

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/crvasa

Acute myocardial infarction due to the left main coronary artery occlusion: Electrocardiographic patterns, angiographic findings, revascularization and in-hospital outcomes

P. Widimsky^{a,*}, J. Štásek^b, P. Kala^c, R. Rokyta^d, B. Kuzmanov^e, O. Hlinomaz^f,
J. Bělohávek^g, M. Malý^h

^aCardiology Department, Third Faculty of Medicine, Charles University Prague, University Hospital Kralovské Vinohrady, Srobarova 50, Prague 10, Czech Republic

^bFaculty of Medicine Hradec Kralove, Czech Republic

^cUniversity Hospital Brno—Bohunice, Czech Republic

^dFaculty of Medicine Plzeň, Czech Republic

^eBulgarian Cardiology Institute, Pleven, Bulgaria

^fUniversity Hospital St. Anne, Brno, Czech Republic

^g1st Faculty of Medicine, Charles University Prague, Czech Republic

^hState Health Institute, Prague, Czech Republic

ARTICLE INFO

Article history:

Received 2 December 2011

Accepted 17 December 2011

Keywords:

Acute myocardial infarction

Percutaneous coronary intervention

Left main coronary artery

ABSTRACT

Background: Primary angioplasty improves outcomes of acute myocardial infarction (AMI). However, in the highest risk subgroups, the mortality remains high despite modern catheter-based reperfusion therapy. This study analyzed patients with AMI caused by the left main coronary artery unstable lesion, a subgroup considered to be associated with very high early mortality.

Methods: A multicenter registry enrolled 6742 consecutive patients with AMI. Ninety-seven patients (1.4% of the entire study population) had left main as the infarct related artery. Baseline clinical characteristics, ECG patterns, coronary angiographic and echocardiographic data were correlated with the revascularization therapies used and with in-hospital outcomes. **Results:** Twenty-five patients (25.8%) died during the hospital stay. The deceased patients were older, had more frequently bundle branch block on the admission ECG, had higher Killip class on presentation, more frequently had TIMI flow <3 and PCI success rate was 72% (vs. 100% among survivors). Left main coronary artery (LMCA) lesion impaired distal flow (TIMI flow 0–2 on presentation) in 35 patients: the most frequent ECG presentation pattern for these LMCA occlusions was ST segment elevation ($n = 17$), followed by RBBB ($n = 9$; with LAH 6 and without LAH 3), LBBB ($n = 6$) and ST segment depression ($n = 3$). In other words: acute LMCA occlusion presents in 51% with ECG changes other than ST segment elevations. Patients with TIMI flow 0–2 had higher Killip class on admission, lower ejection fraction and higher in-hospital mortality (37% vs. 20%), when compared to those with TIMI flow 3 on the initial angiogram.

*Corresponding author.

E-mail address: widim@fnkv.cz (P. Widimsky).

Conclusions: Despite modern interventional therapy, acute myocardial infarction caused by the left main coronary artery obstruction bears high early mortality. The presence of bundle branch block, diminished TIMI flow on the initial angiogram, higher age and Killip class are related with increased mortality.

© 2012 The Czech Society of Cardiology. Published by Elsevier Urban & Partner Sp.z.o.o. All rights reserved.

1. Introduction

Primary percutaneous coronary intervention (PCI) improves outcomes of acute myocardial infarction (AMI) when compared to thrombolytic therapy [1–3]. However, in the highest risk subgroups, the mortality remains high despite modern catheter-based reperfusion therapy. These subgroups include elderly patients, patients with signs of acute heart failure (Killip II–IV class on admission [4]) and patients with critical coronary angiographic findings (left main coronary artery occlusion, last remaining artery occlusion, occlusion of the artery supplying the last viable region of the left ventricle, etc.). This study analyzed one of these high risk subgroups—patients with AMI caused by the left main coronary artery acute occlusion or unstable critical stenosis.

2. Methods

2.1. Patient population

A multicenter registry enrolled 6742 consecutive patients with AMI, who were admitted to one of the seven participating hospitals during a 3 years period. Ninety-seven patients (1,4% of the entire study population) had left main as the infarct related artery. Baseline clinical characteristics are in Table 1.

2.2. Electrocardiographic (ECG) patterns

Upon admission were registered and assigned into one of the following categories: LBBB, RBBB (\pm LAH or LPH), ST segment elevation, ST segment depression, other ECG pattern.

2.3. Coronary angiographic data

Included the infarct related artery (as assigned by the interventional cardiologist, who performed the procedure), TIMI flow grade before and after PCI, number of major epicardial arteries with >50% stenosis and the result of PCI procedure. Ejection fraction was registered by echocardiography.

All these findings were correlated with the revascularization therapies used (PCI, CABG or thrombolysis) and with in-hospital mortality.

2.4. Statistical analysis

For continuous variables, mean values and standard deviations were calculated. After checking normality by the Shapiro–Wilk test, Student's two-sample t-test was used for testing of the hypotheses about the means in compared groups. Satterthwaite's correction for unequal variances was applied where appropriate. Mann–Whitney test was used for the ordinal variables (e.g. Killip class). Categorical data were tested with Fisher's exact test and Pearson's χ^2 test. All tests have been performed as two-sided on the level of significance 0.05. Statistical software Stata, release 9.2 (Stata Corp LP, College Station, TX) was used for the analysis.

3. Results

3.1. Overall mortality among all LMCA—AMI patients

Twenty-five out of the 97 patients (25,8%) died during the hospital stay. The deceased patients were older, had more frequently bundle branch block on the admission ECG, had higher Killip class on presentation, more frequently had TIMI flow <3 and PCI success rate was 72% (vs. 100% among survivors—see Table 2).

Table 1 – Baseline clinical characteristics of patients with AMI caused by the LMCA occlusion or critical stenosis.

| | AMI with LMCA as the infarct related artery | AMI with other infarct related arteries | P value |
|---|---|---|---------|
| N = | 97 | 6645 | |
| Mean age (years; SD) | 68,9 (11.2) | 65,7 (12.0) | 0.009 |
| Females | 30% | 32% | 0.742 |
| Diabetes | 31% | 28% | 0.569 |
| Previous MI | 23% | 21% | 0.706 |
| Killip class on admission (mean; SD) | 2,25 (1.29) | 1,42 (0.83) | <0.001 |
| Bundle branch block on the admission ECG (LBBB or RBBB) | 27% | 10% | <0.001 |
| Ejection fraction (mean; SD) | 38,1% (12.4) | 48,9% (13.4) | <0.001 |
| In-hospital mortality | 25,8% | 5,2% | <0.001 |

Table 2 – Comparison of survivors vs. deceased patients with LMCA as the infarct related artery.

| | Survived (n = 72) | Died (n = 25) | P value |
|--|-------------------|---------------|---------|
| Mean age (years \pm SD) | 67.7 (10.7) | 72.5 (11.6) | 0.062 |
| Females | 28% | 36% | 0.416 |
| Killip class on admission (mean \pm SD) | 1.95 (1.2) | 3.0 (1.2) | <0.001 |
| Bundle branch block on admission ECG | 25% | 32% | 0.601 |
| TIMI flow 0–2 on presentation | 51% | 72% | 0.101 |
| TIMI flow 3 on presentation | 49% | 28% | 0.101 |
| Ejection fraction (mean \pm SD) | 39.1% (11.9) | 34.7% (14.2)* | 0.216 |
| Acute PCI performed | 51% | 72% | 0.101 |
| Acute CABG | 28% | 0** | 0.001 |
| Success rate of acute PCI (% of TIMI-3 flow after PCI) | 100% | 72% | <0.001 |

* EF was calculated only in those patients who survived till post-PCI echocardiography (thus, the calculated value certainly overestimates the value expected in all deceased patients)

** All these patients were in too critical condition (cardiogenic shock, pulmonary edema, resuscitation, etc.) to allow considering CABG.

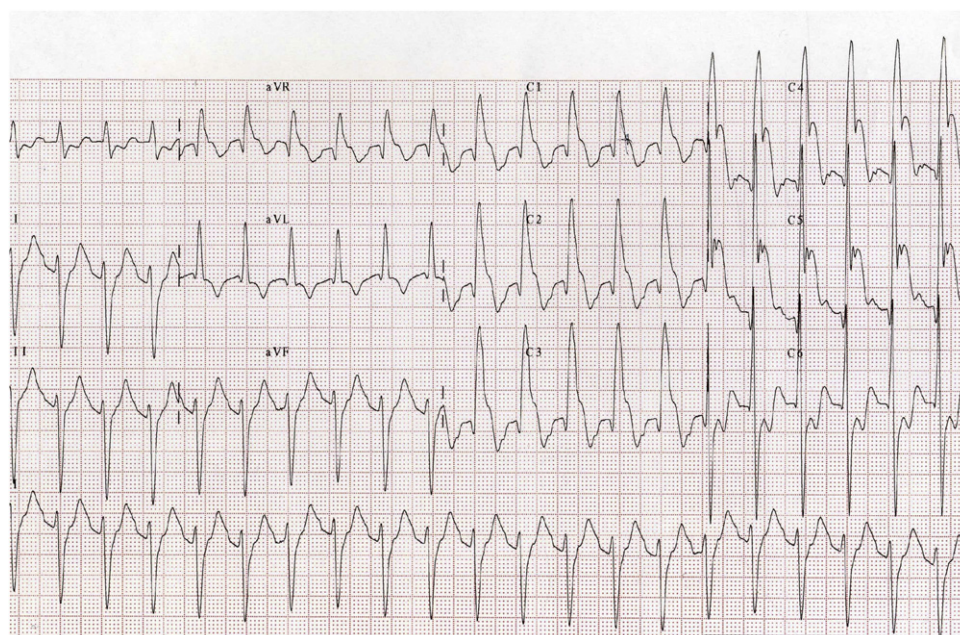


Fig. 1 – Typical ECG from a patient with LMCA subtotal occlusion (99% stenosis with TIMI flow 2). New onset bifascicular block (RBBB+LAH), ST segment elevations in aVR, V1–5, ST segment depressions in I, aVL, V6.

3.2. ECG in the subgroup with LMCA functional occlusion

Left main coronary artery (LMCA) was functionally occluded (TIMI flow 0–2 on presentation) in 35 patients: the most frequent ECG presentation pattern for LMCA occlusion was ST segment elevation ($n = 17$), followed by RBBB ($n = 9$; with LAH 6 and without LAH 3), LBBB ($n = 6$) and ST segment depression ($n = 3$). In other words: acute LMCA occlusion presents in 51% with ECG changes other than just ST segment elevations (Fig. 1). Patients with LMCA functional occlusion (vs. those with initial TIMI-3 flow) had higher Killip class on admission, lower ejection fraction and higher in-hospital mortality (37% vs. 20%) when compared to those with TIMI 3 flow on the initial angiogram (Fig. 2, Table 3).

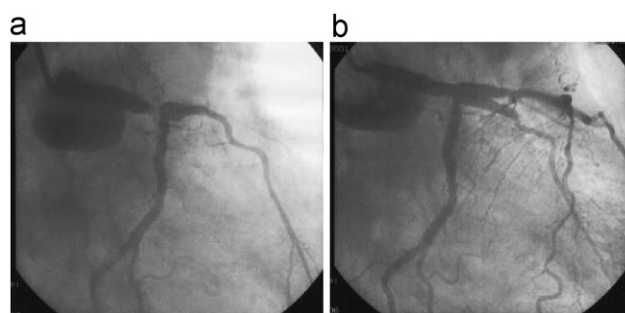


Fig. 2 – A—Critical (99%) LMCA stenosis and 100% ostial LAD occlusion before (a) and after (b) PCI in the same patients as Fig. 1.

Table 3 – Comparison of patients with functionally occluded LMCA (TIMI flow 0–2 in LMCA) versus those with critical LMCA lesion, but normal TIMI flow 3 on the acute admission angiogram.

| | TIMI flow 3 (n = 25) | TIMI flow 0–2 (n = 35) | P value |
|--|----------------------|------------------------|---------|
| Mean age (years \pm SD) | 68.6 (11.2) | 65.5 (11.0) | 0.290 |
| Females | 28% | 20% | 0.543 |
| Killip class on admission (mean \pm SD) | 2.0 (1.3) | 3.1 (1.3) | 0.002 |
| Bundle branch block on admission ECG | 20% | 43% | 0.096 |
| Ejection fraction (mean \pm SD) | 40.7% (14.8) | 34.1% (9.8) | 0.070 |
| Acute PCI performed | 84% | 94% | 0.223 |
| Emergent CABG | 4% | 3% | 1.000 |
| Success rate of acute PCI (% of TIMI-3 flow after PCI) | 100% | 86% | 0.069 |
| In-hospital mortality | 20% | 37% | 0.253 |

4. Discussion

4.1. Survival predictors

The main predictors of survival were lower age, lower Killip class on admission and preserved TIMI 3 flow on the initial coronary angiogram. These variables have been shown to predict survival also in other AMI patients [4]. Patients with LMCA critical unstable lesion and TIMI flow <3 frequently present to the hospital in advanced cardiogenic shock, in pulmonary edema or after resuscitation and thus emergent restoration of the LMCA patency is crucial to keep at least some chance for survival.

4.2. Electrocardiographic signs of LMCA acute occlusion

Terkelsen et al. [5] analyzed mortality from acute myocardial infarction in a defined region of Denmark with known population and full coverage of mortality data. They found, that bundle branch block (and especially RBBB) during acute myocardial infarction is related with the highest mortality among all electrocardiographic types of infarction. Similar observations were published by others [6–14]. Hirano et al. [10] found, that 37% of patients with acute myocardial infarction caused by the left main coronary artery occlusion present with RBBB, while only 3% with LBBB. We have shown, that acute LMCA occlusion presents in 26% only with RBBB, without ST segment elevations being in close accordance both to previously mentioned reports and with Hirano et al., who found, that in 30% of left main coronary artery occlusions no ST segment elevation could be found on the admission ECG, while RBBB with left axis deviation (frequently accompanied by ST-elevation in aVR) is typical for this catastrophic type of AMI. The study by Kurisu et al. [11] found RBBB even in 52% of patients with acute occlusion of the left main coronary artery.

4.3. Revascularization procedures

The guidelines of the European Society of Cardiology (ESC) list only LBBB as an indication for urgent reperfusion therapy [15]. The American Heart Association (AHA)/American College of Cardiology (ACC) guidelines provide similar recommendations

[16]. Our recent study [17] suggested, that RBBB should be listed in the guidelines as an indication for emergent reperfusion therapy, preferably by means of PCI.

4.4. Study limitations

This is not a randomized study, but just a multicenter “real-life” registry. Coronary angiography was not evaluated in an independent core laboratory. This fact may bear inherent risk of interindividual differences in TIMI flow and PCI success evaluation. Moreover, detailed hemodynamic data on admission are not available. However, such a critical setting as LMCA occlusion or preocclusion requires immediate therapeutic intervention and advanced hemodynamic description is not feasible.

5. Conclusions

Despite modern interventional therapy, acute myocardial infarction caused by the left main coronary artery obstruction has high early mortality. The presence of bundle branch block, diminished TIMI flow on the initial angiogram, age and Killip class are related with increased mortality.

Funding

This study was partly supported by the Charles University Prague research project no. MSM0021620817.

REFERENCES

- [1] H.R. Andersen, T.T. Nielsen, K. Rasmussen, L. Thuesen, H. Kelbaek, P. Thayssen, U. Abildgaard, F. Pedersen, J.K. Madsen, P. Grande, A.B. Villadsen, L.R. Krusell, T. Haghfelt, P. Lomholt, S.E. Husted, E. Vigholt, H.K. Kjaergard, L.S. Mortensen, DANAMI-2 Investigators. A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction, *New England Journal of Medicine* 349 (8) (2003) 733–742 (August 21).
- [2] P. Widimský, T. Budesínský, D. Vorác, L. Groch, M. Zelízko, M. Aschermann, M. Branny, J. St'ásek, P. Formánek, 'PRAGUE' Study Group Investigators, Long distance transport for primary angioplasty vs. immediate thrombolysis in acute

- myocardial infarction. Final results of the randomized national multicentre trial—PRAGUE-2, *European Heart Journal* 24 (1) (2003) 94–104 (January).
- [3] E.C. Keeley, J.A. Boura, C.L. Grines, Comparison of primary and facilitated percutaneous coronary interventions for ST-elevation myocardial infarction: quantitative review of randomised trials, *Lancet* 367 (9510) (2006) 579–588 (February 18).
 - [4] P. Widimsky, Z. Motovská, D. Bílková, M. Aschermann, L. Groch, M. Zelízko, The impact of age and Killip class on outcomes of primary percutaneous coronary intervention. Insight from the PRAGUE-1 and -2 trials and registry, *EuroIntervention* 2 (4) (2007) 481–486 (February).
 - [5] C.J. Terkelsen, J.F. Lassen, B.L. Nørgaard, J.C. Gerdes, T. Jensen, L.B. Gøtzsche, T.T. Nielsen, H.R. Andersen, Mortality rates in patients with ST-elevation vs. non-ST-elevation acute myocardial infarction: observations from an unselected cohort, *European Heart Journal* 26 (2005) 18–26.
 - [6] A. Melgarejo-Moreno, J. Galcerá-Tomás, A. Garcia-Alberola et al., Incidence, clinical characteristics, and prognostic significance of right bundle-branch block in acute myocardial infarction. A study in the thrombolytic era, *Circulation* 96 (1997) 1139–1144.
 - [7] S. Kurisu, I. Inoue, T. Kawagoe, et al., Right bundle-branch block in anterior acute myocardial infarction in the coronary intervention era: acute angiographic findings and prognosis, *International Journal of Cardiology* 116 (2007) 57–61.
 - [8] T. Kleeman, C. Juenger, A.K. Gitt, et al., Incidence and clinical impact of right bundle branch block in patients with acute myocardial infarction: ST elevation myocardial infarction versus non-ST elevation myocardial infarction, *American Heart Journal* 156 (2008) 256–261.
 - [9] K. Sakakura, N. Kubo, S. Hashimoto, et al., Determinants of in-hospital death in left main coronary artery myocardial infarction complicated by cardiogenic shock, *Journal of Cardiology* 52 (1) (2008) 24–29.
 - [10] T. Hirano, K. Tsuchiya, K. Nishigaki, et al., Clinical features of emergency electrocardiography in patients with acute myocardial infarction caused by left main trunk obstruction, *Circulation Journal* 70 (2006) 525–529.
 - [11] S. Kurisu, I. Inoue, T. Kawagoe, et al., Electrocardiographic features in patients with acute myocardial infarction associated with left main coronary artery occlusion, *Heart* 90 (2004) 1059–1060.
 - [12] M. Guerrero, K. Harjai, G.W. Stone, B. Brodie, D. Cox, J. Boura, L. Grines, W. O'Neill, C. Grines, Comparison of the prognostic effect of left versus right versus no bundle branch block on presenting electrocardiogram in acute myocardial infarction patients treated with primary angioplasty in the primary angioplasty in myocardial infarction trials, *American Journal of Cardiology* 96 (4) (2005) 482–488.
 - [13] A. Di Chiara, Right bundle branch block during the acute phase of myocardial infarction: modern redefinitions of old concepts, *European Heart Journal* 27 (2006) 1–2.
 - [14] C.K. Wong, R.A.H. Stewart, W. Gao, J.K. French, C. Raffel, H.D. White, for the Hirulog and Early Reperfusion or Occlusion (HERO-2) Trial Investigators. Prognostic differences between different types of bundle branch block during the early phase of acute myocardial infarction: insights from the Hirulog and Early Reperfusion or Occlusion (HERO)-2 trial, *European Heart Journal* 27 (2006) 21–28.
 - [15] F. Van de Werf, J. Bax, A. Betriu, C. Blomstrom-Lundqvist, F. Crea, V. Falk, G. Filippatos, K. Fox, K. Huber, A. Kastrati, A. Rosengren, P.G. Steg, M. Tubaro, F. Verheugt, F. Weidinger, M. Weis, A. Vahanian, J. Camm, R. De Caterina, V. Dean, K. Dickstein, C. Funck-Brentano, I. Hellemans, S.D. Kristensen, K. McGregor, U. Sechtem, S. Silber, M. Tendera, P. Widimsky, J.L. Zamorano, F.V. Aguirre, N. Al-Attar, E. Alegria, F. Andreotti, W. Benzer, O. Breithardt, N. Danchin, C. Di Mario, D. Dudek, D. Gulba, S. Halvorsen, P. Kaufmann, R. Kornowski, G.Y. Lip, F. Rutten, Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation: the task force on the management of ST-segment elevation acute myocardial infarction of the European Society of Cardiology, *European Heart Journal* 29 (23) (2008) 2909–2945.
 - [16] E.M. Antman, D.T. Anbe, P.W. Armstrong, E.R. Bates, L.A. Green, M. Hand, J.S. Hochman, H.M. Krumholz, F.G. Kushner, G.A. Lamas, C.J. Mullany, J.P. Ornato, D.L. Pearle, M.A. Sloan, S.C. Smith Jr., J.S. Alpert, J.L. Anderson, D.P. Faxon, V. Fuster, R.J. Gibbons, G. Gregoratos, J.L. Halperin, L.F. Hiratzka, S.A. Hunt, A.K. Jacobs, ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. A report of the American college of cardiology/american heart association task force on practice guidelines, *Journal of the American College of Cardiology* 44 (2004) 671–719.
 - [17] P. Widimsky, F. Rohác, J. Stásek, P. Kala, R. Rokyta, B. Kuzmanov, M. Jakl, M. Poloczek, J. Kanovsky, I. Bernat, O. Hlinomaz, J. Belohlávek, A. Král, V. Mrázek, V. Grigorov, S. Djambazov, R. Petr, J. Knot, D. Bílková, M. Fischerová, K. Vondrák, M. Maly, A. Lorencová, Primary angioplasty in acute myocardial infarction with right bundle branch block: should new onset right bundle branch block be added to future guidelines as an indication for reperfusion therapy? *European Heart Journal* Sep (2011) 1 [Epub ahead of print].