The Effect Of Successful Primary Angioplasty On The QRS Duration In Anterior ST Elevation Myocardial Infarction

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ABSTRACT

Background: ST-segment resolution is an important marker showing the perfusion at tissue level in interventional treatment of the ST elevation myocardial infarction (STEMI). After the STEMI, reperfusion at tissue level may have a useful effect as shortening the QRS duration which indicates electrical conduction velocity of the ventricle on electrocardiogram. Previously, the relationship between ST-segment resolution and QRS duration has not been thoroughly investigated. Aim of this study was to investigate the effect of successful ST-segment resolution on QRS duration.

Method: The study included 50 Patients (12 female, 38 male and average age 48.2 ±11.3 years) with anterior STEMI, whose infarct related artery was perfused by primary coronary angioplasty. The patients were allocated into three groups depending on the grade of ST-segment resolution. There were successful ST-segment resolution in the group 1; partial ST-segment resolution in the group 2 and unsuccessful ST-segment resolution in the group 3.

Results: Initial and post-interventional treatment QRS durations were 132 ±15ms and 100 ±14 ms in group 1; 126 ±12 and 121 ±11ms in group 2, and 128 ±14 and 125 ±12 ms in group 3, respectively. When the decrease in QRS durations among the groups were compared after interventional treatment, there was a statistical significance between groups 1 and 2 (p <0.001), and groups 1 and 3 (p <0.001). There was no statistical significance between groups 2 and 3 (p >0.05).

Conclusion: On STEMI, successful tissue perfusion after the interventional treatment is an important factor to narrow the duration of QRS. Shortening in QRS duration in these patients may be an indicator of reperfusion.

Keywords

QRS duration, ST segment resolution, PTCA
Anterior ST Elevasyonlu Miyokard İnfarktüsünde Başarılı Primer Anjioplastinin QRS Süresi Üzerine Etkisi

ÖZET

**Giriş:** ST segment elevasyonlu miyokard infarktüsünde (STEMI) girişimsel tedavi ile saptanan perfüzyonun belirlenmesinde ST segment rezolüsyonu önemli bir göstergedir. STEMI hastalarda reperfüzyon QRS üzerinde olumlu etki yapabilir. Bu çalışmada başarılı ST-segment rezolüsyonunun QRS üzerine etkisi incelenmiştir.

**Yöntem:** Çalışmaya infarktüsle ilgili koroner damarı primer koroner anjiyoplasti ile açılan 50 hasta (12 kadın, 38 erkek, ortalama yaş 48 ± 11.3 yıl) alınmıştı. Hastalar ST segment rezolüsyonuna göre 3 gruba ayrıldı. (Grup 1: Başarılı ST segment rezolüsyonu olanlar Grup 2: parsiyel ve grup 3 ST segment rezolüsyonu olmayanlar)

**Bulgular:** Başlangıç ve işlem sonunda QRS segmenti grup 1,2 ve 3 te 132 ± 15/100 ± 14 min; 126 ± 12/121± 11 min; 128 ± 14/125 ± 12 min olarak saptandı. QRS seviyesinde azalma grup 1 ve 2 ile grup 1 ve 3 arasında istatistiksel olarak farklı (p<0,05) grub 2 ve 3 arasında ise fark yoktu (p>0,07).

**Sonuç:** STEMI’li hastalarda başarılı girişimsel tedavi ile QRS süresi daralmaktadır. QRS süresinde kısalma bu hasta grubunda reperfüzyonu göstergesi olarak kabul edilebilir.

**Anahtar Kelimeler**
QRS süresi, ST segment rezolüsyonu, PTKA

**İLETİŞİM ADRESİ**
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**Introduction**

ST-segment changes and QRS prolongation are electrocardiographic (ECG) markers of myocardial ischemia (1). Acute myocardial ischemia decreases electrical conduction velocity through the ischemic myocardium and may produce QRS prolongation on the surface electrocardiogram (2-4). The prolongation of the QRS duration in ST elevation myocardial infarction (STEMI) has been identified as an independent predictor of adverse outcome (5).

Reperfusion therapy was reported to cause decreases in QRS duration and mortality in STEMI (6). Successful myocardial perfusion is not synonymous with Thrombolysis in Myocardial Infarction (TIMI) III flow (7). Although TIMI III flow is provided by interventional treatment in STEMI, seen in recent studies conducted with contrast echocardiography, positron emission tomography and technetium-99 m macroaggregated albumin scintigraphy, it was shown that myocardial metabolism and perfusion were not satisfactory (8-10). Van’t Hof et al (11) defined myocardial blush grade (MBG) and ST segment resolution level in terms of tissue perfusion and demonstrated that there was a strong correlation among ST-segment resolution level, improved left ventricle function, and early peak in increased enzymes such as creatine kinaze-MB isoenzyme and lactate dehydrogenase and decreased mortality.
The relation between ST-segment resolution level after Primary percutaneous coronary intervention and QRS duration has not been studied comprehensively. In the present study, the relationship between ST-segment resolution grade and QRS duration in patients with anterior STEMI and coronary TIMI III flow provided in infarct related artery (IRA) by interventional treatment was investigated.

Methods

Selection of Patients

The study included 50 patients (12 female and 38 male; mean aged 48.2 ±11.3 years) with anterior STEMI, whose infarct related artery (IRA) was perfused by primary Percutan coronary angioplasty. The patients were allocated into three groups depending on the grade of ST-segment resolution (11-12). ST-segment resolution above 70% was considered as successful and these patients enrolled in the group 1. 30-70% resolutions considered as partial ST-segment resolution and these enrolled in the group 2. ST-segment resolution below 30% considered as unsuccessful and these enrolled in the group 3.

ST elevation myocardial infarction was diagnosed based on the presence of all of the criteria below:

1. Angina pectoris being ≥20 minutes
2. ST segment increase being ≥2mm in precordial derivations (in at least two consecutive leads)
3. The level of CK-MB being higher than two folds of the normal level.

Exclusion criteria are presented in Table 1.

Primary angioplasty

The angiographic images were acquired with a Philips mono-plane system at a cine rate of 25 frames/s. Primary Percutan coronary intervention was performed with conventional techniques and coronary stents were used without restrictions. The infarct-related artery was the only target of the procedure. Tirofiban therapy was given by judgment of the operator and usually sta-

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**Table 1**

<table>
<thead>
<tr>
<th>Exclusion criteria</th>
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<tbody>
<tr>
<td>Atrial fibrillation or flutter</td>
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<tr>
<td>Atrioventricular blocks</td>
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<tr>
<td>Ventricular hypertrophy</td>
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<tr>
<td>Preexcitation, intraventricular conduction abnormalities</td>
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<tr>
<td>Electrolyte imbalance</td>
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<tr>
<td>Right Bundle Branch Blocks or Left Bundle Branch Blocks</td>
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<tr>
<td>History of medication use that may affect preprocedure QRS duration. (Class I or III antiarrhythmics)</td>
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<tr>
<td>Symptom onset ≥ 12 hours</td>
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<tr>
<td>Left main coronary disease</td>
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<tr>
<td>Restenotic lesion (Previous coronary intervention)</td>
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<tr>
<td>Rescue percutaneous coronary angioplasty</td>
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<tr>
<td>Previous Coronary artery by-pass graft or myocardial infarction</td>
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<tr>
<td>Infarct-related artery being the right coronary artery or Circumflex artery</td>
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<tr>
<td>Pacemaker rhythm</td>
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The Effect Of Successful Primary Angioplasty on the QRS Duration in Anterior ST Elevation Myocardial Infarction

Ted during the procedure. The perfusion status of IRA was assessed according to TIMI study classification (7). Myocardial blush was graded, according to the dye density score proposed by van’t Hof et al. (11) as patients undergoing primary PCI: from 0 (no contrast density or abnormal persistence of contrast medium), to 3 (normal contrast density, relative to the dye density in uninvolved areas). Both TIMI flow and MBG were graded on the angiograms immediately after primary Percutan coronary intervention.

ECG analysis

Measurement of QRS Duration

On admission and post procedure, QRS duration was assessed by two experienced cardiologist, who did not know the clinical and angiographic data, from standard 12-lead ECG (Ni
hon Kohden–Tokyo-Japan) which were recorded at a paper speed of 50 mm/s. Limb leads and chest leads were recorded separately. For each synchronously recorded six-lead set, QRS duration was measured from the earliest onset to the latest offset of the QRS complex, and the average of the two greatest values from the cardiologists were used. There were not patients having the ST-segment elevation which precluded measurement of QRS duration due to the magnitude of ST elevation.

ST-Segment Measurement and Resolution Grade

ST-segment elevation was measured by taking the lead with maximal ST elevation in millivolts (MV), 40 ms after the J point. When the J point was not clearly demarcated, we used the point of intersection of the tangents to the slopes of the terminal ORS deflection and initial ST-segment portion (13). ST-segment resolution was graded as mentioned above.

The study was conducted after approval of Firat University School of Medicine Ethics Committee was taken, in accordance with Helsinki Declaration.

Statistical Analysis

General definitive characteristics were evaluated as mean ± standard deviation (SD). In intra-group comparisons Wilcoxon’s rank test was used while Mann Whitney U test was performed for inter group comparisons. For correlation analyses Spearman’s correlation test was used. (SPSS/PC 9.05 version, 1998, Chicago, IL). A value of p <0.05 was considered significant.

Results

Basic characteristics of the patients are shown in the Table 2. TIMI III flow was provided in all cases after the procedure. In ECGs, successful ST-segment resolution and MBG 2-3 were seen in 38 patients (76%), partial ST-segment resolution in 10 patients (20%) and unsuccessful ST-segment resolution in 2 patients (4%). The patients with partial and unsuccessful ST-segment resolution had MBG <2. There were no differences among groups in terms of risk factors, stent diameters, symptom onset-ballooning time and left ventricle functions. Stents were implanted at 14 ± 2 atm. for all patients. After procedure, no significant differences were determined in regard to durations of taking ECG in group1, 2, and 3 (34 ± 7, 35 ± 3 and 34 ± 6 mins, p > 0.05 respectively).

Pre-procedure QRS duration values are shown in Table 3. There are no differences among groups in terms of pre-procedure QRS duration (p > 0.05). After intervention, QRS duration decreased from 132 ± 15 ms to 100 ± 14 ms in the group 1, from 126 ± 12 to 121 ± 11 ms in
the group 2, and from 128 ±14 to 125 ±12 ms in the group 3 (Table 3). Shortening of ORS duration was more evident in the group 1 (p <0.001). Although post-intervention QRS durations were not statistically different in the group 2 and 3 (p >0.05) it was lower in the group 1 than group 2 and 3 (p <0.001).

Initially, there was no correlation between ST-segment elevation and QRS duration in the ECGs of the patients. Post procedure successful ST-segment resolution and MBG 2-3 were negatively correlated with shortening in QRS duration (r = -0.216; p = 0.013).

**Discussion**

In our study, successful ST-segment resolution and MBG 2-3 caused a significant decrease in QRS duration. There was no difference between partial ST-segment resolution and unsuccessful ST-segment resolution in terms of QRS duration effects.

Several studies have demonstrated that after reperfusion for STEMI, myocardial rather than epicardial perfusion is strongly correlated with long-term outcome (9,11,12). For this reason, attention has been focused on the identification of methods for a bedside evaluation of myocardial...

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### Table 2

**Basic characteristics of the patients**

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n = 40)</th>
<th>Group 2 (n = 8)</th>
<th>Group 3 (n = 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>48.6 ±6.3</td>
<td>49.4 ±10.2</td>
<td>48.2 ±5.6</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>32/8</td>
<td>4/4</td>
<td>2/0</td>
</tr>
<tr>
<td>Hypercholesterolemia (n)</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Diabetes Mellitus (n)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hypertension (n)</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Family history of CVD (n)</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Smoking (n)</td>
<td>20</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>After procedure (MLD) (mm)</td>
<td>3.31 ±1.1</td>
<td>3.36 ±0.8</td>
<td>3.37 ±0.7</td>
</tr>
<tr>
<td>Symptom onset to balloon time (minutes)</td>
<td>174.1 ±46.1</td>
<td>182.2 ±36.1</td>
<td>190.1 ±42.2</td>
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<tr>
<td>EF (%)</td>
<td>50.2 ±3.8</td>
<td>52.1 ±2.4</td>
<td>50.2 ±2.1</td>
</tr>
</tbody>
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*CVD: cardiovascular disease, EF: ejection fraction, MLD: minimal lumen diameter*

### Table 3

**QRS duration before and after reperfusion**

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (n = 40)</th>
<th>Group 2 (n = 8)</th>
<th>Group 3 (n = 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before procedure (ms)</td>
<td>132 ±17</td>
<td>126 ±12</td>
<td>128 ±14</td>
</tr>
<tr>
<td>After procedure (ms)</td>
<td>100 ±14</td>
<td>121 ±11</td>
<td>125 ±12</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.001</td>
<td>NS</td>
<td>NS</td>
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</tbody>
</table>

*NS: No significant*
The Effect Of Successful Primary Angioplasty on the QRS Duration in Anterior ST Elevation Myocardial Infarction

al perfusion. Among these, electrocardiography represents a reliable and cheap method in the evaluation of myocardial perfusion and prognostic stratification of patients with STEMI treated by pharmacological or mechanical reperfusion (11, 12, 14).

The positive effect of STEMI interventional treatment on mortality is primarily to protect ventricle muscular tissue, reducing mechanical complications such as the septal or free wall rupture or papillary rupture (15) and salvage of muscle and mitigation of remodeling (16). Provision of ventricle electrical conduction velocity might be an additional mechanism. It was reported that successful reperfusion improved QRS duration and decreased mortality (6,17).

In the experimental models performed on mammalians, varying effects of coronary artery ligation on the transmembrane action potential have been described with an initial slight lengthening followed by a subsequent shortening due mainly to a shortening of plateau phase (18,19). There is a parallel decrease in resting membrane potential and action potential magnitude and upstroke velocity. Electrical conduction velocity in the ischemic myocardium is initially decreased during the first 2 mins of ischemia and is subsequently prolonged causing delayed activation of the ischemic tissues (18). Postulate reasons for these changes are ischemia induced increased outward potassium currents and increased extracellular potassium concentration with increased inward sodium and calcium currents and concomitant increases in intracellular sodium and calcium concentrations (19). Increase in these ions in ischemic tissue changes transmembrane action potentials and the conduction in purkinje fibers. Therefore electrical conduction velocity through the ischemic myocardium decreases and this may produce prolongation in QRS duration on the surface electrocardiogram. It was reported that such impairments might be rapidly repaired by successful reperfusion (6,17,20,21). This finding acknowledges our result.

Several studies have demonstrated the prognostic value of QRS duration in the setting of AMI. Brilakis et al (22) found that prolonged QRS duration in the absence of bundle branch block was independently associated with higher in hospital and overal mortality in patients with non ST elevation MI. In GUSTO’s sub-study (5), it was found that in patients with ST elevation MI, QRS duration was strong predictor of cardiac death.

Although TIMI III flow was achieved by interventional treatment in STEMI in recent studies conducted with contrast echocardiography, positron emission tomography and technetium-99m macroaggregated albumin scintigraphy, myocardial metabolism and perfusion were not satisfactory (8-10). Stone et al (23) found that only 29% of the patients in whom TIMI III flow was achieved by interventional treatment of AMI had grade III myocardial perfusion, with higher one-year mortality in patients who did not have full myocardial perfusion. This group of researchers stated that following interventional treatment of STEMI, the strongest indicator of mortality was the absence of distal flow (TIMI O/I), and that in patients in whom normal flow was achieved (TIMI III), MBG was a better determinant of mortality than TIMI III flow (23). Van’t Hof et al. (11) defined myocardial perfusion and ST-segment resolution grades in terms of tissue perfusion and demonstrated that there was a strong correlation between ST-segment resolution grade and improved left ventricle function, and early peak in increased enzymes such as creatine.
kinase-MB isoenzyme and lactate dehydrogenase and decreased mortality. Van’t Hof et al. also reported that successful ST-segment resolution could be provided in only 51% of patients whose TIMI III flow was achieved after primary balloon angioplasty (11). We achieved full ST-segment resolution and MBG 2-3 in 76% of our patients. The reason for the difference between these two findings may be due to our patients’ characteristics and the use of glycoprotein IIb/IIIa receptor inhibitors.

Being no difference in QRS duration after the procedure in our cases with unsuccessful and partial ST segment resolution in spite of TIMI III flow can be due to the decrease in electrical conduction velocity as a result of low intra ventricular myocardial perfusion reported by Stone (23) and Van’t Hof (11).

Limitations of the Study
The major limitations of our study were small sample size. Electrocardiographical measurements were performed manually without using a computer program. The methods demonstrating tissue perfusion such as sestimigraphy and contrast echocardiography were not used. The patients were not followed regarding mortality and morbidity.

Conclusions
Successful ST-segment resolution and MBG 2-3 are good indicators of reperfusion at tissue level provided by interventional treatment. In this study, it was demonstrated that QRS duration shortened in the patients with successful reperfusion. Shortening in QRS duration in these patients may be an indicator of reperfusion.


