

# Inferior wall myocardial infarction with or without right ventricular involvement - treatment and in-hospital course

Piotr Kukla<sup>1</sup>, Dariusz Dudek<sup>2</sup>, Tomasz Rakowski<sup>2</sup>, Artur Dziewierz<sup>2</sup>, Waldemar Mielecki<sup>2</sup>, Kazimierz Szczuka<sup>1</sup>, Jacek S. Dubiel<sup>2</sup>

<sup>1</sup>Internal Diseases Unit, Henryk Klimontowicz Specialist Hospital, Gorlice, Poland

<sup>2</sup>2<sup>nd</sup> Department of Cardiology, Jagiellonian University School of Medicine, Kraków, Poland

## Abstract

**Introduction:** Right ventricular infarction (RVI) is most commonly associated with inferior wall infarction (20-50% of cases). Clinical presentation of RVI may vary.

**Aim:** Assessment of outcome and clinical course of myocardial infarction in patients with inferior wall myocardial infarction with or without RVI. Additionally, risk stratification was attempted in the above-mentioned groups of patients.

**Methods:** The analysis involved 181 consecutive patients (pts) with inferior wall myocardial infarction hospitalised between 1 July 2000 and 1 July 2002.

**Results:** Nineteen in-hospital deaths were noted in the study group (mortality 10.5%), reinfarction occurred in 6 (3.3%) pts, ischaemic stroke in 1 (0.6%) patient, and 2 (1.1%) pts had transient ischaemic attack. Cardiogenic shock occurred in 20 (11.0%) pts, ventricular fibrillation in 15 (8.3%) pts, and pulmonary oedema in 9 (4.9%) pts. In the subgroup of 161 pts without cardiogenic shock 8 (4.9%) pts died. Thrombolytic therapy was administered in 96 (53%) subjects. Isolated inferior wall myocardial infarction was diagnosed in 94 (51.9%) of 181 pts and RVI in 65 (35.9%) pts. Mortality rate in the RVI group was significantly higher than in inferior wall myocardial infarction without RVI and was 18.5% vs 2.12% ( $p=0.0003$ ), respectively (excluding patients with cardiogenic shock: 11.1% vs 1.2%, respectively;  $p=0.016$ ). In patients with RVI aged above 70 years, the mortality rate was significantly higher than in younger patients (32% vs 10%,  $p=0.002$ ). In a subgroup with RVI treated with thrombolysis mortality was considerably higher in subjects aged >70 years compared to patients below 70 years (38.5% vs 7.7%,  $p=0.017$ ).

**Conclusions:** RVI is associated with worse prognosis and increased number of in-hospital complications. Older patients aged >70 years have definitely poorer prognosis. Thrombolytic therapy in a subgroup of older patients with RVI remains ineffective.

**Key words:** right ventricular infarction, reperfusion, inferior wall myocardial infarction, complications of infarction

Kardiologia Polska 2006; 64: 583-588

## Introduction

The incidence of right ventricular infarction (RVI) depends on established diagnostic criteria. RVI occurs in 20-50% of patients with left ventricular inferior wall myocardial infarction (MI) [1]. There is a wide range of haemodynamic disturbances associated with RVI - starting with asymptomatic course to severe heart failure with fully symptomatic cardiogenic shock [2]. Diagnosis based on standard ECG with additional RV leads and echocardiography helps to confirm the diagnosis of RV

impairment as a cause of hypotonia or cardiogenic shock. Correct and rapid diagnosis of RVI aids the implementation of adequate therapy, consisting of maintenance of normal pre- and afterload of RV. However, the key element of treatment is to restore myocardial perfusion as soon as possible by means of thrombolysis or percutaneous coronary intervention (PCI) [3-5].

The aim of this study was to assess outcome and clinical course of MI in patients with inferior MI with or without RVI. Additionally, risk stratification was attempted in this group of patients.

---

### Address for correspondence:

Piotr Kukla, Oddział Wewnętrzny, Szpital Specjalistyczny, ul. Węgierska 21, 38-300 Gorlice, Poland, e-mail: kukla\_piotr@poczta.onet.pl

**Received:** 31 May 2005. **Accepted:** 22 March 2006

## Methods

The analysis involved 181 consecutive patients with inferior MI hospitalised between 1 July 2000 and 1 July 2002 in the Internal Disease Unit of the Specialist Hospital in Gorlice.

The following diagnostic criteria of MI were used: pain duration >30 minutes, increase of cardiac necrosis marker enzymes: phosphocreatine kinase (CK) and creatine kinase isoenzyme MB (CK-MB) twice the upper normal limit in two consecutive measurements, elevation of ST segment in at least 2 leads of II, III and aVF by at least 1 mm measured 60 ms after J point.

On admission all patients routinely had 12-lead ECG with additional RV leads V4R-V6R. Based on the location of changes on ECG, patients were divided into the following groups:

- isolated inferior wall MI (group I) - ST-segment elevation in leads II, III and aVF;
- inferior wall MI with right ventricular involvement (group RVI) - ST-segment elevation in II, III and aVF with additional elevation of ST in lead V4R  $\geq 1$  mm;
- inferior and lateral wall MI - ST-segment elevation in II, III and aVF with concomitant ST elevation in leads V5-V6;
- inferior and posterior wall MI - ST-segment elevation in II, III and aVF with abnormal QRS morphology in leads V1, V2: delayed intrinsicoid deflection of up to 40 ms, increase of R wave amplitude in leads V1-V2 ( $R > S$  or  $R/S=1.2$ ) and depression of ST segment in leads V1-V2.

The sum of ST-segment depressions and elevations was measured in all leads of 12-lead ECG at 60 ms after J point with an accuracy of 0.5 mm.

During in-hospital stay, mortality rate, incidence of nonfatal reinfarction and cardiogenic shock were evaluated. Reinfarction was defined as recurrent angina with repetitive increase of CK levels (50% above the result of the last test or greater than twice the upper normal limit if prior normalisation was observed) and/or new ECG changes (ST-segment elevation, left bundle branch block, presence of new Q waves). Cardiogenic shock was defined as persistent systolic blood pressure <90 mmHg with abnormal peripheral perfusion or decrease in the baseline systemic blood pressure by 30 mmHg lasting at least 30 minutes without administration of pressor agents and systolic blood pressure >90 mmHg but <110 mmHg while on pressor agents. Thrombolytic therapy (streptokinase) was administered in all patients without contraindications and with chest pain lasting <12 hours. Additional pharmacological therapy was given in accordance with currently accepted guidelines on treatment of MI. Echocardiography was performed in 109 (60.2%) patients within the first 24 hours of hospitalization in the emergency room. Left ventricular

ejection fraction measurement (EF%) was performed in the apical 4-chamber view using Simpson's method. Arterial hypertension was diagnosed if arterial blood pressure exceeded 145/90 mmHg or in patients taking anti-hypertensive agents prior to admission. Diabetes mellitus was diagnosed in patients previously treated with insulin or oral antidiabetic agents or de novo during present hospitalisation according to the accepted standard criteria [6].

Diagnosis of hypercholesterolaemia was based on increased total cholesterol concentration >200 mg% or LDL >130 mg% during hospitalisation.

## Statistical analysis

Data are presented as mean  $\pm$  standard deviation or as number and percentage of patients. Categorical data were compared using  $\chi^2$  test and Fisher's exact test; U Mann-Whitney test was used for continuous data and Student's t-test for independent parameter analysis. Two-sided tests with  $p < 0.05$  significance level were used.

## Results

Clinical characteristics of the study patients are detailed in Table I. Mean hospitalisation duration was  $9 \pm 3$  (5-17) days. Isolated inferior MI was diagnosed in 94 (51.9%) patients and RVI - in 65 (35.9%) patients. Patients with RVI reported to the hospital significantly faster had considerably greater sums of ST-segment elevations on ECG and lower systolic blood pressures on admission.

Table II shows in-hospital complications. Patients with RVI had significantly higher mortality, cardiogenic shock rate and third degree AV block incidence.

Thrombolytic therapy was administered in 96 (53%) subjects. Mortality rate of patients treated with thrombolysis was close to that of patients without such treatment (9.3% vs 11.8%,  $p=NS$ ). In thrombolysed patients nonfatal reinfarction tended to be more frequent than in patients who received no thrombolytic agents (5.2% vs 1.1%,  $p=NS$ ).

The entire study population included 39.8% patients aged above 70 years of whom 10 (13.9%) subjects died, whereas in patients aged below 70 years death was reported in 6 (8.2%) cases ( $p=0.22$ ).

In patients with RVI aged above 70 years the mortality rate observed was significantly higher than in patients younger than 70 years. In both subgroups of patients with RVI the incidence of cardiogenic shock and the frequency of thrombolytic treatment were similar. In patients with RVI aged above 70 years treated with thrombolysis the mortality rate was significantly higher

**Table I.** Study group characteristics

	Total	Isolated inferior MI, n=94	RVI, n=65	p*
Gender (M/F) [n]	112/69	55/39	44/21	NS
Age [years]	64.3±11.9	64.2±11.9	64.5±11.7	NS
<b>Risk factors:</b>				
Arterial hypertension [n]	82(45.3%)	45(49.7%)	23(36.9%)	NS
Diabetes mellitus [n]	31(17.1%)	17(18.0%)	11(16.0%)	NS
Hypercholesterolaemia [n]	79(43.6%)	41(44.7%)	30(44.6%)	NS
Smoking [n]	86(47.5%)	50(52.1%)	25(38.9%)	NS
Chest pain duration [hours]	8.1±11.4	9.7±13.0	5.8±8.7	0.03
SBP on admission [mmHg]	132.9±47.3	140±36	117±52	0.003
Max CK (IU/L)	1427±1346	1146±877	1830±1790	0.01
EF [%]	54.9%±8.9	55.9%±9.7	54.1%±7.6	NS
Sum of ST-segment elevation/depression [mm]	16.3±11.2	12.5±7.9	22.8±12.1	0.005

Abbreviations: RVI - inferior wall and right ventricular myocardial infarction, SBP - systolic blood pressure, EF - left ventricular ejection fraction

\*p - related to isolated inferior MI group vs RVI group

than in patients younger than 70 years who received the same treatment. Table III details the results.

Ten (9.7%) subjects died in the subgroup of patients with chest pain lasting <6 hours, 6 (14%) - in the group with chest pain duration of 6-12 hours, and 3 (8.6%) in the group with >12 hours of pain. In patients with RVI, subjects admitted within the first 6 hours from the onset of chest pain had mortality rate two times lower than the group of patients admitted between 6 and 12 hours from the onset of pain (13.6% vs 28.6%; p=0.033). Within the time period of 6-12 hours, patients with RVI aged >70 years had significantly

higher mortality rate than the younger ones (10% vs 62.5%, respectively; p=0.001, see Table IV).

## Discussion

Domestic literature so far contains few publications on the incidence and prognosis of patients with RVI. Only two studies are available - Janion et al. [7] and Slowinski et al. [8] - dealing with the clinical course of the acute phase of MI and prognosis in the chronic phase.

Our analysis and the above-mentioned papers show that the clinical picture of inferior MI may be extremely diverse. Inferior MI with RVI is associated with definite-

**Table II.** Complications during in-hospital stay

Complications	total n (%)	Isolated inferior MI, n (%)	RVI, n (%)	p*
Mortality	19 (10.5)	2 (2.1)	12 (18.4)	0.003
Ischaemic stroke and TIA	3 (1.6)	0 (0)	1v(1.5)	NS
Reinfarction	6 (3.3)	3 (3.1)	2 (3.0)	NS
Pulmonary oedema	9 (4.9)	4 (4.2)	4 (6.1)	NS
Cardiogenic shock	20 (11.0)	4 (4.2)	14 (21.5)	0.004
VF	15 (8.3)	3 (3.1)	9 (10.7)	NS
VT	7 (3.9)	2 (2.1)	5 (7.6)	NS
III degree AV block	26 (14.4)	4 (4.2)	22 (33.8)	0.001
PAF	25 (13.8)	14 (15.9)	10 (15.3)	NS
CHF	55 (30.6)	22 (23.4)	25 (38.4)	NS

Abbreviations: RVI - right ventricular infarction, TIA - transient ischaemic attack, VF - ventricular fibrillation, VT - ventricular tachycardia, PAF - paroxysmal atrial fibrillation, CHF - congestive heart failure during hospitalization

p\* - related to isolated inferior MI group vs RVI group

**Table III.** Mortality in RVI group with respect to age and thrombolysis

	Age >70 years, n=25	Age <70 years, n=40	p
Deaths	8 (32%)	4 (10%)	0.026
Rate of thrombolytic treatment	13 (52%)	26 (65%)	NS
Deaths in thrombolysis group	5 (38.5%)	2 (7.7%)	0.017
Cardiogenic shock rate	5 (20%)	9 (22.5%)	NS

Abbreviations: RVI - right ventricular infarction

**Table IV.** Overall in-hospital mortality in selected time periods in patients aged above 70 years and below 70 years with RVI

Chest pain duration (hours)	Age (years)	Death n (%)	p
0-6	<70	3 (10.3)	
0-6	>70	3 (20.0)	0.37
6-12	<70	1 (10.0)	
6-12	>70	5 (62.5)	0.001

ly increased mortality and complications such as cardiogenic shock, advanced atrioventricular or ventricular conduction disturbances or life threatening ventricular arrhythmias (ventricular fibrillation). However, isolated inferior MI was associated with extremely low in-hospital mortality below 2.1%, and as low as 1% after exclusion of patients with cardiogenic shock.

Patients with RVI remain however a very heterogeneous group. It seems that age notably influences prognosis in this group of patients. It has been shown that older patients aged above 70 years have three times higher mortality rate compared to younger individuals. The analysis of Bueno et al. also demonstrated that older patients aged above 75 years with inferior MI and RVI had a mortality rate of up to 47%, compared to 10% - in RVI-negative patients [9]. However, in their study population the percentage of older patients treated with thrombolysis was relatively low and equalled 18% for inferior MI with involvement of the right ventricle and 23% for isolated inferior MI.

Pharmacological treatment of patients with RVI is associated with very high in-hospital mortality regardless of thrombolytic therapy. Our studies show that it is particularly high in the older patients (above 70 years), hospitalised after 6 hours from the onset of infarction symptoms.

The problem of infarct-related cardiogenic shock, which in patients with RVI results from RV failure, should also be addressed. As demonstrated by the SHOCK Registry [10], the occurrence of shock is associated with a high mortality rate of 53%. The mortality observed in our group of patients with RVI admitted with diagnosis of cardiogenic shock was 42.9%. In the analysis of Janion et al. it reached 45.8% [7], and in the study of Love et al. it reached 40% [11].

Considering our results, the following scheme of management of patients with inferior MI may be suggested for sites without catheterization labs. Patients with isolated inferior MI should be included in the low-risk group of good prognosis and mortality rate below 2%. Patients aged below 70 years with inferior MI and RVI regardless of pain duration comprise the group of moderate risk. The high risk group includes older patients (above 70 years) with RVI regardless of pain duration and patients with RVI complicated with cardiogenic shock. Low- and moderate-risk groups, particularly with 2-3 hour chest pain, could be primarily treated with a novel thrombolytic agent and there is a further possibility of rescue PCI in case of thrombolysis failure. The high-risk group should be transferred to the invasive treatment labs; additional pharmacological treatment in the ambulance remains open.

Our study also led to the indirect conclusion that older patients (above 70 years) should always be treated with mechanical reperfusion. Thrombolytic therapy is less effective, especially after 6 hours from the onset of symptoms, and is also associated with increased risk of bleeding. This was confirmed by the outcomes of the recent clinical trials on treatment of MI in the elderly, which showed the advantage of invasive treatment over thrombolysis [12, 13].

## Conclusions

1. In-hospital mortality in patients with inferior MI and RVI is higher than in patients with isolated inferior MI.
2. Patients with RVI aged above 70 years, admitted to hospital after 6 hours from the onset of symptoms, remain the group at extremely high risk, and thrombolytic treatment (streptokinase) produces no major effects.
3. In-hospital mortality in the group of patients with RVI and cardiogenic shock present on admission still remains very high.

## References

1. Cohn JN, Guiha NH, Broder MI, et al. Right ventricular infarction. Clinical and hemodynamic features. *Am J Cardiol* 1974; 33: 209-14.

2. Cohn JN. Right ventricular infarction revisited. *Am J Cardiol* 1979; 43: 666-8.
3. Kosior D, Opolski G. Zawał prawej komory serca – problem teoretyczny czy kliniczny? *Pol Przegl Kardiol* 2000; 1: 59-64.
4. Silber S, Albertsson P, Aviles FF, et al. Guidelines for percutaneous coronary interventions. The Task Force for Percutaneous Coronary Interventions of the European Society of Cardiology. *Eur Heart J* 2005; 26: 804-47.
5. Van der Werf F, Ardissino D, Betriu A, et al. Management of acute myocardial infarction in patients presenting with ST-segment elevation. The Task Force on the Management of Acute Myocardial Infarction of the European Society of Cardiology. *Eur Heart J* 2003; 24: 28-66.
6. Definitions, diagnosis and classification of diabetes and its complications. *WHO Bulletin* 1999: 1-59.
7. Janion M, Ciuraszkiwicz K, et al. Przebieg kliniczny i rokowanie odległe u pacjentów z zawałem serca ściany dolnej współistniejącym zawałem prawej komory. *Pol Przegl Kardiol* 1999; 1: 23-32.
8. Słowiński S, Moszczyński P, Januś B, et al. Zawał prawej komory – obserwacje własne. *Przegl Lek* 1999; 56: 263-6.
9. Bueno H, Lopez-Sendon R, Bermejo J, et al. In-hospital outcome of elderly patients with acute inferior myocardial infarction and right ventricular involvement. *Circulation* 1997; 96: 436-41.
10. Jacobs AK, Leopold JA, Bates E, et al. Cardiogenic shock caused by right ventricular infarction: a report from the SHOCK registry. *J Am Coll Cardiol* 2003; 41: 1273-9.
11. Love JC, Haffajee CI, Gore MJ, et al. Reversibility of hypotension and shock by atrial or atrioventricular sequential pacing in patients with right ventricular infarction. *Am Heart J* 1984; 108: 5.
12. de Boer MJ, Ottervanger JP, van't Hof AW, et al. Reperfusion therapy in elderly patients with acute myocardial infarction: a randomized comparison of primary angioplasty and thrombolytic therapy. *J Am Coll Cardiol* 2002; 39: 1723-8.
13. Goldenberg I, Matetzky S, Halkin A, et al. Primary angioplasty with routine stenting compared with thrombolytic therapy in elderly patients with acute myocardial infarction. *Am Heart J* 2003; 145: 862-7.

## Zawał ściany dolnej z zajęciem i bez zajęcia prawej komory – leczenie i przebieg kliniczny w obserwacji szpitalnej

Piotr Kukla<sup>2</sup>, Dariusz Dudek<sup>1</sup>, Tomasz Rakowski<sup>1</sup>, Artur Dziewierz<sup>1</sup>, Waldemar Mielecki<sup>1</sup>, Kazimierz Szczuka<sup>2</sup>, Jacek S. Dubiel<sup>1</sup>

<sup>1</sup>II Klinika Kardiologii, Collegium Medicum UJ, Kraków

<sup>2</sup>Oddział Wewnętrzny, Szpital Specjalistyczny im. H. Klimontowicza, Gorlice

### Streszczenie

**Wstęp:** Zawał prawej komory (RVI) najczęściej towarzyszy zawałowi ściany dolnej (20–50% przypadków). RVI charakteryzuje się różnorodnością kliniczną.

**Cel:** Ocena wyników leczenia oraz przebiegu klinicznego zawału serca u chorych z zawałem ściany dolnej z i bez RVI. Dodatkowo próbowano dokonać stratyfikacji ryzyka w ww. podgrupach chorych.

**Metodyka:** Do analizy włączono 181 chorych z zawałem ściany dolnej hospitalizowanych w okresie od 1 lipca 2000 r. do 1 lipca 2002 r.

**Wyniki:** W okresie hospitalizacji w badanej grupie zmarło 19 chorych (śmiertelność 10,5%), u 6 z nich doszło do ponownego zawału serca (3,3%), u 1 chorego do udaru niedokrwienego mózgu (0,6%) oraz u 2 (1,1%) do przejściowego niedokrwienia mózgu. Wstrząs kardiogeny wystąpił u 20 chorych (11,0%), migotanie komór u 15 (8,3%) oraz obrzęk płuc u 9 (4,9%). W podgrupie 161 chorych, którzy nie rozwinęli wstrząsu kardiogenego zmarło 8 (4,9%). Leczenie trombolityczne zastosowano u 96 (53%) chorych. Spośród 181 chorych u 94 (51,9%) rozpoznano izolowany zawał ściany dolnej, a u 65 (35,9%) RVI. Śmiertelność w przypadku RVI była istotnie wyższa niż w zawałe ściany dolnej bez RVI i wyniosła odpowiednio 18,5% vs 2,12%,  $p=0,0003$  (po wyłączeniu chorych we wstrząsie kardiogenym odpowiednio 11,1% vs 1,2%,  $p=0,016$ ). U chorych z RVI powyżej 70. roku życia obserwowano istotnie większą śmiertelność niż u chorych poniżej 70. roku życia (32% vs 10%,  $p=0,002$ ). W podgrupie chorych z RVI leczonych trombolitycznie śmiertelność była istotnie wyższa u osób powyżej 70. roku życia w stosunku do chorych poniżej 70. roku życia (38,5% vs 7,7%,  $p=0,017$ ).

**Wnioski:** Zawał prawej komory wiąże się z gorszym rokowaniem oraz większą liczbą powikłań w trakcie hospitalizacji. Chorzy powyżej 70 lat mają zdecydowanie gorsze rokowanie. Leczenie trombolityczne w podgrupie chorych starszych z RVI jest nieskuteczne.

**Słowa kluczowe:** zawał prawej komory, reperfuzja, zawał ściany dolnej, powikłania zawału

Kardiol Pol 2006; 64: 583-588

### Adres do korespondencji:

Piotr Kukla, Oddział Wewnętrzny, Szpital Specjalistyczny, ul. Węgierska 21, 38-300 Gorlice, e-mail: kukla\_piotr@poczta.onet.pl

Praca wpłynęła: 31.05.2005. Zaakceptowana do druku: 22.03.2006