguous leads representing anterior wall of heart) were included.

Exclusion criteria
1. Age > 75 years
2. Patients with any other heart disease like valvular heart disease, primary myocardial disease, congenital heart disease etc.
3. Previous history of myocardial infarction
4. Patients with bundle branch block
5. Patients with any other systemic illness which may modify the disease outcome.
6. Any contra indication for thrombolysis

Study Design
Baseline clinical data regarding the cardiovascular risk factors and symptomatology, physical examination findings and Killip class were assessed.
Electrocardiograms were taken at admission, 90 minutes, 12 hours, 24 hours and 48 hours post thrombolysis. QRS axis was determined by 2 methods at each time.

1. Bed side method
When any one of the six frontal plane leads has a net QRS magnitude of zero volts the mean QRS axis is taken perpendicular to that lead axis. When net zero voltage is not seen in any of the frontal plane leads, the axis is interpolated from the net QRS voltage of leads I and III.

2. Graph paper method
The net amplitude and direction of the QRS complex in two standard leads (leads I and III) are plotted along the axis of these leads. Perpendicular lines are drawn at these points. A line drawn from the centre of the reference system tothe intersection of the perpendiculars represents the approximate mean QRS axis

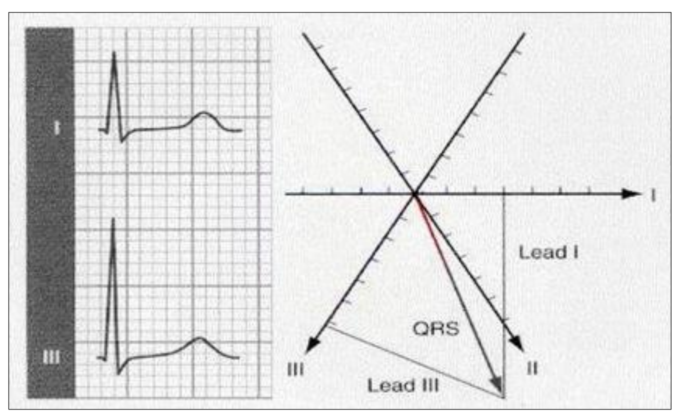

Fig 1: Graph paper method

Shift in electrical axis
The baseline electrical axis is calculated from the 12 lead ECG at the time of admission (pre thrombolysis) by both bedside and graph paper methods.
Any shift in the QRS electrical axis from baseline is calculated at 90 minutes, 12 hours and 48 hours post thrombolysis period

by the above mentioned two methods. Any shift up to 15 degrees is considered as "no shift". Any clockwise axis shift more than 15 degrees (16 to 30 mild shift, >30 marked shift).

Response to thrombolysis

The total ST segment deviation in leads I, aVL, and V1 – V6 are summed up. The difference in the sum of ST at 90 minutes post thrombolysis from baseline ECG is calculated. Any ST segment regression score more than 70% is is considered as good response to thrombolysis, 50% to 70% taken as satisfactory and <50% not satisfactory response.

Infarct size

Infarct size was calculated based on the number of leads (from leads I, aVL, V1 – V6), showing pathological Q waves and / ST segment elevation in any of the ECGs taken within 48 hours. Q waves in > 7 leads is considered as large infarct, 4-6 as medium and ≤ 3 as small infarct.

Results

Patient characteristics

A total of 180 patients with first acute ST elevation anterior wall myocardial infarction were included in the study. Baseline characteristics are shown in table 1.

Table 1: Baseline data of patients with first anterior wall myocardial infarction

	No: 180	**%**
Age (mean) 56 ± 20 yrs		
Females	36	20
DM	36	20
HTN	42	23.3
Smoking	50	27.78
Killip class I	143	79.4
II	18	10
III	3	1.67
IV	16	8.89
Baseline mean QRS electrical axis		
0 to +90	102	56.7
90 to 180	68	37.8
0 to -90	10	5.6
Infarct size		
Small	67	37.2
Medium	93	51.6
Large	20	11.1
Response to thrombolysis		
Good	102	56.7
Satisfactory	47	26.1
Not satisfactory	31	17.2

Axis shift

Axis calculated by graph paper method showed that shift of > 15^0 occurred in 102 cases (56.7%). Of this leftward shift occurred in 48 and rightward shift in 54. The data was almost similar when the axis was calculated by bedside method (table 2)

Table 2: The difference in degrees of axis calculated by bedside and graph paper methods

Shift in QRS axis	**Graph papermethod No:**	**%**	**Bed side method No:**	**%**	**P value**
No shift	78	43.3	83	46	NS
Any shift	102	56.7	97	53.9	NS
Left shift Total	48	26.7	42	23.3	NS
16-30 ^{0}	22	21.5	24	24.7	NS
≥ 31 ^{0}	26	25.5	18	18.5	NS
Right shiftTotal	54	30	55	30.6	NS
16 – 30 ^{0}	27	26.5	25	25.8	NS
≥ 31 ^{0}	27	26.5	30	30.9	NS

Table 3 shows base line data of patients in no axis shift (group 1) and any axis shift (group II).

Table 3: baseline data of patients in group I and group II

	Gr. I n = 78	**%**	**Gr.II n = 102**	**%**	
Age (mean)	54 ± 18		58 ± 21		
Female gender	16	20.5	20	19.6	NS
DM	13	16.6	23	22.5	NS
HTN	20	25.6	22	21.6	NS
Smoking	21	26.9	29	28	NS
Onset of pain to TT	4.30hrs		4.15hrs		NS
Killip class I	62	79.5	81	79.4	NS

II	11	14.1	7	6.9	NS
III	1	1.3	2	1.9	NS
IV	4	5.1	12	11.8	NS
Infarct size					
Small	30	38.5	37	34.3	NS
Medium	43	55.1	50	49	NS
Large	5	6.4	15	14.7	NS

Hospital Outcome

Comparison of hospital outcome of patients with no axis shift (group I) and those with any axis shift (group II) is shown in table 4.

Table 4: Inhospital outcome in the no shift vs any shift groups

	Group I (n=78)	%	Group II (n= 102)	%	P value
Pul. Oedema	13	16.7	20	19.6	NS
Shock	11	14.1	19	18.6	NS
Major arrhythmias	1	1.28	10	9.8	<0.05

There was an insignificant increase in the incidence of pulmonary oedema in the group with any axis shift compared with no axis shift. But there was a significant increase in incidence of major ventriculararrhythmias for patients in the group with any axis shift.

There was no significant difference in the incidence of pulmonary oedema, shock and major arrhythmias when rightward axis shift is compared with no axis shift.

There was statistically significant increase in the incidence of pulmonary oedema (29.2% vs 16.7 % $p < 0.05$), shock (29.2 % vs 14.1 % $p < 0.5$) and major arrhythmias (14.5 % vs 1.88%, $p < 0.01$) when there was shift of axis towards left.

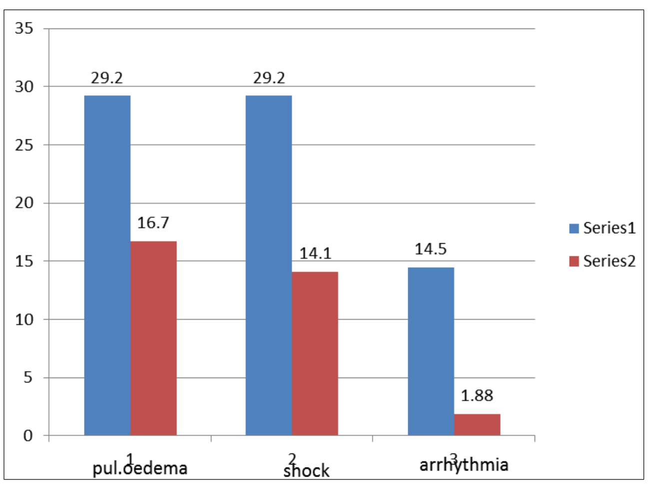

Fig 2: Inhospital outcome - left shift vs no shift

Primary and secondary endpoints

The primary end point was mortality and secondary end point was a composite of death, shock and pulmonary oedema. There was an insignificant increase in the primary and secondary endpoints when the no axis shift group and any axis shift group are compared.

6 patients (7.69 %) in the no shift group and 15 patients (14.7%) in the group of any axis shift died during the hospital stay (p = NS). Composite end point was noticed in 28 (12%) patients in the no axis shift group and 51 (16.7 %) patients in the any axis shift group (p= NS)

There was no significant difference in primary (7.69% vs 5.55%, P=NS) and secondary (12% vs 8.6% p= NS) endpoints while comparing the no axis shift group and right ward axis shift group.

There was a nonsignificant increase in primary (7.69% vs 2.5%, p=NS) and secondary end points (12% vs 27.7% p=NS) when no axis shift group and left ward shift was compared.

Discussion

The present study was designed to study the incidence of axis shift in first anterior wall ST elevation myocardial infarction. It was also aimed to see whether axis shift any had correlation with inhospital outcome. The axis change was calculated with two different methods, a commonly used bedside method and a standard graph paper method. It was found that there was a good correlation in the axis calculated by the two methods.

The baseline characteristics of patients in the no axis shift and any axis shift were similar. The cardiac risk factors like diabetes mellitus, systemic hypertension, and history of smoking were equally prevalent in patients with no axis shift and any axis shift.

The percentage of patients presenting with Killip class I to IV also did not show any significant difference.

There was an insignificant increase in the number of patients presented with larger infarcts, 15 (14.7%) vs 5 (6.4%) compared with no axis shift.

In hospital Outcome

There was a significant increase in the number of patients who developed major arrhythmias 10 (9.8%) vs 1 (1.28%) in the group with any axis shift ($p<0.05$). But there was no difference in the incidence of pulmonary oedema and shock.

While comparing the leftward axis shift with no axis shift, there was significant increase in shock (29.2% vs 14.1% $p < 0.05$) and major arrhythmias (14.8% vs 1.28% $p < 0.01$). But there was increased occurrence of pulmonary oedema in the leftward axis shift group (29.2 % vs 16.7%), which was not statistically significant. There was no significant change when the incidence of these variables were compared between the no axis shift and rightward axis shift groups.

Primary and secondary end points

The primary end point was inhospital mortality and secondary end point was a composite of death, shock and pulmonary oedema. There was an insignificant increase in primary (14.7% vs 7.69% p= NS) and secondary end points (16.7% vs 12% p=NS) in the group with any axis shift compared with no axis shift. while the left ward axis shift showed significant increase in these variables (25% vs 6% p=NS vs 27.7% vs 12% p=NS) compared with no axis shift, the rightward axis shift failed to demonstrate any significant change in primary and secondary end points. (5.6% vs 7.69% p=NS and 8.6% vs 12% p=NS).

Thus in this study, it is observed that there can be right ward and left ward axis shift during an episode of acute ST elevation anterior wall myocardial infarction without obvious budle branch blocks compared to no axis shift group. the group with any axis shift had higher inhospital morbidity and mortality. The inhospital outcome and primary and seconday end points were increased in the group with left ward axis shift compared to those with right ward axis shift.

Summary and conclusion

Basal study design to assess the prognostic significance of axis shift during the initial 48 hours of acute myocardial infarction. Enrolled 180 patients with first ST elevation anterior wall myocardial infarction who have undergone thrombolytic therapy. The change of axis calculated in multiple ECGs taken during the initial 48 hours was correlated with the clinical events during hospital stay and the following conclusions are drawn.

1. There was a statistically significant increase in major arrhythmias, pulmonary oedema and shock in the group with left ward axis shift compared with the group without axis shift.
2. Primary and secondary end points were not different in those with and without axis shift.
3. There was an insignificant increase in the primary (mortality) and secondary (composite of death, shock and pulmonary oedema) end points in the group with leftward axis shift compared to those with right ward axis shift.

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