

Recording lead V₄R is associated to enhanced use of fibrinolytic therapy in acute myocardial infarction[☆]

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Abstract

Background: ST-segment elevation in the right-sided chest lead V₄R in inferior wall myocardial infarction is recognized as a sign of proximal occlusion of the right coronary artery with evolving right ventricular myocardial infarction. Our objective is to study how often lead V₄R is recorded in clinical practice and how this might be associated with use of reperfusion therapy and outcome of patients.

Methods: Recording of lead V₄R in 814 consecutive patients with acute myocardial infarction, administration of therapy, and outcome of the patients during a median follow-up of 285 days (174–313 days) were studied.

Results: V₄R was recorded in 52% of patients with inferior ST-elevation myocardial infarction. Patients with V₄R recorded were more likely to receive fibrinolytic therapy compared with patients without recording (65% vs 51%; $P = .035$). In multivariate analysis, recording of lead V₄R (odds ratio [OR] 1.6, 95% confidence interval [CI] 1.1–2.2; $P = .006$), along with age ($P < .001$), previous myocardial infarction (OR 2.2, 95% CI 1.3–3.5; $P = .002$), and diabetes (OR 3.9, 95% CI 1.1–2.4; $P = .03$) correlated to the use of reperfusion therapy. Patients with lead V₄R recorded had less ($P = .055$) reinfarction, unstable angina, stroke, and/or death during follow-up.

Conclusions: Lead V₄R was recorded in only half of patients with inferior ST-elevation myocardial infarction. Patients with V₄R recorded were more likely to receive thrombolytic therapy than those without recording of the additional chest lead.

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Keywords:

Lead V₄R; Fibrinolytic therapy; Acute myocardial infarction; Right ventricular infarction

Introduction

Electrocardiography (ECG) recorded during the acute phase of an ST-elevation myocardial infarction contains clinically important diagnostic and prognostic information. When Sanders¹ published the first case report of a right ventricular myocardial infarction in 1930, it was not possible to make the diagnosis by ECG. Cohn et al² first described the clinical importance of right ventricular myocardial infarction in 1974. Acute myocardial infarction involving only the right ventricle is a rare event, but acute inferior wall myocardial infarction is much more common

(24%–52%) resulting in higher mortality.^{3–6} Proximal right coronary artery occlusion also seems to be a significant risk factor for prehospital sudden cardiac death.⁷ In the ECG, ST elevation in lead V₁ indicates right ventricular myocardial infarction in relation with inferior myocardial infarction. However, absence of this finding does not exclude infarction in the right ventricle.⁸ Placing additional chest leads V₃R to V₅R improves diagnostic accuracy. Studies have shown that ST-segment elevation in the additional chest lead V₄R is a sign of an occlusion of the right coronary artery proximal to the right ventricular branches (Fig. 1).⁹

Guidelines for the management of myocardial infarction include a 13-lead ECG measurement including lead V₄R in patients with inferior ST-segment elevation, but it is not known how often this is implemented in real life.¹⁰ It is not known how often lead V₄R is recorded in routine practice.

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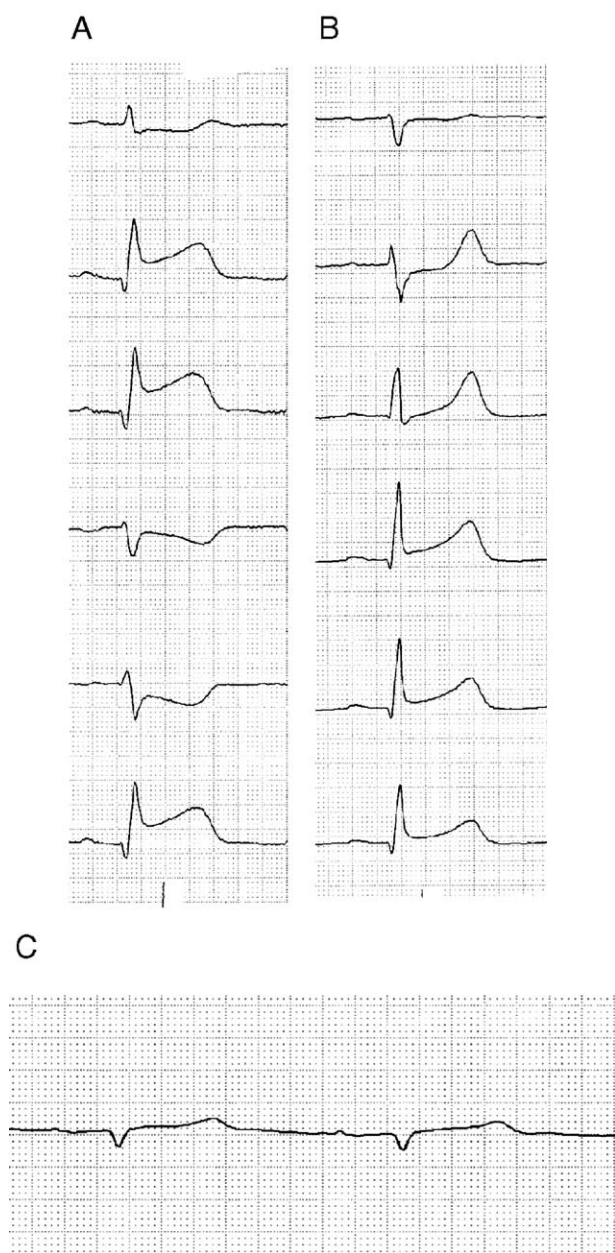


Fig. 1. A, ECG (50 mm/s) showing the extremity leads (I, II, III, aVR, aVL, and aVF). ST elevation in leads II, III, and aVF and reciprocal ST depression in I and aVL. B, ECG showing the chest leads V1-V6. ST depression in V2 and ST elevation in V4-V6. C, ST elevation (1 mm) in the right-sided chest lead V4R.

The aim of our study is to evaluate how often the additional lead was recorded in unselected consecutive patients with acute myocardial infarction, and how this might be associated to usage of fibrinolytic therapy and outcome of the patients.

Material and methods

Study population

This prospective observational study included 814 consecutive patients with acute ST-elevation or non-ST-elevation myocardial infarction with elevated cardiac troponin I levels admitted to the emergency department of

Tampere University Hospital between January and December 2002. We excluded patients who died in the emergency department. Blood samples for cardiac troponin I were collected at baseline and after 6 to 12 hours. Myocardial infarction was defined as elevated cardiac troponin I (normal value $<0.2 \mu\text{g/L}$; ACS:180, Bayer Diagnostics, Tarrytown, NY) in the clinical setting of acute myocardial ischemia.¹¹ An ECG from the acute phase was analyzed. All study participants gave their written informed consent for study participation at hospital admission, and the Ethics Committee at Tampere University approved the study protocol. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. A study nurse contacted all alive patients by telephone to collect follow-up data. Causes of death were registered from official statistics. The outcome of the patients was defined on the basis of composite end points (reinfarction, unstable angina, stroke, and/or death). Patient follow-up ended in case of a composite end point or at the time of the phone call by the study nurse. The median follow-up was 285 days (174–313 days).

ECG analysis

The prevailing American College of Cardiology/American Heart Association (ACC/AHA) guidelines for ECG recording adopted for routine praxis include the use of lead V₄R in inferior myocardial infarction.¹⁰ Two investigators (KCN and MJE) analyzed the ECGs ($N = 814$) from the acute phase manually. The ECGs were recorded at the admitting health center, in the ambulance, or in the emergency department. During the collection of the patient series, the investigators did not actively intervene to change routine practice in recording additional leads. ST-segment deviation from the isoelectric line, determined by drawing a line between subsequent PQ segments, was considered elevated or depressed if it was ≥ 0.5 mm above or below the isoelectric line, respectively. Measurement was done at 80 ms after the J-point.

ECG criteria for fibrinolytic therapy were defined as ST-segment elevation ≥ 2 mm in 2 or more consecutive chest leads, ≥ 1 mm in 2 or more consecutive extremity leads, or (presumed) new left bundle branch block.

Statistical analysis

The associations between the use of V₄R and the noncontinuous parameters were compared with Pearson χ^2 test, Fisher exact test, or with the Mann-Whitney test. A multivariate logistic regression analysis for factors leading to the use of fibrinolytic therapy in the whole study cohort was calculated using age, sex, previous myocardial infarction, hypertension, smoking, as well as diabetes mellitus as covariates. A probability value of $<.05$ was considered statistically significant. All calculations were performed using the SPSS 11.5 statistical package (SPSS Inc, Chicago, Ill).

Results

Mean age of the whole study cohort ($N = 814$) was 71.8 years, 58% were male and 42% female. Of the study population, 26% had a history of prior myocardial infarction,

Table 1
Regression analysis for fibrinolytic therapy in patients with acute MI (N = 814)

	OR	95% CI	P
DM type II	1.6	1.1–2.4	.03
Recording of lead V ₄ R	1.6	1.1–2.2	.006
Age	1.0	1.0–1.1	<.001
Previous MI	2.2	1.3–3.5	.002

OR, odds ratio; CI, confidence interval; DM, diabetes mellitus; MI, myocardial infarction.

1% of percutaneous coronary intervention, 3% of coronary bypass surgery, and 1% of both procedures. Lead V₄R was recorded in 366 (45%) patients in the whole study population (N = 814), in 271 (47%) patients with non-ST-elevation myocardial infarction (n = 577), and in 110 (46%) patients with ST-elevation myocardial infarction (n = 237). V₄R had been recorded in 44 (52%) patients with inferior ST-elevation myocardial infarction (n = 86) and in 66 (44%) patients with other ST-elevation myocardial infarctions (n = 151). The difference in recording rate in favor of inferior myocardial infarctions was not statistically significant ($P = .17$). Lead V₄R was recorded more often in men compared with women in all age groups, but the difference was not statistically significant (men vs women <55 years [44% vs 38%], 55–64 years [52% vs 50%], 65–74 years [45% vs 37%], and ≥ 75 years [45% vs 37%]; $P = .53$). There were no patients with ST-segment elevation in lead V₄R only. Of all patients fulfilling criteria for fibrinolytic therapy, 58% were treated. Of 153 patients treated with thrombolytic therapy, 22 (9%) did not fulfil traditional ECG criteria for fibrinolysis. Of these, 68% had lead V₄R recorded, and 32% did not.

Patients with lead V₄R recorded were more likely to receive fibrinolytic therapy: in patients, in whom the additional lead was not recorded in the acute phase, 51% were treated by fibrinolytic therapy compared with 65% with the lead recorded ($P = .035$). In a forced logistic regression model (Table 1) with age, sex, previous myocardial infarction, hypertension, smoking, as well as diabetes mellitus as covariates, receiving fibrinolytic treatment was positively associated with age, previous myocardial infarction, recording of lead V₄R, and diabetes mellitus. Among patients with acute inferior myocardial infarction, those with lead V₄R recorded tended to have better prognosis: patients with lead V₄R recorded had less ($P = .055$) composite end points (reinfarction, unstable angina, stroke, and/or death) during follow-up (no composite end point 64% vs 68%, one composite end point 35% vs 22%, 2 composite end points 0% vs 9%, respectively).

Discussion

Lead V₄R is recognized as an important tool in the diagnosis and risk stratification of acute myocardial infarction indicating proximal occlusion of the right coronary artery and evolving right ventricular myocardial infarction.¹² Reperfusion therapy with a fibrinolytic agent or primary percutaneous coronary intervention (PCI) should

be considered without delay.¹³ Our study showed that usage of lead V₄R had a significant positive impact on the rate of administration of fibrinolytic therapy. If the right-sided chest lead V₄R was recorded in the acute phase, fibrinolytic therapy was administered in 65% of cases compared with 51% in patients without the additional lead. Studies have shown that reperfusion therapy is underused in acute myocardial infarction patients. In the National Registry of Myocardial Infarction (NRM)-2 Registry, only 66% of eligible patients were given fibrinolytic therapy.¹⁴ These findings are largely reproduced in Western Europe and Canada.¹⁵ In daily practice, half of the patients do not receive reperfusion treatment with fibrinolysis or primary PCI.¹⁶

V₄R was recorded in less than half of all the patients with acute myocardial infarction in our study. The presence of ST elevations in the ECG did not significantly increase the probability of recording the additional lead. Even in patients with inferior ST-elevation myocardial infarction, where the importance of right-sided chest leads has been best documented, lead V₄R was recorded in only 52%. According to the ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction, a 12-lead ECG should be performed and shown to an experienced emergency physician within 10 minutes of emergency department arrival for all patients with chest discomfort or other symptoms suggestive of ST-elevation myocardial infarction. In patients with inferior ST-elevation myocardial infarction, right-sided chest leads should be obtained.¹⁰

In Finland, a nurse or a laboratory technician usually records the ECG before the evaluation by a doctor. An ECG showing acute ST-segment elevations, recorded immediately upon a patient's arrival at the emergency department, might speed up the decision process. According to the ACC/AHA guidelines, hospitals should develop guideline-based, institution-specific written protocols for triaging and managing patients with suspected myocardial infarction. In addition, indications for the recording of an additional ECG lead—V₄R—should be included in local guidelines. At the time of our study, there was no written institution-specific protocol for ECG recording in patients with acute coronary syndrome available at the emergency department of our hospital.

Our study gives no definite answers as to why recording of an additional right-sided chest lead led to enhanced usage of reperfusion therapy. Overall, the rate of recording lead V₄R was 45%. It was only slightly higher (52%) in patients with inferior ST-elevation myocardial infarction, in whom a right-sided chest lead always should be recorded. There was a trend for a better prognosis in patients with inferior myocardial infarction with lead V₄R recorded compared with those without. Awareness of right ventricular involvement by ST-segment elevation in lead V₄R by treating physicians could have resulted in a more accurate decision on reperfusion therapy and subsequently in a greater chance of an open infarct related artery.

After completing the study, the investigators sent a questionnaire to all emergency department personnel

involved in ECG recording. According to the results of the questionnaire, answered by practically all the personnel, there was a tendency to record lead V₄R more often if the patient had chest pain or if the ECG showed obvious changes, like left bundle branch block, old Q waves, left ventricular hypertrophy, or ST-segment elevation. Despite a lack of institution-specific guidelines for ECG recording in patients with acute coronary syndrome, nurses and laboratory technicians may identify high-risk patients based on clinical and 12-lead ECG findings.

Several surveys have shown that the implementation of new guidelines is suboptimal. There may be many reasons why practitioners do not apply guidelines. Lack of awareness can account for 23%–28% of poor compliance with recommendations in some guidelines.^{17,18} Physicians may also disagree with the contents. In a study by Novak et al.,¹⁹ 93% of cardiologists and 78% of emergency physicians (of 69 cardiologists and 171 emergency physicians) identified the diagnostic criteria of V₄R to V₆R. Still, only 18.5% of cardiologists and 13.0% of emergency physicians responded that they regularly use right ventricular leads in the diagnosis of myocardial infarction.¹⁹

Manual analysis of all the patients' ECGs by 2 of the investigators revealed that 9% of all patients treated with thrombolytic therapy did not fulfil traditional criteria for fibrinolysis. All of these patients, however, had some degree of ST-segment elevation, usually in leads V₁ and V₂ in conjunction with widespread ST-segment depression. In addition, by definition, all patients had acute myocardial infarction with elevated troponin levels. The proportion of patients with lead V₄R recorded in cases with "inappropriate" thrombolysis was higher (68%) than in the whole study cohort (45%). The numbers are too small to enable any reliable statistical analysis, but strict adherence to guidelines for treatment of ST-elevation myocardial infarction is important.

Primary percutaneous coronary intervention is the preferred treatment for ST-elevation myocardial infarction in many institutions. Fibrinolysis is widely available but applicable to only about 50% of patients. Primary angioplasty has been shown to have favorable effects on many myocardial infarction end points, and its position as treatment of choice has gained universal acceptance.¹⁰ Only a minority of hospitals can provide prompt, high-quality primary percutaneous coronary intervention as routine treatment for ST-elevation myocardial infarction patients. If local protocols for treatment included individual risk stratification based on ECG parameters, lead V₄R may be useful in sorting out a high-risk subset with right ventricular myocardial infarction.

Study limitations

This study has a number of limitations. It was not a randomized controlled trial. The number of patients with inferior ST-elevation myocardial infarction was rather low, making it difficult to draw firm conclusions about the value of recording lead V₄R. However, it represents a cohort of consecutive patients from everyday clinical practice. We

were not able to compare possible differences in the number of patients with contraindications to fibrinolytic therapy between patients in whom lead V₄R was recorded or not. It seems unlikely that there would have been a significant difference because contraindications are not related to ECG findings. There were only a few patients with acute myocardial infarction who died in the emergency department during the study period. Hence, we do not think that excluding these patients has had any significant impact on the main result of the study.

In conclusion, lead V₄R was recorded in only half of patients with inferior ST-elevation myocardial infarction. Patients with V₄R recorded were more likely to receive thrombolytic therapy than those without recording of the additional chest lead.

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