The Egyptian Journal of Hospital Medicine (July 2022) Vol. 88, Page 3994-3998

Coronary Angiographic Findings in Acute Coronary Syndrome with and without ST-Segment Elevation in Lead aVR Patients

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ABSTRACT

Background: Acute coronary syndrome (ACS) is usually associated with dynamic electrocardiographic (ECG) changes and serial ECGs can present important information, especially if the ECG at first medical contact was not informative.
Objective: To achieve better management of association between ST-segment shifts in lead augmented vector right (aVR).

Patients and methods: This is an observational cross-sectional study multi-center study that was conducted on patients with acute coronary syndrome in Cardiology Departments at Zagazig University Hospitals, Mansoura University Specialized Medical Hospital, and 15 May Hospital to assess the correlation between ST-elevation in lead AVR in patient with acute coronary syndrome and coronary angiographic findings. 120 patients were recruited and were as follows: 52 patients with ACS whose ECG showed ST segment elevation (STE) in lead aVR and 68 patients with ACS but without STE in lead aVR.

Results: left main coronary artery (LMCA), left anterior descending (LAD), left circumflex (LCx), and right coronary artery (RCA) stenosis were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR ($p < 0.001$, 0.006, <0.001, and <0.001 respectively). 2 and 3 vessels affection were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR ($p = 0.002$ and <0.001). STE in aVR was a significant predictor for LMCA stenosis (OR: 14.67 and p value <0.001), 3 vessels disease (OR: 3.97, p value =0.004).

Conclusion: STE in aVR could be used as a significant predictor for LMCA stenosis and 3 vessels disease. In addition, GABG is considered the best management to improve ASC with STE in aVR.

Keywords: Acute coronary syndrome, Augmented Vector Right, Electrocardiogram, ST-segment elevation.

INTRODUCTION

Over 17 million people die from cardiovascular illnesses each year, making them the world's leading cause of mortality. These illnesses include vascular conditions affecting the brain, the heart, and the arteries [(1)]. Moreover half of all cardiovascular disease-related fatalities globally are linked to coronary artery disease [(2)]. Serial electrocardiograms (ECGs) can provide crucial information, especially if the ECG at the time of the initial medical contact was uninformative, as dynamic electrocardiographic (ECG) alterations are often linked with acute coronary syndrome [(3)].

The 12 lead ECG is an essential part of the investigations done for the patients with suspected acute myocardial infarction and should be obtained and evaluated immediately (preferable in 10 min) following the first medical contact[(4)]**.** Unlike the other 11 leads, lead aVR has been long neglected until recent years. However, recent investigations have shown that an analysis of ST-segment shift in lead aVR provides useful information on the coronary angiographic anatomy and risk stratification in Acute Coronary Syndrome (ACS) [(5)].

The aim of the study wa to achieve better management of association between ST-segment shifts in lead augmented vector right (aVR).

PATIENTS AND METHODS

This cross-sectional study was conducted on 120 patients with acute coronary syndrome in Cardiology Departments at Zagazig University Hospitals, Mansoura University Specialized Medical Hospital, and 15 May Hospital.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria:

Accepted to be enrolled in the study. Had ECG done on admission or at acute onset of chest pain. Had cardiac biomarker done on admission or 12 hours from acute onset of chest pain. Indicated for invasive coronary angiographic done.

Exclusion criteria:

Right bundle branch block. Digitalis therapy. Prior history of coronary artery bypass grafting surgery. Pervious coronary angiographic done within 5 years.

Received: 13/4/2022
Accepted: 12/6/2022

Previously diagnosed with pulmonary embolism. Patients' refusal to participate in the study. Known to have right side heart failure. Known congenital heart disease.

All patients were subjected to full history taking, clinical examinations including vital signs (blood pressure, heart rate, respiratory rate, temperature), signs of left ventricle (LV) dysfunction. Laboratory investigations; 4 ml of venous blood were obtained from the patients and subdivided into two parts each was 2 ml. First part was used for blood glucose test and CBC test with detection of neutrophil and lymphocytes and neutrophil to lymphocyte ratio. We put in EDTA tube to prevent coagulation.

Electrocardiogram (ECG) 12 lead ECG was done prior to revascularization or medical therapy where ECGs were manually examined for lead AVR ST-elevation. Bedside Transthoracic echocardiography (TTE) was performed.

Coronary angiography was done via femoral arterial approach using 6F catheter with non-ionic, low-osmolar, iodinated contrast agent. Number of diseased vessels and lesion sites were identified. A luminal diameter narrowing >70% was considered as significant lesion. We analyzed the results of the invasive coronary angiography of the patients, which was done within one week of admission and during their in-hospital stay. Invasive coronary angiography was performed with standard techniques and at least 2 different views were obtained for each main vessel.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Qualitative data were represented as frequencies and relative percentages and were compared by Chi square test (χ^2). Quantitative data were expressed as mean ± SD (Standard deviation), range, median and interquartile range (IQR). Independent samples t-test and Mann-Whitney test were used to compare between two independent groups of normally distributed variables (parametric data) and abnormally distributed variables (nonparametric data) respectively. P value < 0.05 was considered significant.

RESULTS

The age of ACS patients with STE in aVR was significantly higher compared to the age of ACS patients without STE in aVR. There was no significant difference in sex between the two groups.

Regarding risk factors in the studied groups, diabetes was significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR (Table 1).

Table (1): Demographic data of the studied groups

Demographic data	ACS with STE in aVR (n=52)	ACS without STE in aVR (n=68)	Test of significance	P-value
Age / years Mean ± SD Min – Max	61.4 ± 4.44 50 – 70	56.13 ± 7.93 41 – 72	t =4.39	**<0.001***
Sex Male Female	30 (58%) 22 (42%)	45 (66%) 23 (34%)	x^2 =0.905	0.341
isk factors				
Smoking	20 (38.5%)	21 (30.9%)	x^2 =0.753	0.386
Diabetes	41 (78.8%)	29 (42.6%)	x^2 =15.89	**<0.001***
Hypertension	36 (69.2%)	45 (66.2%)	x^2 =0.125	0.723
Dyslipidemia	45 (86.5%)	54 (79.4%)	x^2 =1.04	0.309

ACS: Acute coronary syndrome, STE: ST-segment elevation, aVR: Augmented vector right, t: Student t-test, X^2: chi-square test, *: Statistically significant

Table 2 shows that there was no significant difference in RWMA and EF between the studied groups. Mitral regurgitation and diastolic dysfunction were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR.

Table (2): Echocardiographic results and ejection fraction in the studied groups

Echocardiographic results	ACS with STE in aVR (n=52)	ACS without STE in aVR (n=68)	Test of significance	P-value
RWMA	33 (63%)	31 (46%)	x^2 =3.78	0.06
Mitral regurgitation	25 (48%)	14 (21%)	x^2 =10.15	**0.001***
Diastolic dysfunction	48 (92.31%)	46 (67.65%)	x^2 =10.55	**0.001***
Ejection fraction				
EF Mean ± SD Min – Max	54.87 ± 8.83 38 – 79	56.59 ± 7.31 41 – 73	t =1.167	0.246
EF >55 ≤55	31 (59.61%) 21 (40.38%)	43 (63.24%) 25 (36.76%)	x^2 =0.163	0.686

ACS: Acute coronary syndrome, STE: ST-segment elevation, aVR: Augmented vector right, X^2: chi-square test, RWMA: Regional wall motion abnormalities, *: Statistically significant

Regarding ECG findings in the studied groups, there was no significant difference in sinus rhythm, AFib, and IVCD between the studied groups. STD/TWI were significantly higher in ACS patients with STE in aVR than ACS patients without STE in aVR (Table 3).

Table (3): ECG findings in the studied groups

ECG findings	ACS with STE in aVR (n=52)	ACS without STE in aVR (n=68)	Test of significance	P-value
Sinus rhythm	43 (83%)	58 (85%)	x^2 =0.15	0.699
AFib	2 (4%)	6 (9%)	x^2 =1.17	0.463
IVCD	6 (11.54%)	4 (5.88%)	x^2 =1.23	0.267
STD/ TWI	48 (92.31%)	23 (33.82%)	x^2 =41.7	**<0.001***

ACS: Acute coronary syndrome, STE: ST-segment elevation, aVR: Augmented vector right, X^2: chi-square test, AFib: Atrial fibrillation, IVCD: Interventricular conduction delay, STD: ST-depression, TWI: T-wave inversion, *: Statistically significant

Regarding coronary angiography results in the studied groups, coronary stenosis in LMCA, LAD, LCx, and RCA were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR. Regarding number of affected vessels in the studied groups, single vessels affection was significantly higher in ACS patients without STE in aVR compared to ACS patients with STE in aVR. While 2 and 3 vessels affection were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR. Gensini score was significantly higher in ACS patients with STE in aVR than ACS patients without STE in aVR (Table 4).

Table (4): Coronary stenosis by coronary angiography, number of vessels affected and Gensini score in the studied groups

Coronary stenosis	ACS with STE in aVR (n=52)	ACS without STE in aVR (n=68)	Test of significance	P-value
LMCA	21 (40%)	3 (4%)	x^2 =23.83	**<0.001***
LAD	36 (69%)	30 (44%)	x^2 =7.51	**0.006***
LCx	23 (44.23%)	10 (14.71%)	x^2 =12.88	**<0.001***
RCA	30 (57.69%)	16 (23.53%)	x^2 =14.55	**<0.001***
Number of vessels				
Single vessel	5 (10%)	22 (32%)	x^2 =8.73	**0.003***
2 vessels	15 (29%)	5 (7%)	x^2 =9.8	**0.002***
3 vessels	18 (35%)	5 (12%)	x^2 =14.14	**<0.001***
Ejection fraction				
Gensini Median (IQR) Range	22 (11 – 31) 5 – 64	7 (4 – 19) 1 - 58	U =935	<0.001*

ACS: Acute coronary syndrome, STE: ST-segment elevation, aVR: Augmented vector right, X^2: chi-square test, LMCA: Left main coronary artery, LAD: Left anterior descending, LCx: Left circumflex, RCA: Right coronary artery, IQR: Interquartile range, *: Statistically significant

Regarding suggested management in the studied groups, there was no significant difference in PCI between ACS patients with STE in aVR and ACS patients without STE in aVR. CABG was significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR. Medical treatment was significantly higher in ACS patients without STE in aVR compared to ACS patients with STE in aVR (Table 5).

Table (5): Suggested management in the studied groups

Suggested management	ACS with STE in aVR (n=52)	ACS without STE in aVR (n=68)	Test of significance	P-value
PCI	23 (44%)	35 (51%)	x^2 =0.618	0.432
CABG	22 (42%)	8 (12%)	x^2 =14.66	**<0.001***
Medical management	9 (17.31%)	29 (42.65%)	x^2 =8.74	**0.003***

ACS: Acute coronary syndrome, STE: ST-segment elevation, aVR: Augmented vector right, X^2: chi-square test, PCI: Percutaneous Coronary Intervention, CABG: Coronary artery bypass graft, *: Statistically significant

In univariate logistic regression, STE in aVR was a significant predictor for LMCA stenosis and 3 vessels disease. Then cases were classified into MI cases (according to the elevation of troponin and cardiac enzymes) with or without STE in aVR (Table 6).

Table (6): Logistic regression analysis of ST elevation for prediction of LMCA stenosis and 3 vessels disease

	LMCA stenosis		3 vessels disease	
	OR (95% CI)	P value	OR (95% CI)	P value
STE in aVR	14.67 (4.06 – 52.95)	**<0.001***	3.97 (1.56 – 10.09)	**0.004***

STE: ST-segment elevation, aVR: Augmented vector right, LMCA: Left main coronary artery, OR: Odds ratio, *: Statistically significant

DISCUSSION

The age of ACS patients with STE in aVR was significantly higher compared to the age of ACS patients without STE in aVR. There was no significant difference in sex between the two groups. Regarding risk factors in the studied groups, there was no significant difference in smoking, hypertension, and dyslipidaemia between the studied groups. Diabetes was significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR.

These results showed that there was a statistically insignificant difference between the ACS with STE in aVR and ACS without STE in aVR groups regarding the RWMA echocardiographic results. While mitral

regurgitation (MR) and diastolic dysfunction were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR.

These results are in accordance with **Nabati *et al.*** [6] who explained that the STE in lead aVR was strongly associated with higher incidence of MR compared to ASC patients without STE in lead aVR (P= 0.021). Furthermore, MR predicts poor long-term outcomes among patients with MI.

Regarding diastolic dysfunction our results are contrasted to **Nabati *et al.*** [6] who measured the echocardiographic data and revealed that the diastolic dysfunction was insignificantly different between ACS patients with STE in aVR compared to ACS patients without STE in aVR. The study design and different population could explain this contradiction.

In the present study, STD/TWI were significantly higher in ACS patients with STE in aVR than ACS patients without STE in aVR. Also, the coronary angiography presented that coronary stenosis in LMCA, LAD, LCx, and RCA were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR.

Furthermore, **Nabati *et al.*** [6] highlighted that lead aVR can be very valuable in ischemic heart disease in determining the site of the coronary artery occlusion and the size of the ischemic area. Furthermore, acute right ventricular overload is usually manifested in the electrocardiogram as STE in lead aVR.

Moreover, our study examined the number of affected vessels in the studied groups and found that single vessels affection was significantly higher in ACS patients without STE in aVR compared to ACS patients with STE in aVR. While 2 and 3 vessels affection were significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR. In agreement with work of **Nabati *et al.*** [6] who concluded that patients with STE in lead aVR were more likely to have three-vessel or multi-vessel disease (P=0.01).

In the current study, the Gensini score was evaluated and showed a significant increase in ACS patients with STE in aVR compared to the ACS patients without STE in aVR. This was confirmed by **Nabati *et al.*** [6] who concluded that patients with STE in lead aVR were more likely to have higher Gensini score of the coronary arteries (P=0.004).

This study observed that ejection fraction (EF%) showed insignificant difference between ACS patients with STE in aVR and the ACS patients without STE in aVR. In contrary, **Mousavi *et al.*** [7] found that aVR-STE has been associated with lower ejection fraction compared to patient without STE in aVR group (p=0.015). The different sample size may account for the conflicted results.

Regarding suggested management in the current studied groups, there was no significant difference in percutaneous coronary intervention (PCI) between ACS patients with STE in aVR and ACS patients without STE in aVR. In accordance with our results, **Yan *et al.*** [8] recruited their study to assess the relationship of ST elevation in lead aVR with angiographic findings and outcome in non–ST elevation acute coronary syndromes. The results demonstrated that there was no statistically significant difference regarding the management of ACS patients with STE in aVR and ACS patients without STE in aVR via PCI.

The coronary artery bypass graft (CABG) was significantly higher in ACS patients with STE in aVR compared to ACS patients without STE in aVR.

Medical treatment was significantly higher in ACS patients without STE in aVR compared to ACS patients with STE in aVR. Contrasted to our results, **Yan *et al.*** [8] found that there was no statistically significant difference regarding the management of ACS patients with and without STE in aVR by CABG. This may be accounted by the discrepant study design and sample size.

In our study, the univariate logistic regression was conducted and explained that STE in aVR was a significant predictor for left main coronary artery (LMCA) stenosis (OR: 14.67), and 3 vessels disease (OR: 3.97). In consistent with our findings, **Ducas *et al.*** [9] conducted their study to evaluate the relationship between the presence of ST-elevation in lead aVR and prediction of significant LMCA stenosis. The univariate analysis results explained that the presence of aVR-STE proved to be significant predictor of LMCS (p = 0.008; Odds Ratio = 3.112; 95% Confidence Interval 1.344–7.205). Similar to our findings, **Rostoff *et al.*** [10] recruited their study to assess the value of lead aVR for the detection of LMCAS in patients with ACS and reported that aVR-STE is a significant predictor for LMCS in acute coronary syndrome patients.

Limitations: Relatively small sample size. Post-procedure ECG and 30 days ECG for the resolution of aVR ST elevations and its correlation with outcome was not evaluated.

CONCLUSION

Acute coronary disease with STE in aVR is associated to worse clinical condition at presentation. Moreover, STE in aVR could be used as a significant predictor for left main coronary artery (LMCA) stenosis and 3 vessels disease.

Conflict of interest: The authors declare no conflict of interest.

Sources of funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution: Authors contributed equally in the study.

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