Changes in Electrocardiogram Following Percutaneous Coronary Intervention and its Prognostic Implications

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ABSTRACT

Background: The elevation of troponin-T (Trop-t) and creatinine kinase myocardial isoform (Ckmb) and elevation of these markers lead to major adverse cardiac events (MACEs). The association between above-mentioned parameters along with electrocardiogram (ECG) changes can be suitable diagnostic tool for myocardial injury following percutaneous coronary intervention (PCI). The present study was attempted to know the association of the changes in surface ECG and cardiac biomarkers and MACEs following PCI with the outcome in follow up among patients in eastern India. Methods: In present study, 100 patients were randomly selected for coronary angioplasty between April 2012 to March 2013. All the cases were referred to catheterization laboratory for elective PCI for single vessel or multivessel in native coronary artery. The biomarkers such as Trop-t and Ckmb and MACEs along with changes in ECG were estimated as per standard protocol. Results: ECG changes were statistically significantly correlated with post procedure Trop-t elevation (p<0.001), Ckmb elevation (p<0.001) and MACEs (P<0.01 and p<0.001) in 6 months followed up. Conclusion: In conclusion, the present study showed significant relationship between MACEs during PCI period and the possible need for rescue percutaneous coronary intervention (PCI). How to cite this article: Acharyya M, Mondal I, Mukhopadhyay D. Changes in Electrocardiogram Following Percutaneous Coronary Intervention and its Prognostic Implications. Int Arch BioMed Clin Res. 2018;4(4):26-29.

INTRODUCTION

The interpretation of electrocardiogram (ECG) ST-segment abnormalities is suitable for the assessment and decision making on patients with acute myocardial infarction (MI). Beyond determining infarct location and candidacy for acute reperfusion therapy, the extent of ST-segment elevation or deviation (sum of elevation and depression) provides necessary prognostic information.[1] The deviation of ST-segment can easily be recovered in each case to prevent lower short- and long-term risk of death, recurrent ischemia, reinfarction, and congestive heart failure.[2] According to Van de Werf et al.,[3] Antman et al.[4] and Buller et al.[5] above-mentioned relationship may be robust and constitutes the basis for guideline recommendations promoting reassessment of ST-segments 90 minutes after initiation of therapy and the possible need for rescue percutaneous coronary intervention (PCI). It is interesting to note that PCI may lead to myocardial damage due to distal vessel thrombosis, embolization of plaque debris, platelet aggregates and side branch occlusion.[6–7] In this context, the research works on changes in surface ECG following PCI are lacking, which may be potential to serve as a diagnostic tool for early identification.
of periprocedural myocardial damage while alteration of cardiac biomarkers such as cardiac troponin-T (Trop-t) and creatinine kinase myocardial isoform (Ckmb) following PCI has already been studied by Acharyya et al. and well-known diagnostic tool. Moreover, unipolar intracoronary ECG recording from angioplasty catheter guide wire has been shown to be more sensitive and reliable in detecting regional myocardial ischemia during balloon inflation than standard surface ECG. But intracoronary unipolar ECG facility is not available in most of the catheterization laboratory. The present study was attempted to prove the association of the changes in surface ECG and cardiac biomarkers and MACEs following PCI with the outcome followed up among patients in eastern India.

**METHODS**

**Study design**

The present study was a prospective observational study. All patients were subjected to taken detailed history followed by general and systemic examination. This study was done between April 2012 to March 2013 and 100 (60 males and 40 females) randomly selected subjects referred to our catheterization laboratory for elective PCI for single vessel or multivessel PCI in native coronary artery were considered for this study. The study was conducted at Department of Cardiology, Institute of Cardio Vascular Sciences (ICVS), Institute of Post Graduate Medical Education and Research (IPGME&R) and Seth Sukhlal Karnani Memorial (SSKM) Hospital, Kolkata. The studied subjects were admitted in Department of Cardiology and all of them were followed up in Cardiology OPD. The sample was designed accordingly with following inclusions and exclusions criteria.

**Inclusion Criteria**

Following inclusion criteria were considered:

1. Elective PCI for single or multiple lesion in one, two or three major native coronary arteries.
2. Men or women more than equal to 18 years of age.
3. Normal Ckmb and cardiac trop-t values before the procedure.
4. Patients in stable condition without any anginal chest pain in preceding 48 hours.
5. PCI procedure was successful optimal final results were obtained i.e. TIMI 3 flow achieved with residual stenosis ≤20%.
6. Absence of major (> 1.5mm) side branch occlusion or evident distal embolization.

**Exclusion Criteria**

Following exclusion criteria were considered:

1. Unstable patients.
2. Patients with ventricular conduction disturbance on standard ECG.
3. Patients who had procedural complications.

**Study of biomarkers in blood**

The blood sample was collected from each subject and kept in an EDTA vial for biomarkers estimation. The estimation protocol for cardiac troponin-T (Trop-t) was followed by the methods of Tate11] and Giannitsis et al.12] The method for creatinine kinase myocardial isoform (Ckmb) estimation in serum has been modified from IFCC method.13-14] The estimation methods for both biomarkers have already been described in earlier study.10]

**Study of biomarkers and major adverse cardiac events (MACE) in patients with other incidences**

Major adverse cardiac events (MACEs) were categorized as per previous study by Acharyya et al. (2018) in which the categorizations such as no events (MACE-1), deaths (MACE-2), non-fatal acute myocardial infarction (MACE-3), repeat PCI either related to target lesion or a new lesion (MACE-4) and coronary artery bypass grafting (MACE-5) were done. Among 100 patients who underwent coronary angioplasty, in 49 cases drug-eluting stents (DES) were used and in 51 cases bare metal stents (BMS) were used.

**Study of ECG**

A baseline surface ECG were obtained immediately before PCI, immediately after the procedure is completed. Then after 6 hours, 12 hours and 24 hours changes in multi-channel ECG monitor were recorded during PCI balloon inflation. ECG proper speed was 25 mm/sec and 10 mm/mv of signal amplitude. ST segment changes were measured 20 sec after the end of QRS or QS complex and approximated to nearest 0.5 mm. The isoelectric line was considered the TP segment preceding the QRS (or QS) complex. Three consecutive QRS complex were analyzed and mean ST shift values were calculated. After PCI ST shift (elevation or depression) was considered significant, if ≥1 mm compared with the corresponding baseline value. Other changes that were considered were appearance of a new Q wave and T wave inversion.

**Follow-up**

The follow up was done by the assessment of any major adverse cardiac events (MACE), any new symptoms such as chest pain as per Canadian Cardiovascular Society (CCS) class, left ventricular failure (LVF) and shortness of breath (SOB) on exertion, functional class as New York Heart Association (NYHA) I/II/III/IV, left ventricular ejection fraction (LVEF), any new regional wall motion abnormalities left anterior descending (RWMA LAD)/left circumflex artery (LCX)/right coronary artery (RCA) and myocardial thickness. The patient’s vital conditions were recorded at 3rd and 6th month post-PCI. All the patients were followed up also over mobile phone in case of any MACEs.

**Statistical analysis**

The statistical analyses were carried out by using software (SPSS, version 20). The comparisons were expressed as number of patients and percentage of patients and compared across the groups using Pearson’s chi square test for independence of attributes. All the variables were expressed as Mean ± Standard Deviation (M ± SD) and compared across the 2 groups Mann-Whitney test. The confidence interval (CI) value was expressed along with significant data. P<0.05 value was considered as significant.

**RESULTS**

The present study is based on the categorization of ECG patterns, biomarkers and MACE as without any change in ECG (ECG 1), ST segment shift (ECG 2), appearance of new Q wave (ECG3) and T wave inversion (ECG 4) while for both biomarkers (Trop-t and Ckmb) as Trop-t-1 (without elevation as no change), Trop-t-2 (≤3 times elevation) and Trop-t-3 (>3 times elevation) as well as Ckmb-1 (without elevation as no change), Ckmb-2 (≤3 times elevation) and Ckmb-3 (>3 times elevation) while MACEs were obtained MACE-1 (death),
MACE-2 (non-fatal MI), MACE-3 (repeat PCI), MACE-4 (CABG) and MACE-5 (no MACE) respectively following the post-procedure. The association between biomarker (Trop-t) and ECG changes, it was observed that both Trop-t (Trop-t-2 and Trop-t-3) elevations without change in ECG (ECG 1) had 23 patients and 45 patients observed without changes in Trop-t-1 and ECG1 while Trop-t-3 elevation showed significantly (P<0.001) in 11 patients significant ST segment shift (ECG 2), 9 had appearance of new Q wave (ECG3) and 6 had T wave inversion (ECG 4) but changed in ECG (ECG 4) were only observed 6 subjects for Trop-t-1 (without elevation) following the post-procedure (Table 1 and 2).

The association between biomarker (Ckmb) and ECG changes, both Ckmb (Ckmb-2 and Ckmb-3) elevation without change in ECG (ECG 1) were observed in 14 patients and 45 patients observed without changes (Ckmb-1 and ECG1) while Ckmb-3 elevation showed in 11 patients significant ST segment shift (ECG 2), 9 had appearance of new Q wave (ECG3) and 5 had T wave inversion (ECG 4) while changed in ECG (ECG 4) was also observed 1 subject for Ckmb-2 and 1 subject for Ckmb-2 elevation but changed in ECG (ECG 4) were only observed 6 subjects for Ckmb-1 (without elevation) following the post-procedure (Table 1 and 2).

The association between MACE and ECG changes, no death occurred (MACE-1) and no changes in ECG patterns (ECG1 – ECG4) were observed. No changes in EGG patterns (EGC1, ECG2 and ECG4) were observed in case of MACE-2 except significant (P<0.01) change in ECG3 was obtained in MACE-2 for 2 patients in 6 months followed up, and both had significant ST segment shift in post-procedure. In case of MACE-3, it was observed 6 patients for ECG2, 5 patients for ECG3 and 3 patients for ECG4 but 7 patients had no change in ECG (ECG1). Among 10 patients who underwent CABG (MACE-4) in 6 months followed up, 8 had post-PCI ECG changes (2 had significant ST segment shift and 4 had appearance of new Q wave and 2 had T wave inversion) but 2 patients had no change in ECG (ECG1). The groups of no MACE (MACE-5), ECG changes were occurred only in 1 patients (ECG2) and 2 patients (ECG4) but no change in ECG (ECG1) was observed in 2 patients following the post-procedure (Table 1 and 2).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ECG1</th>
<th>ECG2</th>
<th>ECG3</th>
<th>ECG4</th>
</tr>
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<tbody>
<tr>
<td>Trop-t-1</td>
<td>45 (88.2)</td>
<td>0</td>
<td>0</td>
<td>6 (11.8)</td>
</tr>
<tr>
<td>Trop-t-2</td>
<td>13 (100)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trop-t-3</td>
<td>10 (27.8)</td>
<td>11 (30.5)</td>
<td>9 (25)</td>
<td>6 (16.7)</td>
</tr>
<tr>
<td>Ckmb-1</td>
<td>54 (90)</td>
<td>0</td>
<td>0</td>
<td>6 (10)</td>
</tr>
<tr>
<td>Ckmb-2</td>
<td>3 (75)</td>
<td>0</td>
<td>0</td>
<td>1 (25)</td>
</tr>
<tr>
<td>Ckmb-3</td>
<td>11 (30.6)</td>
<td>11 (30.6)</td>
<td>9 (25)</td>
<td>5 (13.8)</td>
</tr>
<tr>
<td>MACE-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MACE-2</td>
<td>0</td>
<td>2 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MACE-3</td>
<td>7 (33.3)</td>
<td>6 (28.6)</td>
<td>5 (23.8)</td>
<td>3 (14.3)</td>
</tr>
<tr>
<td>MACE-4</td>
<td>2 (20)</td>
<td>2 (20)</td>
<td>4 (40)</td>
<td>2 (20)</td>
</tr>
<tr>
<td>MACE-5</td>
<td>2 (40)</td>
<td>1 (20)</td>
<td>0</td>
<td>2 (40)</td>
</tr>
</tbody>
</table>

In Table 2, ECG changes were statistically significantly correlated with post procedure Trop-t elevation (P<0.001), Ckmb elevation (P<0.001) and MACE in 6 months followed up (P<0.01 and P<0.001).

Table 2: ECG change and association with biomarkers and MACE in post-PCI

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Std. Err.</th>
<th>P-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trop-t-1</td>
<td>0.16</td>
<td>&lt;0.001</td>
<td>1.99 – 2.62</td>
</tr>
<tr>
<td>Trop-t-2</td>
<td>0.13</td>
<td>&lt;0.001</td>
<td>1.08 – 1.62</td>
</tr>
<tr>
<td>Trop-t-3</td>
<td>0.26</td>
<td>&lt;0.001</td>
<td>0.48 – 1.52</td>
</tr>
<tr>
<td>Ckmb-1</td>
<td>0.13</td>
<td>&lt;0.001</td>
<td>1.05 – 1.55</td>
</tr>
<tr>
<td>Ckmb-2</td>
<td>0.49</td>
<td>&lt;0.001</td>
<td>0.78 – 2.72</td>
</tr>
<tr>
<td>Ckmb-3</td>
<td>0.16</td>
<td>&lt;0.001</td>
<td>1.90 – 2.55</td>
</tr>
<tr>
<td>MACE-1</td>
<td>0.67</td>
<td>&lt;0.01</td>
<td>0.68 – 3.32</td>
</tr>
<tr>
<td>MACE-2</td>
<td>0.21</td>
<td>&lt;0.01</td>
<td>1.78 – 2.60</td>
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<td>MACE-3</td>
<td>0.30</td>
<td>&lt;0.001</td>
<td>2.01 – 3.19</td>
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<td>MACE-4</td>
<td>0.42</td>
<td>&lt;0.001</td>
<td>1.56 – 3.23</td>
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<tr>
<td>MACE-5</td>
<td>0.12</td>
<td>&lt;0.001</td>
<td>1.00 – 1.48</td>
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</table>

**DISCUSSION**

PCI is an important way of revascularization but there is a risk of peri-procedural myocardial injury and these can be detected through the assessment of surface ECG and elevation of biomarkers such as Trop-t as well as Ckmb. In the earlier study, it was observed alteration of cardiac biomarkers such as Trop-t and Ckmb as well as MACEs following PCI. [8] The surface ECG changes were statistically significantly correlated with Trop-t as well as Ckmb elevation in post-PCI and major adverse cardiac event in the follow up (P<0.001). The present results are in conformity with study of Balian et al., [10] however, they evaluated intracoronary ECG, but surface ECG was equally sensitive in predicting periprocedural myocardial damage. But in the study of Balian et al., [10] it was observed that standard ECG changes and chest pain after PCI are inaccurate in assessment of myocardial damage. Possibly in these patients an innocent embolization occurred without any distal myocardial damage. Despite the treatment ischemia, it was correctly recorded by the ECG. Alternately, myocardial damage was eventually prevented by aggressive antithrombotic service. Surface ECG ST segment shift after PCI could result in improved diagnosis of periprocedural AMI and allow consideration for institution of adjunctive therapies aimed and reducing AMI and improving late outcome.

**LIMITATIONS**

The present study was done with only 100 subjects and a greater number of patients with long duration of follow-up may justify the more accurate results. However, the surface ECG and biomarkers were found closely associated for myocardial damage in post-PCI. The followed-up period was only 6 months. As high-risk cases were referred in this institute from across Eastern India, some referral bias may have contributed to increased major adverse cardiovascular events in followed up.
CONCLUSION
It is concluded that the present study showed significant relationship between major adverse events during followed up and changed in surface ECG and Trop-t and Ckmb elevation in the post-PCI period. This study population was high risk population with a significant number of MACEs occurred in follow up. This may be contributed to some extend by referral, hospital admission bias.

Acknowledgement
Authors are thankful to all the staff members of laboratories helped in analysis of blood and hospital staff members for patient’s coordination during the study.

Ethical approval
The ethical approval has been given by Institutional Ethical Committee, IPGME&R and SSKM Hospital, Kolkata, India. The ethical committee have given the written permission with Memo No. Inst/IEC/1564 dated 16.03.2012 for conducting the present research work.

REFERENCES