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THE IMPORTANCE OF PREHOSPITAL RECOGNITION OF ST SEGMENT ELEVATION IN THE AVR LEAD IN ACUTE CORONARY SYNDROME

Gordana TODOROVIĆ¹, Aleksandar JOLDŽIĆ¹, Dragana VESIĆ²

¹City Institute for Emergency Medical Aid, Belgrade, Serbia; ²EMS, Stara Pazova, Serbia
³Klinika za očne bolesti, KCS; ⁴Medicinski fakultet, Univerzitet u Beogradu, Beograd,
Srbija; ⁵Klinika za očne bolesti, KBC Zvezdara, Beograd, Srbija; ⁶Gradski zavod za hitnu
medicinsku pomoć, Beograd, Srbija; ⁷Klinika za nefrologiju, KCS, Beograd, Srbija

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Korespondencija:

Gordana Todorović

Gradski zavod za hitnu
medicinsku pomoć

Franše dEperca 5

11000 Beograd, Srbija

Tel: +38164 8435 608

E-mail: nesa58@gmail.com

ABSTRACT

Introduction/Objective The acute coronary syndrome is a medical condition that Emergency Medical Service physicians deal with daily. An especially prompt reaction is required when an ST elevation in the aVR lead is discovered, as it signifies a critical coronary lesion. The objective of the article is to present how educated the Emergency Medical Service doctors included in the STEMI network are in recognizing and treating the aVR lead elevation, as an atypical ECG finding.

Case report Three patients with chest pain lasting from 30 minutes to 2.5 hours are presented. The ECG recording shows significant ST segment depressions >1mm in 6 or more leads (I, II, III, aVL, aVF, V2-V6) coupled with a 3-4mm ST elevation in the aVR lead and similar or slightly less pronounced ST elevation in V1. The strategy for primary PCI had been initialized for all three patients, who were then, after consultation with interventional cardiologists in UHMC Bezanijska kosa, Clinical Hospital Centre Zvezdara and the Military Medical Academy and having taken the initial dose of dual antiplatelet therapy (except for the third patient), transported to the hospital catheterization labs in these three institutions.

Conclusion ST segment depression of 1 mm or more in six or more leads (inferolateral depression) coupled with ST segment elevation in aVR and/or V1 points to the three-vessel disease (3VD) or left main coronary artery (LMCA) obstruction. The Emergency Medical Service doctors react adequately and promptly and, pending consultation with interventional cardiologists, the patients arrive directly into the catheterization lab. The final decision about reperfusion therapy is made by cardiologists and cardiac surgeons. Early invasive approach and adequate therapy (PCI/CABG) lower the risk of cardiogenic shock development and death.

Keywords: aVR elevation, atypical ECG, EMS.

Introduction

The aVR lead has been present in clinical electrocardiography for 70 years, but only since the year 2000 has it become interesting for analysis. In 2013, the British Cardiology Society [1] pointed out atypical ECG findings, where aside from an isolated posterior myocardial infarction and left bundle branch block (LBBB) according to Sgarbossa criteria [2], a marked ST elevation in the aVR lead is a predictor of main coronary artery occlusion.

The Emergency Medical Service physicians deal with the acute coronary syndrome (ACS) daily and it is of the utmost importance to promptly recognize and

provide treatment based on the protocol for the patients with STEMI (ST elevation myocardial infarction). In the STEMI network, the City Institute for Emergency Medical Aid performs the key roles of coordination, communication with interventional cardiologists and referral of patients directly to catheterization labs. The City Institute for Emergency Medical Aid is familiar with many cases outside of Belgrade as well, where we were asked to intervene to enable the patient to receive the percutaneous coronary intervention (PCI) in as short a time as possible, which often saves lives through minimizing the extent of necrosis in the ischemic myocardium.

An especially prompt reaction is required when an ST elevation in the aVR lead is discovered, as it signifies a critical coronary lesion which can lead to left ventricle dysfunction, malignant cardiac arrhythmias, cardiogenic shock, and death[3].

Objective

The objective of the article is to present three case reports and use them to determine how educated the Emergency Medical Service doctors included in the STEMI network are in recognizing and treating the aVR lead elevation, as an atypical ECG finding, which initializes the primary PCI strategy („STEMI equivalent”).

First case report

On 1st January 2020, at 9.15 p.m. a call was received on the STEMI hotline from a physician working for the

EMS „Stara Pazova” about an 80-year-old female patient with retrosternal chest pain described as a squeezing sensation radiating towards the jaw, the back of the head and the shoulders. Her blood pressure was 190/110mmHg. The ECG (image 1) showed sinus rhythm with a frequency of 85/min, a marked horizontal ST segment depression up to 4mm in leads I, II, aVL and V2-V6, as well as a marked ST segment elevation up to 3mm in aVR and up to 1mm in V1. Suspecting left main coronary artery (LMCA) occlusion, the EMS physician prescribes dual antiplatelet therapy for STEMI according to the protocol: 300mg of Aspirin P.O. and two tablets of Ticagrelor 90mg. Before coming to the EMS, the patient had taken a tablet of Kaptopril Plus. With the assistance of the Head of Shift at the City Institute for Emergency Medical Aid, Belgrade, the interventional cardiologist has been consulted and the patient was transported by a medical team to the catheterization lab at the UHMC Bezanijska Kosa, where a three-vessel disease (3VD) was diagnosed.

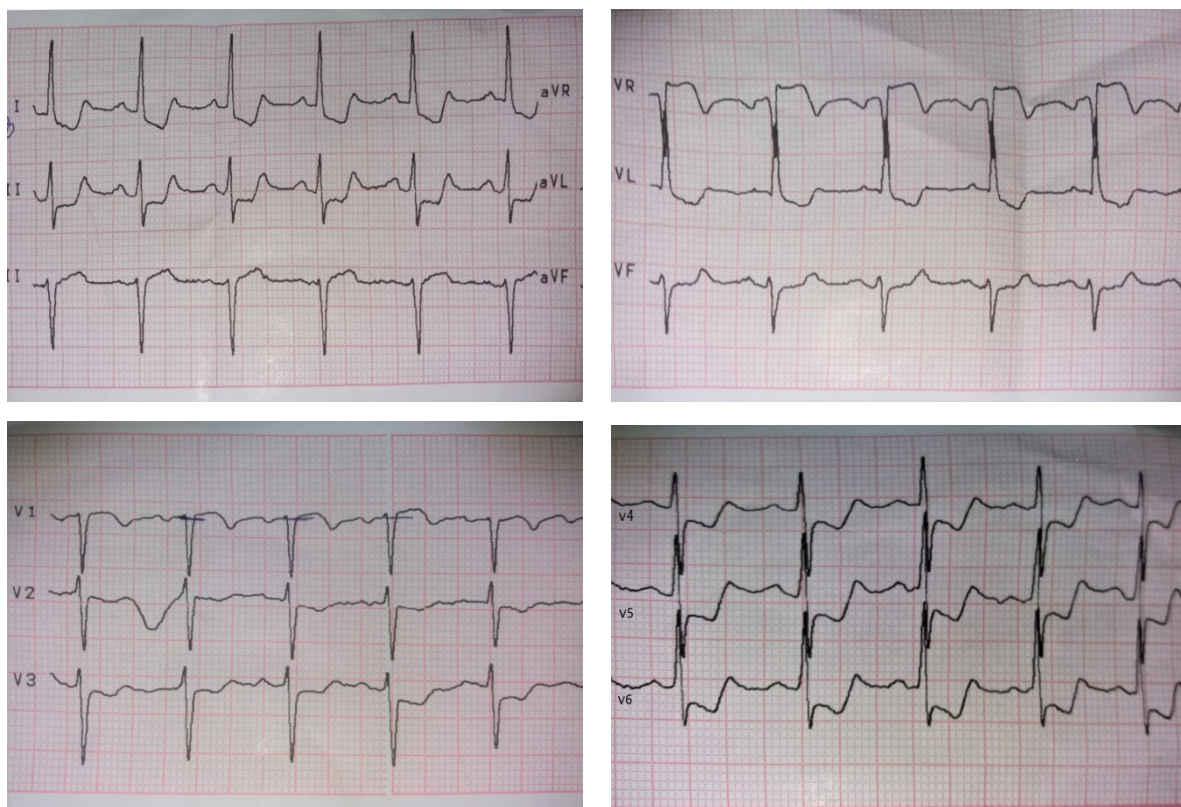


Image 1. The ECG recording of the female patient by the EMS Stara Pazova

Second case report

A medical team of the City Institute for Emergency Medical Aid was dispatched to an emergency call on 27th January 2018, 14 minutes after midnight. The reason was a severe difficulty in breathing. The patient was a 78-year-old man, treated for hypertension and diabetes. Upon the medical team's arrival, the patient was in critical condition and heteroanamnesis revealed that he had complained of difficulty in breathing, but no

chest pain. He was somnolent, dyspnoeic, pale, covered in cold sweat with notable signs of central cyanosis and afebrile. He had an increased heart rate, dull heart sounds, no murmurs. Breath sounds were decreased, prolonged expirium with marked respiratory effort and no additional findings. The abdomen was soft, painless with normal peristalsis. Neurologically, the patient was somnolent with slower pupil reaction to light. Blood

pressure could not be measured, heart rate was around 160/min, respiratory rate 14/min, blood oxygen saturation 88%. The ECG recording (image 2) showed a wide QRS complex tachycardia with RBBB configuration and heart frequency 160/min. A dose of 150mg of Amiodarone hydrochloride was administered i.v. diluted in 10ml of 5% Glucose. The second ECG recording (image 3) registered a heart frequency of 110/min, with a now marked RBBB, but also with a ST segment depression up to 5 mm in leads I, II, III, aVF and V3-V6 and an ST segment elevation larger than 4mm in aVR, as well as a similar elevation in V1. The patient was then treated according to the STEMI

protocol, an interventional cardiologist on call was consulted, the patient received an Aspirin tablet 300mg P.O. and two tablets of Ticagrelor 90mg. Attached to a Dopamine infusion and receiving 5l/min oxygen by mask, the patient was in a more stable condition and with continuous ECG monitoring transported to the catheterization lab at the CHC Zvezdara, where a proximal occlusion of the left anterior descending artery (LAD) was later confirmed.

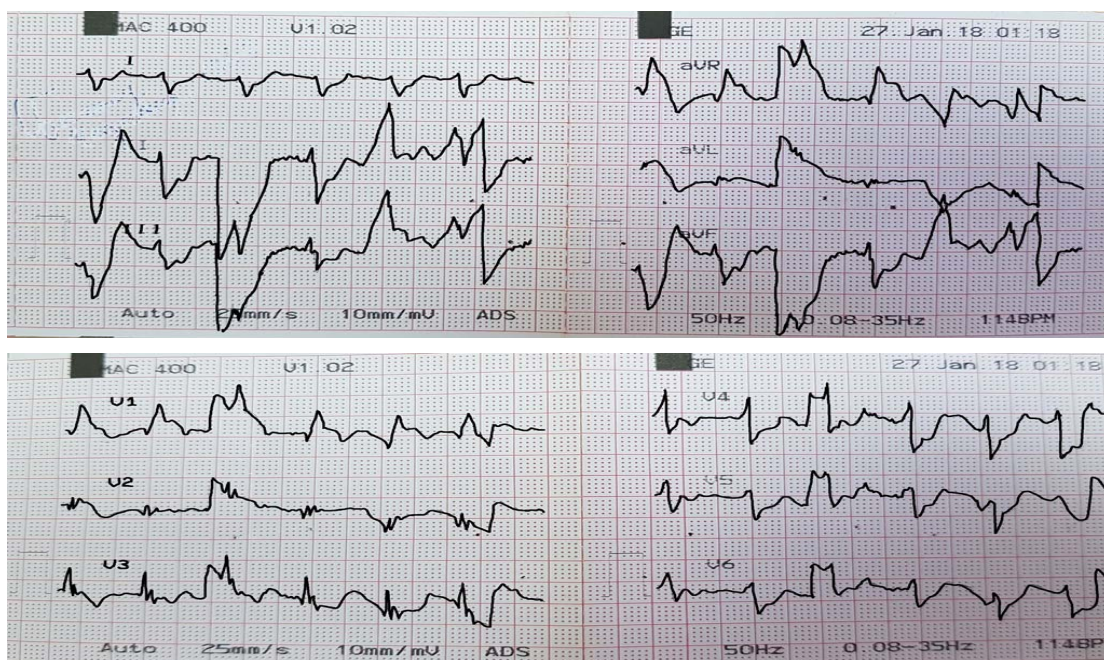


Image 2. ECG recording, before therapy

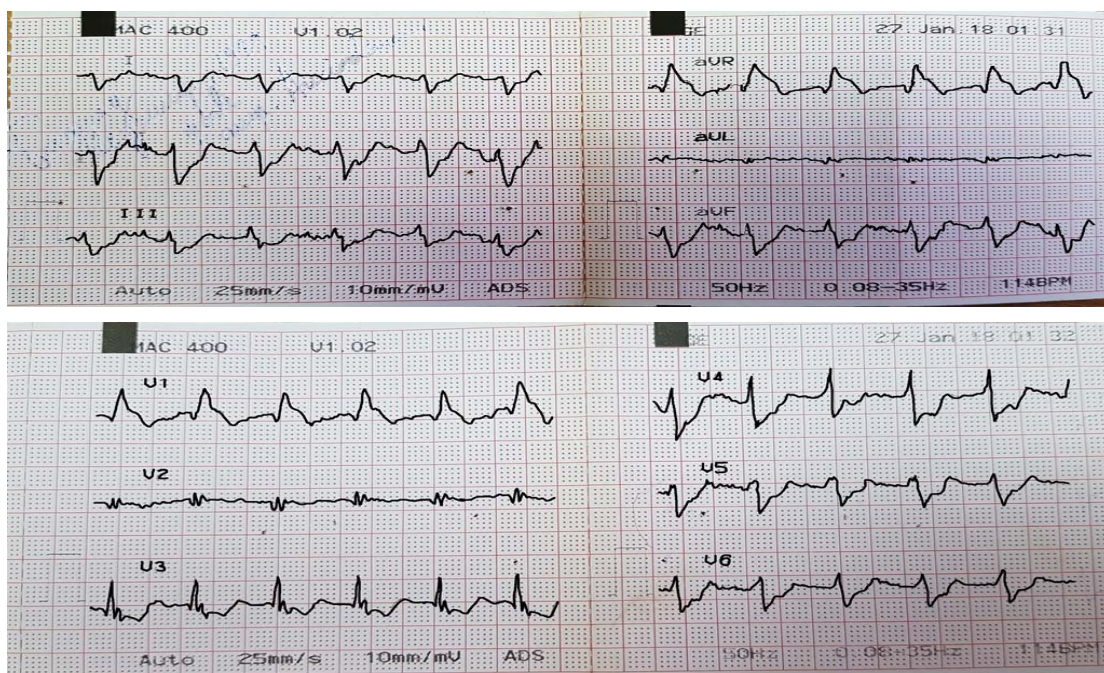


Image 3. ECG recording, after therapy

Third case report

This is another case of dealing with "STEMI equivalents" and presenting the cooperation of doctors from different institutions. The Community Health Center in Borca called the 194 hotline number on 5th February 2020, at 7.20 p.m. for a 50-year-old man complaining of chest pain for the first time, lasting for 30 minutes and under the suspicion of the acute coronary syndrome (ACS). Upon arriving at the scene, the City Institute for Emergency Medical Aid medical team learns that the pain started when the patient was resting, that it was retrosternal, radiated into both shoulders, was described as a feeling of pressure with pain level 7/10 and lasted for 30 minutes. The patient was conscious, oriented, eupnoeic, afebrile, with normal skin and mucous membrane coloration. Heart sounds were in rhythm, slightly less pronounced with no murmurs. Breath sounds were discretely decreased, with no additional findings. The abdomen was soft and painless, in line with the thorax.

The basic neurological assessment came back normal. There was no pretibial edema. Blood pressure was 150/90 mmHg, heart rate was 90/min, respiratory rate was 16/min, blood oxygen saturation was 95%. The ECG recording (image 4) showed sinus rhythm, the heart frequency of 90/min, a ST segment depression up to 1mm in leads I, II, aVL and a more pronounced horizontal depression up to 4mm in V3-V6, as well as an ST segment elevation up to 3mm in aVR, with a negative T wave in V1. The Community Health Center doctor had administered Aspirin 300mg P.O., 0.4mg Nitroglycerin spray SL, and a Kaptopril 12.5mg tablet before the medical team arrived, after which the pain had retreated and the more significant ST segment depressions were no longer so pronounced (image 5). In consultation with the interventional cardiologist at the Military Medical Academy, the patient was transported to the cardiology infirmary at the Military Medical Academy under constant cardiac monitoring, with no dual antiplatelet therapy, where the cardiology team was to assess him and decide on further treatment after performing a coronary angiogram.

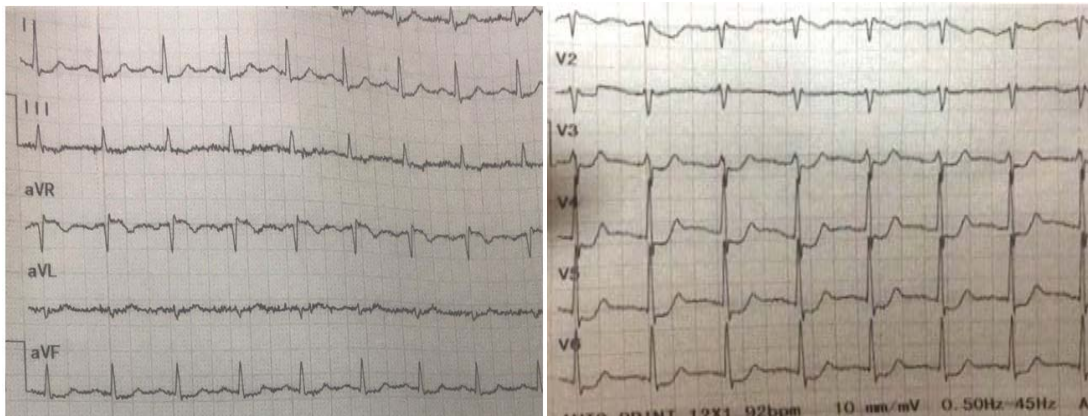


Image 4. ECG recording, before therapy

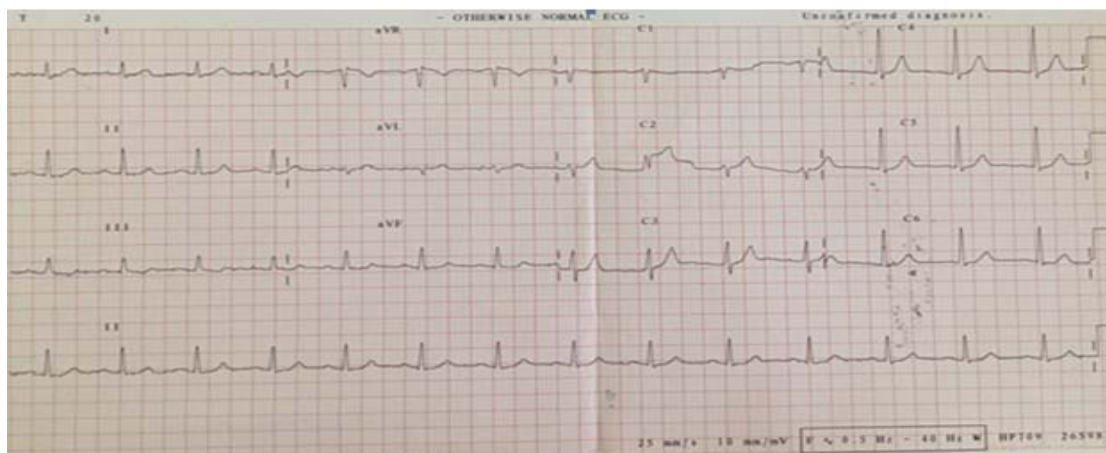


Image 5. ECG recording, after therapy

Discussion

The aVR lead is very important when interpreting an ECG recording because it is the only lead that presents the activity of the upper parts of the heart. Its vector in the frontal plane looks directly at the upper right side of the heart – the right ventricular outflow and basal parts of the interventricular septum, beneath the pulmonary and aortic valves. Through the left ventricular cavity, it looks at the interior part of the apex and lateral wall. In that way, it electrically opposes the standard leads I, II, aVL and precordial leads V4 and V6 [4].

The vascularisation of this part of the myocardium is provided by the left coronary artery (LCA), whose proximal segment is the left main stem (LMS), which then branches into the circumflex artery (Cx) and the left anterior descending artery (LAD). The ST segment elevation in the aVR lead, with or without ST segment elevation in V1 with inferolateral ST segment depression can represent:

1. main branch occlusion (LMCA);
2. Presence of a „critical lesion" in the proximal segment of the LAD;
3. Severe three-vessel disease (3VD).

The mechanism of ST segment elevation development in the aVR lead is twofold: diffuse subendocardial ischemia (leading to ST depression in

lateral leads and contrariwise elevation in aVR) and transmural ischemia (basal interventricular septum infarction) (image 6) [5].

Specific ECG changes: ST segment depressions ≥ 1 mm in six or more leads (inferolateral ST depression) coupled with ST elevation in aVR and/or V1, with present myocardial ischemia symptomatology (chest pain) are the basis of this „STEMI equivalent" or atypical ECG recording which should initiate the primary PCI strategy [6].

The ECG diagnosis of an ST elevation in the aVR lead is made based on the following criteria:

1. Wide, horizontal ST segment depression in most prominent leads I, II, aVL, V4, V6;
2. ST segment elevation in aVR ≥ 1 mm is highly specific for LAD occlusion proximal to the first septal branch or the occlusion of the LMCA/3VD;
3. ST segment elevation in aVR > 1 mm points to the need for CABG;
4. ST segment elevation in aVR $\geq V1$ differentiates between the LMCA occlusion and proximal LAD occlusion, while the similar level of elevation points to the proximal LAD occlusion;
5. If ST segment elevation in aVR is not present, it almost completely rules out the possibility of a significant LMCA stenosis.

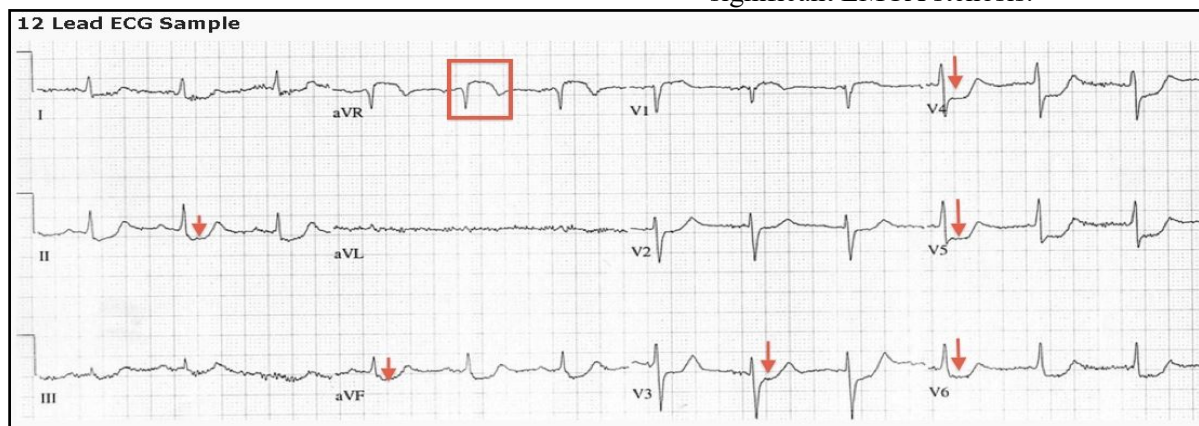


Image 6. ECG RECORDING of ST elevation in aVR with ST depression in II, AVF, V3, V4, V5, V6.

(Source: Hamoda M. STEMI equivalents. Health & Medicine. 2015. Available online: <https://www.slideshare.net/MohamedHamoda/stemi-equivalents-55640011>)

The magnitude of ST segment elevation in aVR directly correlates to mortality in these patients:

1. STE in aVR $\geq 0,5$ mm correlates to a 4-fold rise in mortality
2. STE in aVR ≥ 1 mm correlates to a 6-fold rise in mortality
3. STE in aVR $\geq 1,5$ mm correlates to high mortality of 20-75%[7];

The patients with ST segment elevation in the aVR lead are a high-risk group that presents with a diverse, but an often dramatic clinical picture.

Pain, dyspnoea, cardiac arrhythmias with possible development of respiratory insufficiency, lung edema, cardiogenic shock and unfortunately a common lethal outcome both in and out of the hospital, point to the necessity of early recognition and early reperfusion therapy [8].

According to the European Cardiology Society Guidelines from 2017, these conditions should be understood as myocardial infarction with ST segment elevation („STEMI equivalent“) and they do indicate PCI or CABG (bypass surgery), together with dual antiplatelet therapy (DAPT). A potent P2Y12 inhibitor (Prasugrel or Ticagrelor) is recommended, and if they are not available or are contraindicated, it is possible to administer Clopidogrel with 300 mg of Aspirin, if they are not contraindicated. The final decision on administering those drugs and reperfusion therapy should be made by cardiologists and a cardiac surgery medical team [5].

Conclusion

An ST segment depression ≥ 1 mm in six or more leads (inferolateral depression) coupled with ST

segment elevation in aVR and/or V1 points to the three-vessel disease (3VD) or left main coronary artery (LMCA) obstruction. The EMS doctors react adequately and promptly, treating the ST segment elevation in the aVR lead as a „STEMI equivalent“ and, through communication with the City Institute for Emergency Medical Aid and consultation with the interventional cardiologist, patients are transported directly to catheterization labs for further diagnostics and treatment. Early invasive procedures and adequate therapy (PCI/CABG) lower the possibility of cardiac shock and lethal outcome [9].

Informed consent: An informed consent has been provided by the patients for publishing this article.

Conflict of interest: the authors state that there is no conflict of interest.

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ORIGINALNI RAD

ZNAČAJ PREHOSPITALNOG PREPOZNAVANJA ST ELEVACIJE U AVR ODVODU U AKUTNOM KORONARNOM SINDROMU*Gordana TODORVIĆ¹, Aleksandar JOLDŽIĆ¹, Dragana VESIĆ²*¹Gradski zavod za hitnu medicinsku pomoć, Beograd, Srbija; ²Služba hitne medicinske pomoći, Stara Pazova, Srbija**SAŽETAK**

Uvod/cilj Lekari SHMP se svakodnevno sreću sa akutnim koronarnim sindromom. Izuzetna važnost se pripisuje tumačenju EKG zapisa od strane lekara SHMP, u cilju detekcije ST elevacije u aVR odvodu, koja može ukazati na kritičnu koronarnu leziju. ST depresija ≥ 1 mm u šest ili više odvoda (inferolateralna depresija) udružena sa elevacijom ST segmenta u aVR i/ili V1 ukazuje na trosudovnu koronarnu bolest, ili opstrukciju glavnog stabla leve koronarne arterije. Cilj rada je bio, prikazati u kojoj meri su lekari SHMP, uključenih u STEMI mrežu, edukovani u prepoznavanju i zbrinjavanju AVR elevacije kao atipičnog EKG zapisa.

Prikazi bolesnika Opisana su tri pacijenta sa bolom u grudima, trajanja od 30 min do 2,5h. U EKG zapisu uočene su značajne depresije ST segmenta >1 mm u 6 i više odvoda (I, II, III, AVL, AVF, V2-V6) sa elevacijom u AVR odvodu oko 3-4mm i V1 odvodu slične ili manje magnitude. Za sva tri pacijenta inicirana je strategija za primarni PCI, pa su u konsultaciji sa interventnim kardiolozima nakon primenjene dvojnje antiagregacione terapije (osim u trećem slučaju), direktno transportovani u angio sale nadležnih KBC.

Zaključak Lekari SHMP adekvatno i pravovremeno reaguju u prepoznavanju ST elevacije u aVR odvodu u akutnom koronarnom sindromu. Nakon konsultaciju sa interventnim kardiolozima, takvi pacijenti stižu direktno u angio sale. Konačnu odluku o tipu reperfuzione terapije donose kardiolozi i/ili kardiohirurzi. Rani invazivni pristup i adekvatna terapija (PCI/CABG) smanjuju mogućnost nastanka kardiogenog šoka i smrtnog ishoda.

Ključne reči: AVR elevacija, atipičan EKG zapis, SHMP