sciendo e-ISSN 1822-7767

Original paper

Retrospective analysis of complications and survival in patients with acute inferior myocardial infarction accompanied by right ventricular myocardial infarction

Gintarė Neverauskaitė-Piliponienė [a,*], Rasa Kūgienė [a,b,c], Žaneta Petrulionienė [a,b,c], Pranas Šerpytis [a,b,c]

[a] *Faculty of Medicine, Vilnius University, Vilnius, Lithuania*
[b] *Clinic of Cardiovascular Diseases, Institute of Clinical Medicine Faculty of Medicine, Vilnius University, Vilnius, Lithuania*
[c] *Vilnius University Hospital Santaros Klinikos, Vilnius, Lithuania*

Received 14 March 2019; accepted 25 April 2019

Summary

Right ventricular myocardial infarction (RVMI) accompanies about 30–50% of inferior wall myocardial infarction. RVMI is associated with higher rates of cardiogenic shock, atrioventricular block, atrial fibrillation, increased mortality rates. The topic requires a scientific update, as only a few studies have been made on RVMI during the past decade. We aimed to analyse the impact of RVMI on inferior myocardial infarction.

Design and methods: Retrospective study included 310 patients with documented inferior myocardial infarction (with and without RVMI) between January 2013 and January 2014. Data on baseline characteristics, mortality, in-hospital complications: cardiogenic shock and rhythm and conduction disorders was collected.

Results: In 102 (32.9%) patients with inferior myocardial infarction, RVMI was present and 208 (67.1%) cases were without RVMI involvement. RVMI patients had higher rate of rhythm and conduction disturbances than patients without RVMI involvement: atrioventricular block (OR 3.8, 95% CI 2.0–7.1, $p < 0.001$), atrial fibrillation (OR 1.6, 95% CI 0.9–2.9, $p = 0.001$), also higher incidence of cardiogenic shock (OR 2.6, 95% CI 1.7–3.9, $p < 0.001$). Mortality rates after 24 months were higher in RVMI group (OR 1.8, 95% CI 1.2–3.8, $p = 0.034$). No significant difference was found on in-hospital mortality.

Conclusions: Right ventricular involvement complicates the long-term mortality and outcomes after inferior myocardial infarction. It is related to a higher incidence of in-hospital complications, especially I–III degree AV block and atrial fibrillation. However, influence on long-term mortality needs further investigation.

Seminars in Cardiovascular Medicine 2019; 25:9–13

Keywords: right myocardial infarction, complications, mortality

Background

Coronary heart disease (CHD) is the most common cause of death out of all cardiovascular diseases. Myocardial infarction (MI) can be responsible for up to 15% of lethal cases [1]. Clinical studies on the matter began in the early 20th century [2,3], mainly focusing on left ventricular MI. Only in 1974, Cohn published a study about how right ventricular myocardial infarction (RVMI) has influence on more severe MI outcomes [4].

Right ventricular myocardial infarction (RVMI) accompanies around 30–50% of inferior wall MI [5], yet, isolated RVMI is a rare case [6,7]. The fourth universal definition of MI suggests that diagnosis of RVMI should be based on ECG findings (ST-segment elevation in leads V3R and V4R $\geq$0.5 mm or $\geq$1 mm in men under 30 years old). It also highlights that the absence of ST-elevation in the right precordial leads does not exclude RVMI, in this case, myocardial imaging should be performed [3]. RVMI is associated with higher rates of mortality and complications. Therefore,

* Corresponding address: Gintarė Neverauskaitė-Piliponienė, Faculty of Medicine, Vilnius University, M. K. Čiurlionio str. 21/27, Vilnius 03101, Lithuania.
E-mail: gintare.neverauskaite@gmail.com.

it also complicates the prognosis of inferior myocardial infarction [8].

According to recent reviews by Goldstein et al. and Namana et al., RVMI is being linked with higher rates of cardiogenic shock, electrical complications (e.g. atrioventricular block, atrial fibrillation) and mechanical complications [9,10]. However, only a few studies have been made on RVMI during the past decade. Reviews that are mentioned are mostly based on older research data with small patient numbers. Nevertheless, the topic remains important and requires a scientific update. In this study, we aimed to analyse the incidence, in-hospital complications and survival of inferior myocardial infarction with RVMI.

Design and methods

This retrospective study was conducted at Vilnius University Hospital Santaros Klinikos. The study enrolled patients with documented inferior MI (with and without right ventricular myocardial infarction) who were admitted to our hospital between January 2013 and January 2014.

Inclusion criteria were as follows: age > 18 years old, both genders, diagnosis of inferior myocardial infarction (elevated troponin I, chest pain and ECG presentation of inferior myocardial infarction with/without RVMI, ST-segment elevation in leads II, III, AVF were used to determine an inferior myocardial infarction). RVMI was diagnosed by recording additional right precordial leads and detection of ST-segment elevation in leads V3R-V6R and V1.

Overall, 310 patients were involved into the study. A total of 95 (30.6%) females and 215 (69.4%) males were included in the study. Mean age for women was 73.2 ± 10.4, men – 63.1 ± 11.7 ($p < 0.001$) years. Patients' clinical characteristics were collected from electronic health records. Collected data included baseline characteristics (age, gender, clinical symptoms on admission, dyslipidaemia, hypertension, diabetes mellitus, coronary artery disease, Killip class, systolic and diastolic blood pressure (BP)), in-hospital and long term (24-months) mortality, in-hospital complications: cardiogenic shock and cardiac rhythm and conduction disorders.

The study conforms with the principles outlined in the Declaration of Helsinki and was approved by the local ethics committee (approval number 158200-18/11-1075-574).

Statistical analysis

Statistical analysis was performed using SPSS statistical software package version 23.00 (IBM/SPSS). We verified the assumption of normality by using Kolmogorov–Smirnov test of normality. Categorical variables were compared using the chi-square test. Comparison of continuous variables was performed using the independent t-test (parametrical) or Mann–Whitney (non-parametrical). Binary logistics regression analysis was used to assess the odds ratio [OR] for RVMI influence on mortality, cardiogenic shock and electrical complications. Groups of interest were compared depending on RVMI involvement (with RVMI *vs* no RVMI). Data is presented as mean ± SD or proportions. The results were assumed significant when the *p*-value was <0.05.

Results

The study involved 310 patients with interior MI. In 208 (67.1%) patients RVMI was absent, and 102 (32.9%) cases of inferior MI were complicated by RVMI. We compared the baseline characteristics between patients with and without right ventricular involvement in inferior myocardial infarction. Patients with RVMI were more often asserted to Killip class IV than patients without RVMI (14.4% vs 10.3%, $p < 0.001$). Furthermore, patients with RVMI had a significantly lower systolic blood pressure (on-admission) of 125.7 ± 23 mmHg in comparison to no RVMI – 130.2 ± 25 mmHg, $p < 0.001$. No significant differences were found between other baseline characteristics. The comparison of baseline characteristics between groups is summarised in Table 1.

Regression analysis revealed that patients with RVMI had a significantly higher incidence of cardiogenic shock than patients without RVMI involvement (OR 2.6, 95% CI 1.7–3.9, $p < 0.001$). Patients who had inferior MI combined with RVMI were more likely to have electrical complications. A significant difference between groups was in I–III atrioventricular (AV) block incidence (OR 3.8, 95% CI 2.0–7.1, $p < 0.001$), also in atrial fibrillation incidence (OR 1.6, 95% CI 0.9–2.9, $p = 0.001$). Patients with RVMI also had a higher mortality rate when compared to those without RVMI. In-hospital mortality rates did not statistically differ between patients with RVMI and without it (6.4% versus 4.6%, $p = 0.23$), but 24-month mortality was higher in patients with RVMI (OR 1.8, 95% CI 1.2–3.8, $p = 0.034$). All complication rates within groups are presented in Table 2.

Discussion

Studies and reviews have confirmed that RVMI involvement is associated with more frequent complications and higher mortality rates after inferior myocardial infarction [8–11]. A lot of attention is focused on electrical complications (e.g.

Table 1.
Baseline characteristics

	Men	Women	*p*-value
Age, years	63.1 ± 11.7	73.2 ± 10.4	<0.001
	RVMI (*n* = 102)	No RVMI (*n* = 208)	*p*-value
Gender, % men	63.7	72.1	NS
Age, years	67.4 ± 12.5	66.4 ± 12.5	NS
Hypertension, %	81.4	80.8	NS
Diabetes mellitus, %	14.7	23.0	NS
Chronic kidney failure, %	8.2	5.5	NS
Dyslipidemia, %	96.3	94.7	NS
Killip class, %			
I	66	71.9	NS
II–III	19.6	17.6	NS
IV	14.4	10.3	<0.001
TCP, %	5	4.4	NS
Systolic BP, mm Hg	125.8 ± 23	130.2 ± 25	<0.001
Diastolic BP, mm Hg	74 ± 12.8	77.1 ± 12.7	NS

RVMI – right ventricular myocardial infarction, BP – blood pressure, TCP – temporary cardiac pacing, BNP – brain natriuretic peptide, NS – not significant ($p > 0.05$).

Table 2.
Outcomes after inferior myocardial infarction

	Complications (%) after inferior myocardial infarction		Regression analysis of complications (RVMI vs. No RVMI)		
COMPLICATION	RVMI (*n* = 102)	No RVMI (*n* = 208)	Odds Ratio	95% CI	*p*-value
Cardiogenic shock, %	18.6	7.8	2.6	1.7–3.9	<0.001
I–III° AV block, %	27.5	9.1	3.8	2.0–7.1	<0.001
RBBB, %	3.8	2.9	NS		0.45
LBBB, %	8.1	4	NS		0.15
Atrial fibrillation, %	23.5	15.9	1.6	0.9–2.9	0.001
Mortality, %					
In-hospital	6.4	4.6	NS		0.23
24 months	6.2	4.1	1.8	1.2–3.8	0.034

RVMI – right ventricular myocardial infarction; AV – atrioventricular; RBBB – right bundle branch block; LBBB – left bundle branch block; CI – confidence interval; NS – not significant ($p > 0.05$).

atrioventricular block and tachyarrhythmias) and their influence on short-term and long-term mortality. Our study only covers the population of Lithuania; however, our results confirm data from previous studies and state that RVMI involvement complicates inferior myocardial infarction with a poorer long-term prognosis and a greater rate of electrical complications.

In-hospital mortality

Based on our study results RVMI is not linked with higher rates of in-hospital mortality. According to McNamara R. L. et al., in-hospital mortality after acute coronary syndrome is influenced by female gender, age, history of hypertension and diabetes mellitus, cardiogenic shock and lower systolic blood pressure [12]. Our RVMI group did not differ by gender, age or comorbidities, although it did have a higher rate of cardiogenic shock and lower systolic blood pressure. These results can be explained by a report from the SHOCK registry published in 2003, which stated that RVMI does not influence in-hospital mortality rates on patients in cardiogenic shock [13]. Moreover, recent studies have shown that in-hospital mortality after inferior myocardial infarction with RVMI depends on the presence of restrictive right ventricular filling [14]. In our study, we did not evaluate the echocardiographic findings, this remains a subject of interest for a further studies.

Long-term mortality

On the contrary to short-term prognosis, RVMI may influence long-term mortality. Due to the retrospective study design, we can only highlight the tendency when patients with inferior myocardial infarction accompanied by RVMI have a higher rate of mortality 24-months after initial

hospitalisation. Despite that, our results coincide with previously published larger trials, such as the CORE study (multicentre, randomised, double-blinded, placebo-controlled trial on right ventricular involvement) [15]. The cause for poor prognosis might be due to the higher rates of complications linked to the right ventricle [16,17].

Electrical complications

In our population patients with RVMI were more likely to have I–III degree AV block and atrial fibrillation. It is known that inferior MI is prone to have higher rates of AV blocks [18]. Studies, including ours, have linked this complication with RVMI, which compromised up to 33% cases of inferior myocardial infarction in our study. Several mechanisms can be responsible for this phenomenon. Firstly, AV block might be caused due to increased parasympathetic tone in the inferior wall [19], also AV node blood supply could be compromised, since it comes from AV nodal artery which in a majority of population arises from the right coronary artery [21,22]. Additionally, our study found RVMI cases predisposed to atrial fibrillation. No prior research on the matter found this association and mechanism behind it remains unclear [15,23].

Limitations

Our study has a few limitations. This was a retrospective single-centre study and data was collected from hospitals' electronic records. Such data gathering might result in missing some important data. Also, retrospective study design limited our possibilities of comprehensive follow-up for long-term outcomes and end points.

Conclusions

In this study, we estimated the impact of RVMI on inferior myocardial infarction. Results from our study population support findings from earlier studies and establish new, previously not reported increased rate of atrial fibrillation. RVMI was involved in 32.9% cases of inferior myocardial infarction. Right ventricular involvement complicates the long-term prognosis and outcomes after inferior myocardial infarction. It is related to a higher incidence of complications, especially I–III degree AV block and atrial fibrillation. Influence on long-term mortality needs further investigation.

References

[1] Townsend N, Wilson L, Bhatnagar P, Wickramasinghe K, Rayner M, Nichols M. Cardiovascular disease in Europe: epidemiological update 2016. Eur Hear J 2016;37:3232–45.
[2] Herrick JB. Clinical features of sudden obstruction of the coronary arteries. JAMA 1912;LIX:2015–22.
[3] Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction (2018). Eur Hear J 2019;40:237–69.
[4] Chhapra DA, Mahajan SK, Thorat ST. A study of the clinical profile of right ventricular infarction in context to inferior wall myocardial infarction in a tertiary care centre. J Cardiovasc Dis Res 2013;4:170–6.
[5] Albulushi A, Giannopoulos A, Kafkas N, Dragasis S, Pavlides G, Chatzizisis YS. Acute right ventricular myocardial infarction. Expert Rev Cardiovasc Ther 2018;16:455–64.
[6] García-Niebla J, Pérez-Riera AR, Barbosa-Barros R, Díaz-Muñoz J, Daminello-Raimundo R, de Abreu LC, et al. Acute inferior myocardial infarction with right ventricular involvement and several clinical-electrocardiographic markers of poor prognosis. Ann Noninvasive Electrocardiol 2019;24:e12592.
[7] Namana V, Balasubramanian R, Hollander G. A 71-year-old man with complicated myocardial infarction. JAMA Cardiology 2016;1:735.
[8] Goldstein JA. Pathophysiology and management of right heart ischemia. J Am Coll Cardiol 2002;40:841–53.
[9] Goldstein JA. Acute right ventricular infarction. Cardiol Clin 2012;30:219–32.
[10] Namana V, Gupta SS, Abbasi AA, Raheja H, Shani J, Hollander G. Right ventricular infarction. Cardiovasc Revasc Med 2018;19:43–50.
[11] Foussas SG, Zairis MN, Tsiaousis GZ, Theodossis-Georgilas A, Prekates AA, Kontos CF, et al. The impact or right ventricular involvement on the postdischarge long-term mortality in patients with acute inferior ST-segment elevation myocardial infarction. Angiology 2010;61:179–83.
[12] McNamara RL, Kennedy KF, Cohen DJ, Diercks DB, Moscucci M, Ramee S, et al. Predicting in-hospital mortality in patients with acute myocardial infarction. J Am Coll Cardiol 2016;68:626–35.
[13] Jacobs AK, Leopold JA, Bates E, Mendes LA, Sleeper LA, White H, et al. Cardiogenic shock caused by right ventricular infarction. J Am Coll Cardiol 2003;41:1273–9.
[14] Altıntaş B, Yaylak B, Ede H, Altındağ R, Baysal E, Bilge Ö, et al. Impact of right ventricular diastolic dysfunction on clinical outcomes in inferior STEMI. Herz 2017;44:155–60.
[15] Mehta SR, Eikelboom JW, Natarajan MK, Diaz R, Yi C, Gibbons RJ, et al. Impact of right ventricular involvement on mortality and morbidity in patients with inferior myocardial infarction. J Am Coll Cardiol 2001;37:37–43.
[16] Assali AR, Teplitsky I, Ben-Dor I, Solodky A, Brosh D, Battler A, et al. Prognostic importance of right ventricular infarction in an acute myocardial infarction cohort referred for contemporary percutaneous reperfusion therapy. Am Heart J 2007;153:231–7.
[17] Kumar V, Sinha S, Kumar P, Razi M, Verma CM, Thakur R, et al. Short-term outcome of acute inferior wall myocardial infarction with emphasis on conduction blocks: a prospective observational study in Indian population. Anatol J Cardiol 2017;17:229–34.
[18] Hreybe H, Saba S. Location of acute myocardial infarction and associated arrhythmias and outcome. Clin Cardiol 2009;32:274–7.
[19] Aguiar Rosa S, Timóteo AT, Ferreira L, Carvalho R, Oliveira M, Cunha P, et al. Complete atrioventricular block in acute coronary syndrome: prevalence, charac-

terisation and implication on outcome. Eur Heart J Acute Cardiovasc Care 2018;7:218–23.
[20] Simons GR, Sgarbossa E, Wagner G. Atrioventricular and intraventricular conduction disorders in acute myocardial infarction: a re-appraisal in the thrombolytic era. Pacing Clin Electrophysiol 1998;21:2651–63.
[21] James TN. Anatomy of the coronary arteries in health and disease. Circulation 1965;32:1020–33.
[22] Kennel AJ, Titus JL. The vasculature of the human atrioventricular conduction system. Mayo Clin Proc. 1972;47:562–6.
[23] Jim MH, Chan AO, RSE HF, Barold SS, Lau CP. Clinical and angiographic findings of complete atrioventricular block in acute inferior myocardial infarction. Ann Acad Med Singapore 2010;39:185–90.