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Original Article

Effects of hypocalcemia on prognosis of patients with ST-segment elevation acute myocardial infarction and nursing observation

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Abstract: Objective: The aim of this study was to explore the effects of hypocalcemia on prognosis of patients with ST-segment elevation acute myocardial infarction (AMI) by systematically analyzing their clinical data. Methods: A total of 192 patients with ST-elevation AMI were retrospectively analyzed. They were divided into a hypocalcemia group (serum calcium levels <2.14 mM, 84 cases) and normal serum calcium group (≥2.14 mM, 108 cases). General patient data, cardiogenic shock, acute renal failure, ventricular aneurysm, ventricular septal perforation, cardiac function, short-term prognosis of 30 days, and long-term mortality of 150 days of the two groups were compared and independent risk factors for patients with AMI were analyzed using multivariate logistic regression. Results: No significant differences were observed in gender, heart rate, hypertension, diabetes, smoking, serum potassium, and serum chlorine between the hypocalcemia group and normal serum calcium group (all P>0.05). However, there were significant differences in age (t=2.220, P=0.028), hyperlipidemia (χ^2=5.578, P=0.018), Killip classification (χ^2=4.701, P=0.030), and serum sodium (t=2.723, P=0.007). Compared with patients in the normal serum calcium group, cardiogenic shock, ventricular aneurysm, and interventricular septum perforation of patients in the hypocalcemia group were not significantly different (all P>0.05), but risk of acute renal failure was significantly higher (χ^2=4.443, P=0.035). Left ventricular ejection fraction of hypocalcemia patients was significantly lower than those with normal serum calcium (t=2.188, P=0.030). Serum calcium (OR=4.309, 95% CI: 1.538-9.735, P=0.009), age (OR=3.410, 95% CI: 1.322-8.655, P=0.016), and serum sodium (OR=3.272, 95% CI: 1.290-6.104, P=0.022) were risk factors for death in patients with acute myocardial infarction, while hyperlipidemia and Killip classification ≥3 did not have high prognostic value (both P>0.05). Conclusion: Hypocalcemia is a risk factor for AMI and could be used as an independent predictor for prognosis of AMI, providing a theoretical basis for choice of nursing scheme for patients with hypocalcemia.

Keywords: Acute myocardial infarction, hypocalcemia, prognosis, nursing observation

Introduction

Acute myocardial infarction (AMI) is usually the result of heart coronary atherosclerosis, wherein coronary artery spasms induced by agitation, fatigue, constipation, and environmental factors result in acute ischemia, hypoxia, and irreversible cardiomyocyte degeneration and necrosis [1-3]. Due to acute onset and high mortality rate, AMI is a severe cardiologic condition and a major focal point of clinical nursing. At present, the main nursing measures of AMI include psychological intervention, oxygen support, detection of blood pressure, heart rate and respiration, and timely opening of venous passages. These provide a good nursing environment for early implementation of percutaneous coronary intervention (PCI). Comprehensive and quality nursing measures can significantly reduce poor prognosis in patients, including cardiogenic shock, ventricular aneurysm, ventricular septal perforation, acute renal failure, reperfusion arrhythmia, or even death [4]. Therefore, more information on risk factors influencing AMI prognosis with timely and targeted nursing measures can significantly improve prognosis of AMI patients after implementation of PCI.

Studies have found that hypocalcemia can affect the prognosis of various diseases like acute necrotizing pancreatitis, sepsis, cerebral hemorrhage, and severe pneumonia but its effects on prognosis of AMI patients are not well understood [5-8]. To investigate whether hypocalcemia is a risk factor or an independent prognostic factor for AMI, this study retrospectively analyzed 192 patients with ST-segment elevation AMI. Parameters such as cardiogenic shock, acute renal failure, ventricular aneurysm, ventricular septal perforation, short-term prognosis, and long-term mortality were compared in patients with different serum calcium levels and risk factors were determined using multivariate logistic regression.

Materials and methods

General data

A total of 192 patients diagnosed with ST-segment elevation AMI, admitted to the Department of Cardiology in Jining No.1 People's Hospital, from June 2012 to October 2015, having received PCI within 12 hours after onset of symptoms, were selected for the study.

Inclusion criteria: (1) Symptoms including chest pain and chest tightness lasting more than 30 minutes not alleviated by the use of nitroglycerin and other drugs; (2) Electrocardiogram (ECG) showing increased convex type of ST segment or pathological Q wave in two or more leads; (3) Elevation of myocardial necrotic markers like troponin I, troponin T, etc.; and (4) Patients with normalized coronary artery blood supply, reduction in chest pain, and other symptoms along with normalized ECG and myocardial necrosis substances after treatment of PCI.

Exclusion criteria: Patients with heart failure, severe liver and kidney dysfunction, malignant tumors, cerebrovascular diseases, infectious diseases, rheumatic immune diseases, and blood system diseases [9].

All patients signed the informed consent and all research methods used in this study met the ethical standards of Jining No.1 People's Hospital.

Grouping and methods

Venous blood was collected from all patients at the time of admission to determine serum levels of calcium ions, of which 84 patients were classified into the hypocalcemia group (<2.14 mM) and 108 into the normal serum calcium group (≥2.14 mM). Clinical data including gender, age, heart rate, hypertension, diabetes, hyperlipidemia, smoking, Killip classification, and serum levels of sodium, potassium, and chloride were also collected. After 7 days of PCI treatment, left ventricular ejection fraction (LVEF) was measured using cardiac Doppler ultrasound. Patients were followed up after discharge to collect clinical data such as cardiogenic shock, acute renal failure, ventricular aneurysm, and ventricular septal perforation to determine short term prognosis within 30 days after AMI. Occurrence of all-cause deaths within 150 days after AMI was recorded.

Statistical analysis

Statistical analysis was carried out using SPSS 13.0 software. All data with normal distribution and homogeneity of variance are expressed as mean ± standard deviation ($\overline{x}$ ± sd). Student's t-test was used to compare between the two groups and enumeration data were analyzed using χ^2 test. Kaplan-Meir survival analysis was used to compare survival rates of the two groups and multivariate logistic regression was used to analyze risk factors for death. $P<0.05$ was considered statistically significant.

Results

Comparison of clinical data of AMI patients with different serum calcium levels

The normal and hypocalcemia groups did not differ significantly in terms of gender (males: χ^2=0.265, P=0.607; females: χ^2=0.265, P=0.607), heart rate (t=1.282, P=0.201), hypertension (χ^2=0.033, P=0.855), diabetes (χ^2=3.099, P=0.078), smoking (χ^2=0.309, P=0.578), serum potassium (t=0.418, P=0.677), and serum chlorine (t=0.802, P=0.424) levels. However, there were significant differences in age (t=2.220, P=0.028), hyperlipidemia (χ^2=5.578, P=0.018), Killip classification (χ^2=4.701, P=0.030), and serum sodium levels (t=2.723, P=0.007). Therefore, AMI patients with hypocalcemia were older, hyperlipidemic, hyponatremic, and had a higher Killip classification, indicating that these factors might affect prognosis. See **Table 1**.

Table 1. Comparison of clinical data of AMI patients with different serum calcium levels

Clinical data	Hypocalcemia (n=84)	Normal blood calcium (n=108)	t/χ^2	P
Male (n, %)	57 (67.86)	77 (71.30)	0.265	0.607
Female (n, %)	27 (32.14)	31 (28.70)	0.265	0.607
Age (year, $\bar{x}$ ± sd)	65.30±9.22	62.44±8.56	2.220	0.028*
Heart rate (beats/min, $\bar{x}$ ± sd)	89.80±31.41	83.49±35.60	1.282	0.201
Hypertension (n, %)	47 (55.95)	59 (54.63)	0.033	0.855
Diabetes (n, %)	30 (35.71)	26 (24.07)	3.099	0.078
Hyperlipidemia (n, %)	29 (34.52)	21 (19.44)	5.578	0.018*
Smoking (n, %)	24 (28.57)	27 (25.00)	0.309	0.578
Killip classification ≥3 (n, %)	10 (11.90)	4 (3.70)	4.701	0.030*
Serum sodium levels (mmol/L, $\bar{x}$ ± sd)	140.20±3.08	141.50±3.43	2.723	0.007**
Serum potassium (mmol/L, $\bar{x}$ ± sd)	4.06±0.63	4.10±0.68	0.418	0.677
Chlorine (mmol/L, $\bar{x}$ ± sd)	103.40±3.11	103.80±3.66	0.802	0.424

Note: *P<0.05, **P<0.01. AMI, acute myocardial infarction.

Table 2. Comparison of short-term prognosis of AMI patients with different serum calcium levels (n, %)

Clinical data	Hypocalcemia (n=84)	Normal blood calcium (n=108)	χ^2	P
Cardiogenic shock	5 (5.95)	2 (1.85)	2.262	0.133
Acute renal failure	7 (8.33)	2 (1.85)	4.443	0.035*
Ventricular aneurysms	7 (8.33)	5 (4.63)	1.106	0.293
Ventricular septal perforation	1 (1.19)	1 (0.93)	0.032	0.858

Note: *P<0.05. AMI, acute myocardial infarction.

Comparison of short-term prognosis of AMI patients with different serum calcium levels

Short-term prognosis of 30 days was determined by analyzing various clinical features after PCI. These included cardiogenic shock, acute renal failure, ventricular aneurysms, and ventricular septal perforation. No significant differences were seen between the hypocalcemia group (84 cases) and normal serum calcium group (108 cases) regarding incidence of cardiogenic shock (χ^2=2.262, P=0.133), ventricular aneurysms (χ^2=1.106, P=0.293), and ventricular septal perforation (χ^2=0.032, P=0.858), while incidence of acute renal failure was significantly different (χ^2=4.443, P=0.035). See **Table 2**.

Comparison of cardiac function of AMI patients with different serum calcium levels

To compare cardiac function of the two group of patients, LVEF of 192 patients with ST-elevation AMI was measured. LVEF was found to be significantly lower in patients with hypocalcemia compared to those with normal serum calcium levels (t=2.188, P=0.030), indicating that hypocalcemia might affect myocardial function in patients with AMI. See **Figure 1**.

Comparison of survival rates of AMI patients with different serum calcium levels

Patients were followed up for 150 days after AMI to record all-cause death events. Survival rates of the two groups were compared using the Kaplan-Meir method. The survival rate of patients with hypocalcemia was significantly lower than that of patients with normal serum calcium levels (χ^2=5.138, P=0.023) and death events in both groups mainly occurred within 30 days after AMI. See **Figure 2**.

Multivariate logistic regression analysis of mortality risk factors in patients with AMI

Multivariate logistic regression analysis was performed on risk factors correlated to deaths within 150 days after AMI. Serum calcium levels (OR=4.309, 95% CI: 1.538-9.735, P=0.009), age (OR=3.410, 95% CI: 1.322-8.655, P=0.016), and serum sodium levels (OR=3.272, 95% CI: 1.290-6.104, P=0.022) were independent predictors of death in AMI patients, while

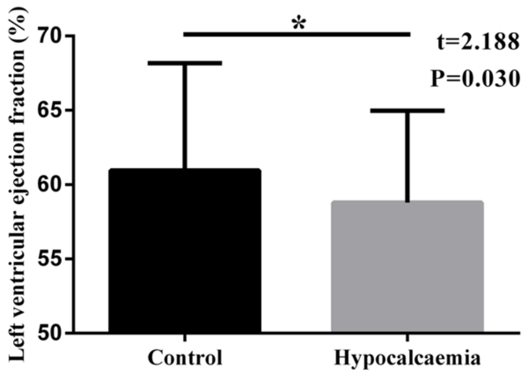

Figure 1. Comparison of left ventricular ejection fraction of AMI patients with different serum calcium levels. *P<0.05. AMI, acute myocardial infarction.

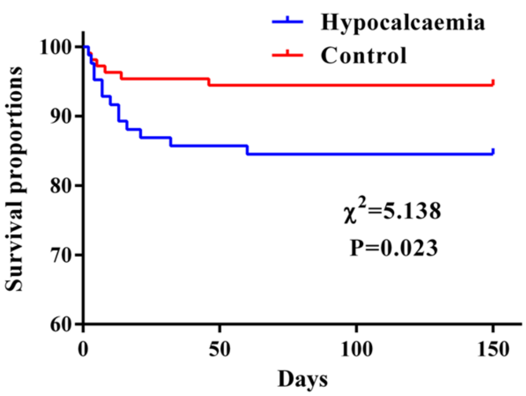

Figure 2. Comparison of survival rates of AMI patients with different serum calcium levels. There were 84 patients with hypocalcemia and 108 patients with normal blood calcium. The 150-day survival rates in the two group were 84.52% and 94.44%, respectively. AMI, acute myocardial infarction.

hyperlipidemia and Killip classification ≥3 were not predictive. See **Table 3**.

Discussion

Although smoking, hypertension, hyperglycemia, hyperlipidemia, obesity, and poor diet have been extensively studied as key risk factors of AMI, they cannot be quantified and are difficult to use as prognostic factors [10]. In recent years, studies have found that clinical biochemical indicators can affect the prognosis of AMI, offering the advantages of simple clinical detection, short analysis time, and accurate quantification for easy prognostic evaluation. For example, Tada et al. found that hyponatremia (<136 mmol/L), within 72 hours of hospitalization in patients with AMI, could significantly increase short-term complications, such as congestive heart failure, and increase long-term outcomes mortality [11]. Other studies have found that high-sensitivity C-reactive protein, butyrylcholinesterase, alanine aminotransferase, aspartate aminotransferase, and other biochemical indicators could also affect the prognosis of patients with AMI, having important implications for early targeted clinical nursing and treatment [12-15].

Calcium ions are essential for maintaining homeostasis in the human body, playing an important role in myocardial contraction, electrical nerve conduction, enzyme activity, and other physiological processes. According to previous studies, hypocalcemia is a serious electrolyte disturbance commonly seen in critical diseases like acute necrotizing pancreatitis, septicemia, systemic inflammatory response syndrome, trauma, and burns [16, 17]. Acute myocardial infarction affects the balance of calcium ions in the body through the metabolism of neurohormones, kidneys, and gastrointestinal tract, causing occurrence of hypocalcemia [18]. However, the effects of hypocalcemia on short-term and long-term prognosis of patients with acute myocardial infarction in early stages of admission are still relatively unknown.

This present study retrospectively analyzed 192 patients with ST-elevation AMI, finding that patients with hypocalcemia always had clinical features such as old age, hyperlipidemic, hyponatremic, and higher Killip classifications. Therefore, it is highly likely that these factors affect the prognosis of patients with AMI. Analysis of short-term prognostic indicators showed that, compared to patients with normal serum calcium levels, hypercalcemic patients had significantly higher incidence of acute renal failure, which could significantly reduce LVEF. However, cardiogenic shock, ventricular aneurysm, and ventricular septal perforation were not significantly different between the two groups, suggesting that early hypocalcemia might affect the short-term prognosis of acute renal failure in patients with AMI. This study's 150-day follow up showed that hypocalcemia could increase the mortality of patients. The underlying mechanisms are not clear yet but might be a result of the combination of older age, hyponatremia, and reduced myocardial function [19, 20]. Since these factors might also affect prog-

Table 3. Multivariate logistic regression analysis of mortality risk factors in patients with AMI

Risk factor	OR	95% CI	P
Serum calcium	4.309	1.538-9.735	0.009**
Age	3.410	1.322-8.655	0.016*
Hyperlipidemia	1.694	0.811-8.672	0.128
Killip classification ≥3	1.980	1.055-7.080	0.109
Serum sodium	3.272	1.290-6.104	0.022*

Note: *P<0.05, **P<0.01. AMI, acute myocardial infarction.

nosis and interfere with evaluation of the effects of hypocalcemia, the independent prognostic value of each of these factors was analyzed using multivariate logistic regression analysis. Results showed that, although age and serum sodium levels were also independent risk factors, the OR value of hypocalcemia was the highest (4.309). This indicates, after excluding the effects of age, serum lipids, serum sodium levels, and other factors, that risk of death in patients with hypocalcemia was 4.309 times higher than in patients with normal serum calcium levels. Therefore, hypocalcemia is a major independent predictor of death for patients with AMI.

AMI has both rapid onset and rapid progression. Therefore, it is necessary to implement PCI therapy within a very short time window, in addition to completing oxygen therapy, measuring blood pressure, heart rate and respiration, establishment of venous access, comforting anxious patients, and other nursing measures. Therefore, serum calcium level analysis is often ignored at admission. This study's results indicate that hypocalcemia, at the time of admission, could lead to poor prognosis and increase risk of death. Therefore, it is clinically significant to measure serum calcium levels before admission and consider giving calcium supplements to patients.

Although this analysis of clinical data clearly shows hypocalcemia as an independent risk factor for patients with AMI, the exact mechanisms are not yet clear. Alterations in electrophysiological properties, mechanical contraction, and pathological manifestations of myocardium brought about by lower calcium ion concentrations are beyond the scope of the current study. In addition, this study did not clarify whether calcium ion supplementation during early nursing intervention can improve prognosis. These issues require further study.

In conclusion, hypocalcemia is an independent risk factor for AMI and can be used to assess prognosis. Early detection of serum calcium levels in patients with AMI should be carried out and, in the event of hypocalcemia, calcium supplements should be given to create good conditions, possibly reducing risk of short-term complications and long-term mortality.

Disclosure of conflict of interest

None.

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