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SIGNIFICANCE OF ST-SEGMENT DEVIATION IN STANDARD ECG FOR PREDICTION OF CULPRIT ARTERY IN ACUTE INFERIOR WALL ST-ELEVATION MYOCARDIAL INFARCTION

By

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ABSTRACT

Background: Inferior wall Myocardial Infarction (IWMI) is usually caused by the occlusion of right coronary artery (RCA)or the left circumflex coronary artery (LCX). ECG is widely available method that is routinely applied and used to predict culprit artery in inferior STEMI.

Objective: To evaluate clinical significance of ST segment deviation in standard ECG during inferior wall STEMI for prediction of infarct related artery (IRA).

Patients and methods: Fifty patients with acute inferior myocardial infarction who were diagnosed based on the presence of history of chest pain of<12 hours with ST segment elevation>1mm in at least 2 or 3 inferior leads & ST segment deviation of other leads with increase in cardiac enzymes All patients were subjected to echocardiography and coronary angiography as the culprit artery was determined from angiographic characteristic of occlusion.

Results: In our study, fifty patients with acute inferior myocardial infarction were included. The studyinclude37(74%) males and 13(26%) females with age ranged from 37 to 85 years old with mean age as (55±17) years. According to coronary angiography, RCA was responsible for 34 (68%) patients and LCX was responsible for 16 (32%) patients. Criteria of ECG are useful in prediction of LCX artery inpatients with inferior STEMI were:(I) ST segment elevation inlead III < lead II. (II) ST segment depression in lead avR. (III)ST segment depression in V2, V3. (IV)ST segment elevation in V5, V6. The most useful criteria of ECG for RCA occlusion were ST segment elevation (lead III>II).

Conclusion: The conventional ECG criteria based on ST segment deviations in different leads allowed us to predict the location of occlusion with good accuracy.

Key words: Inferior STEMI, ST segment, Coronary arteries.

INTRODUCTION

The 12-lead electrocardiogram (ECG) remains the most immediately accessible and widely used initial diagnostic tool for guiding management in patients with suspected myocardial infarction (MI) *(Miranda et al., 2018)*.

The use of ECG in predicting the location of the culprit coronary lesion within the infarct related artery (IRA) could provide additional valuable information to augment clinical decision making and expedite reperfusion therapy *(Mahmoud et al., 2015)*.

ST segment elevation in leads II, III, and arterio-venous fistula (aVF) is key to diagnosing an evolving AMI that affects the infero-posterior wall of the heart, some characteristic ST segment changes in these leads, reciprocal leads (I, AVL, and V1–V3), and the right precordial leads (V3R–V5R) may provide information that identifies the culprit artery (RCA or LCX) *(Kamal et al., 2018)*.

Several ECG criteria based on ST-segment deviation in limb leads have been proposed for prediction of RCA as CCA in IWMI *(Liang et al., 2018)*.

AIM OF THE WORK

The purpose of this study is evaluation of clinical significance of ST segment deviation in standard ECG as indicators during inferior wall STEMI for prediction of infarct related artery (IRA) and better guidance of therapy for reperfusion.

PATIENTS AND METHODS

This study include 50 patients with acute inferior myocardial infarction,admitted to cardiology department Al-Azhar university hospital in Assuit and CCU in EL Noor center for cardiology& catheterization, who were diagnosed based on the presence of history of chest pain of<12 hours with ST segment elevation>1mm in at least 2 or 3inferior leads& with increase in cardiac enzymes.

Inclusion criteria:

- Patients with inferior STMI with ST deviation in standard ECG.
- Both males & females included.

Exclusion criteria:

- History of previous myocardial infarction.
- Right or left bundle branch block.
- Pericarditis.
- Patients not candidate for thrombolytic therapy.

Ethical Aspects:

Consent was obtained from every patient after explanation of the procedure. Medical research and ethics committee approved the study.

Data collection:

The data collection includes:

- Full history taking from all patients include: Name, Age, Sex, Occupation, Family history, Smoking, Addiction, Hypertension, Diabetes mellitus, Dyslipidemia and Sedentary life style.
- Full examination include pulse, blood pressure, head &neck examination, upper and lower limb examination, chest &heart examination.
- 12 Lead electrocardiography (ECG): Were recorded at speed of 25mm/s and voltage of 10mm/mv.

The following findings were identified:

- ST-segment elevation in inferior leads.
- ST-segment deviation in all other leads.

Transthoracic Echocardiography:

Left ventricular ejection fraction was estimated and detect site of segmental wall motion abnormality.

Coronary angiography:

All patients were subjected to coronary angiography. The culprit artery was determined from angiographic characteristic of occlusion (occlusion due to thrombus formation or ulceration with decrease contrast density). Coronary artery stenosis of more than 70% was defined as obstructive and multi-vessel coronary artery disease was defined as having 2 or more coronary arteries with obstructive lesion.

Statistical analysis:

Data was analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2 College Station, TX: Stata Corp LP.). Quantitative data was represented as mean, standard deviation, median and range.

The following tests were done: Data was analyzed using student t-test to compare means of two groups. When the data was not normally distributed Mann-Whitney test was used.Qualitative data was presented as number and percentage and compared using either Chi square test or fisher exact test. Graphs were produced by using Excel or STATA program. Probability (p-value): p-value less than 0.05(<0.05) was considered significant, and p-value >0.05 was considered insignificant.

RESULTS

In our study, the mean age of the patients was55.72±10.17,37patients (74%) were males and 13 (26%) were females **(table 1)**, 23 patients (46%) were hypertensive, 19 patients (38%) were diabetic, 36 (72%) were current smokers,28 (56 %) patients were dyslipidemic **(table 2)**.

Table (1): Demographic data of the study population

Socio-demographic characteristics	**Study sample (No=50)**	
	No	**%**
Gender		
Male	37	74
Female	13	26
Age (Years)		
Mean± SD	55.72± 10.17	

Table (2): Distribution of study populations as regards Clinical risk factors

Clinical data	Study sample (No=50)			
	Positive		Negative	
	No	%	No	%
Smoking	36	72	14	28
HTN	23	46	27	54
DM	19	38	31	62
Dyslipidemia	28	56	22	44

According to ECG finding: Leads I,avL were isoelectric in one patient(6.25%), 2 patients (5.88%) and depressed in 15(93.75%), 32(94.12%) patients in LCX and RCA respectively P value (1.00). E III>II present in 7 patients (43.75%) in LCX and 34(100%) in RCA P value (<0.0001). Lead avR were isoelectric in 2 patients (12.50%), 17(50%), depressed in 13(81.25%), 17(50%) and elevated in 1(6.25%), and zero in LCX and RCA respectively P value (0.02). Lead V1 were isoelectric in 3(18.75%) patients, 20(58.82%), depressed in 10(62.50%), 12(35.29%) and elevated in 3(18.75%) patients, 2(5.88%) in LCX and RCA respectively P value (0.02). Lead V2 were isoelectric in zero, 10(29.41%) patients, depressed in 15(93.75%), 23(67.65%) patients and elevated in 1(6.25%), 1(2.94%) patient in LCX&RCA respectively P value (0.05). Lead V3 were isoelectric in 0,12(35.29%) patients, depressed in 12(75%), 21(61.67%) patients and elevated in 4(25%), 1(2.94%) patient in LCX &RCA respectively P value (0.004). Lead V4 were isoelectric in 0,14(41.18%) patients, depressed in 11(68.75%), 19(55.88%) patients and elevated in 5(31.25%), 1(2.94%) patient in LCX&RCA respectively P value (0.001). Lead V5 were isoelectric in 1(6.25%), 19(55.88%) patients, depressed in 7(43.75%), 13(38.24%) patients and elevated in 8(50%), 2(5.88%) patients in LCX &RCA respectively P value (<0.0001). Lead V6 were isoelectric in 2(12.50%), 20(58.82%) patients, depressed in 1(6.25%), 11(32.35%) patients and elevated in 13(81.25%), 3(8.28%) patients in LCX &RCA respectively P value (<0.0001).

Table (3): Relation between ECG finding and Culprit artery

Variable	LCX N=16	RCA N=34	P value
I, avl			
Isoelectric	1 (6.25%)	2 (5.88%)	1.00
Depression	15 (93.75%)	32 (94.12%)	
E III>II			
No	9 (56.25%)	0	<0.0001
Yes	7 (43.75%)	34 (100%)	
avR			
Isoelectric	2 (12.50%)	17 (50.00%)	0.02
Depression	13 (81.25%)	17 (50.00%)	
Elevation	1 (6.25%)	0	
V1			
Isoelectric	3 (18.75%)	20 (58.82%)	0.02
Depression	10 (62.50%)	12 (35.29%)	
Elevation	3 (18.75%)	2 (5.88%)	
V2			
Isoelectric	0	10 (29.41%)	0.05
Depression	15 (93.75%)	23 (67.65%)	
Elevation	1 (6.25%)	1 (2.94%)	
V3			
Isoelectric	0	12 (35.29%)	0.004
Depression	12 (75.00%)	21 (61.76%)	
Elevation	4 (25.00%)	1 (2.94%)	
V4			
Isoelectric	0	14 (41.18%)	0.001
Depression	11 (68.75%)	19 (55.88%)	
Elevation	5 (31.25%)	1 (2.94%)	
V5			
Isoelectric	1 (6.25%)	19 (55.88%)	<0.0001
Depression	7 (43.75%)	13 (38.24%)	
Elevation	8 (50.00%)	2 (5.88%)	
V6			
Isoelectric	2 (12.50%)	20 (58.82%)	<0.0001
Depression	1 (6.25%)	11 (32.35%)	
Elevation	13 (81.25%)	3 (8.82%)	

According to cardiac enzymes: Mean of CKMB (77.79± 56.94) and (63.99±50.97) in LCX &RCA respectively with P value 0.29. Mean of Troponin (27.01±30.57) and (15.60±12.56) in LCX & RCA respectively with P value 0.08. There is no significant difference in cardiac enzymes between RCA &LCX as (P>0.05).

Table (4): Relation between culprit artery and cardiac enzymes

Variable	LCX N=16	RCA N=34	P value
CKMB Mean ± SD Median (range)	77.79±56.94 66 (20.77:258.6)	63.99±50.97 45.35 (3.9:234)	0.29
Troponin Mean ± SD Median (range)	27.01±30.57 19.90 (5.68:132.5)	15.60±12.56 10.45 (1.86:51)	0.08

According to Echocardiographic findings: Mean of EF percentage were (58.19±4.32) and (57.65±6.37) in LCX &RCA respectively with P value 0.76. SWMA present in 15(93.75%) patients and 30(88.24%) patients in LCX &RCA respectively with p value 1.00. There is no significant difference in Echo finding between RCA & LCX as (P>0.05).

Table (5): Relation between culprit artery and Echo finding

Variable	LCX N=16	RCA N=34	P value
EF% Mean ± SD Median (range)	58.19±4.32 58 (52:68)	57.65±6.37 58 (45:75)	0.76
SWMA No Yes	1 (6.25%) 15 (93.75%)	4 (11.76%) 30 (88.24%)	1.00

According to Lipid profile findings: Mean of total cholesterol were (211.24±84.26) and (224.44±90.68) in LCX&RCA respectively with P value 0.61. Mean of triglyceride were (211.68±114.28) and (233.56±109.47) in LCX &RCA respectively with P value 0.30. Mean of LDL were (122.21±43.74) and (118.38±38.99) in LCX &RCA respectively with P value 0.59.Mean of HDL were (38.79±7.49) and (39.11±7.51) with P value 0.89.MEAN of VLDL were (59.62±35.86) and (59.00±36.38) with P value 0.90. There is no significant difference in lipid profile finding between RCA & LCX as(P>0.05).

Table (6): Relation between culprit artery &lipid profile finding

Variable	RCA N=34	LCX N=16	P value
Total cholesterol			
Mean ± SD	211.24±84.26	224.44±90.68	0.61
Median (range)	202.5 (90:378)	207.5 (105:390)	
Triglyceride			
Mean ± SD	211.68±114.28	233.56±109.47	0.30
Median (range)	174 (68:500)	245 (105:432)	
LDL			
Mean ± SD	122.21±43.74	118.38±38.99	0.59
Median (range)	112 (50:231)	107.55 (66:190)	
HDL			
Mean ± SD	38.79±7.49	39.11±7.51	0.89
Median (range)	38 (28:55.9)	38 (30:55.9)	
VLDL			
Mean ± SD	59.62±35.86	59.00±36.38	0.90
Median (range)	45.5 (16:139)	42.5 (23:140)	

According to Coronary Angiography: In our study LM affected in only one patient (2%), LAD affected in 29(58%) patients, LCX affected in 28(56%) patients, RCA affected 39(78%) patients. Culprit artery was LCX in 16(32%) patients & RCA in 34(68%) patients.

Table (7): Coronary angiography finding of studied population

Variable	Summary statistics
LM affected	
No	49 (98.00%)
Yes	1 (2.00%)
LAD affected	
No	21 (42.00%)
Yes	29 (58.00%)
LCx affected	
No	22 (44.00%)
Yes	28 (56.00%)
RCA	
No	11 (22.00%)
Yes	39 (78.00%)
Culprit artery	
LCX	16 (32.00%)
RCA	34 (68.00%)

DISCUSSION

The importance of Electrocardiographic (ECG) changes and their relationship with the infarct-related artery (IRA) was recognized in the 1980s *(Almansori et al., 2010).*

Several ECG criteria have been proposed to identify the RCA as the culprit artery in inferior wall STE myocardial infarction *(Liang et al., 2018)*.

In our study, we aimed to evaluate the role of ST segment in standard ECG for prediction of Infarct related artery (IRA) in Inferior wall MI(IWMI).

12 lead electrocardiography (ECG) were recorded at speed of 25mm/s and voltage of 10 mm/mv and identified ST-segment elevation in inferior leads &ST-segment deviation in all other leads in all patients in the study.

Our study results confirm that ECG criteria have high predictive value for LCX occlusion: ST segment elevation in lead III < lead II, ST segment depression (STD) in lead avR, ST segment depression in V1-V4 and ST segment elevation in V5, V6. The best predictive value used as diagnostic indicators for RCA occlusion: ST segment elevation(STE)III>II. Similar to our study, Chao et al. (2010) study shows that when ST segment elevation lead III < lead II, lead avL ST segment elevation, and lead avR ST segment depression exist in the inferior wall myocardial infarction, the possibility of LCX occlusion increase.

Kanei et al. (2010), which suggested ST depression inavR had some predictive value for LCX occlusion.

Almansori et al. (2010) showed that the best criteria to identify RCA as the culprit artery in IWMI were ST elevation in lead III greater than in lead II, and ST depression in lead I.

Noriega et al. (2014) research showed that the predictive sensitivity and specificity of ST elevation inV6 for LCX occlusion were 71.0% and 83%, respectively.

Vives-Borrás et al. (2019), As compared with RCA occlusion, patients with LCCA occlusion presented with: (1) Lesser ST-segment elevation in leads III and aVF, (2) a noticeable ST-segment elevation in leads V5 to V6, and (3) less marked reciprocal ST-segment depression in leads I and avL, but more pronounced reciprocal changes in leads avR, V1, and V3.The best single criteria for RCA were ST-segment depression of ≥0.1 mV in leads I and aVL, and ST-segment depression of ≥0.05 mV in lead I.

LIMITATIONS

There are some limitations in our study that should be considered:

First, the number of patients was relatively small to draw final conclusions.

Second, near 75% in our population were males; therefore, our results may not be applied to general population.

Third, the study is a single center study included patients admitted in a limited period of time.

CONCLUSION

The conventional ECG criteria based on ST segment deviations in different leads allowed us to predict the location of occlusion of artery with good accuracy.

RECOMMENDATION

1. We recommend the use of Standard ECG as a simple, an in-expensive, non-invasive, and readily available clinical tool, has a role as a predictor of culprit artery and its location especially in patients with inferior STEMI.
2. Further studies on a larger number of populations is needed to be done to

give a more accurate and conclusive results to explore the specificity and sensitivity of Standard ECG for prediction of culprit artery in inferior STEMI.

3. A multi-center study is recommended to detect more accurate data that could be applied to general population.

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دلالة إنحراف قطعة اس تى فى مخطط القلب الكهربائى القياسي فى التنبؤ بالشريان المسبب للاحتشاء الحاد للجدار السفلى لعضلة القلب

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خلفية البحث: احتشاء الجدار السفلى للقلب يمكن ان يكون نتيجة انسداد إما الشريان التاجى الايمن او الشريان الايسر المقوس. رسم القلب الكهربائى المعيارى هو التكنولوجيا المتاحة التى يتم تطبيقها بشكل روتينى ويستخدم للتنبؤ بموقع الشريان التاجى المتسبب فى الاحتشاء.

الهدف من البحث: تقييم الاهمية السريرية (الاكلينيكية) لانحراف قطعة اس تى فى رسم القلب المعيارى خلال احتشاء الجدار السفلى للقلب للتنبؤ بالشريان المسبب له.

المرضى وطرق البحث: أجريت هذه الدراسة بقسم القلب بمركزالنور لامراض القلب والقسطرة بسوهاج على خمسين مريض من مرضى احتشاء حاد فى الجدار السفلى للقلب وتم تشخيص حالتهم بناءً على وجود الم بالصدر خلال اقل من 12 ساعة ووجود ارتفاع فى قطعة اس تى اكثر من او يساوى 1 واحد ملليمتر فى على الاقل 2 او 3 من وصلات التسجيل السفلية ووجود انحراف فى قطعة اس تى فى الوصلات الاخرى مع زيادة فى انزيمات القلب وتم عمل اشعة موجات فوق صوتية على القلب (ايكو) وقسطرة على الشرايين التاجية لجميع المرضى.

نتائج البحث: تحتوى دراستنا على خمسين مريض يعانون من احتشاء حاد في الجدار السفلى للقلب منهم 37 ذكور بنسبة 74% و13 اناث بنسبة 26% وتتراوح اعمارهم بين 37 الى 85 سنة بمتوسط 55±17 سنة. وفقا لنتائج القسطرة فأن الشريان التاجى الايمن مسئول عن 34 مريض بنسبة 68% والشريان الايسر المعوج مسئول عن 16 مريض بنسبة 32%.مع وجود معايير مخطط القلب الكهربائى والتى تفيد بامكانية التنبؤ بانسداد الشريان الايسر المعوج والايمن.

الاســـتنتاج: المعـــايير التقليديـــة لمخطـــط القلـــب الكهربـــائى والتـــى تعتمـــد علـــى انحـــراف قطعـــة اس تـــى فـــى الوصـــلات المختلفـــة قـــد ســـمحت لنـــا بـــالتنبؤ بدقـــة عاليـــة بموقـــع انســـداد الشريان.