Clinical Trials and Regulatory Science in Cardiology 13 (2016) 29–33

Contents lists available at ScienceDirect

Clinical Trials and Regulatory Science in Cardiology

journal homepage: http://www.elsevier.com/locate/ctrsc

The prevalence and prognosis of contrast-induced acute kidney injury according to the definition in patients with acute myocardial infarction who underwent primary percutaneous coronary intervention

Osamu Kuboyama [a,*], Takeshi Tokunaga [b]

[a] Tsukuba Heart Clinic, Japan
[b] JA Toride Medical Center, Japan

ARTICLE INFO

Article history:
Received 16 September 2015
Received in revised form 8 November 2015
Accepted 22 November 2015
Available online 2 December 2015

Keywords:
Contrast-induced acute kidney injury
RIFLE criteria
AKIN criteria
Primary percutaneous coronary intervention
Cardiovascular event
Acute myocardial infarction

ABSTRACT

Background: Contrast-induced acute kidney injury (CI-AKI) is associated with adverse outcomes. However, the problem complicating CI-AKI relates to its definition. More than 30 definitions of AKI have been used in the literature. We examined the prevalence of CI-AKI according to three criteria. Prevalence of cardiovascular events according to each criterion was also investigated.

Methods: We studied 247 consecutive patients with acute myocardial infarction (66.7 ± 9.0 years, 189 males) who underwent primary percutaneous coronary intervention in our hospital. Three definitions of CI-AKI were applied: (i) traditional CI-AKI, (ii) CI-AKI derived from RIFLE criteria, (iii) CI-AKI derived from AKIN criteria. Cardiovascular events comprised in-hospital death, sudden death, cerebral infarction, heart failure, and acute coronary syndrome.

Results: Prevalence of CI-AKI was 27.1% (67/247) according to the traditional CI-AKI definition, 23.9% (59/247) according to the CI-AKI definition derived from RIFLE criteria, and 15.8% (39/247) according to the CI-AKI definition derived from AKIN criteria. Prevalence of cardiovascular events was 13.8% (34/247). Prevalence of cardiovascular events with and without CI-AKI was 19.4% (13/67) and 11.7% (21/180) according to the traditional CI-AKI definition ($P = 0.13$), 22.0% (13/59) and 11.2% (21/188) in the CI-AKI definition derived from RIFLE criteria ($P = 0.035$), and 35.9%(14/39) and 9.6% (20/208) according to the CI-AKI derived from AKIN criteria ($P = 0.00001$).

Conclusion: Prevalence of CI-AKI varies widely depending on the criteria used. The CI-AKI definition derived from AKIN criteria was the most effective predictor of cardiovascular events.

1. Introduction

Primary percutaneous coronary intervention (PCI) for patients with acute myocardial infarction (AMI) enables rapid restoration of patency of coronary arteries and contributes to salvage of the myocardium. Primary PCI also results in improvement of the prognosis.

In general, when employing coronary angiography (CAG) and CT angiography (CTA), injection of iodinated contrast media is undertaken, but can result in contrast-induced acute kidney injury (CI-AKI). CI-AKI is associated with in-hospital and long-term morbidity and mortality [1–10]. Several risk factors for CI-AKI have been reported: advanced age, acute myocardial infarction (AMI), chronic renal insufficiency, diabetes mellitus, congestive heart failure, depletion of intravascular volume, and a large volume of contrast media [5,11,12].

The most widely used criteria of CI-AKI are an increase of serum creatinine (sCr) ≥0.5 mg/dL or ≥25% above baseline values within 72 h of an intervention. However, a consensus for AKI is lacking. More than 30 definitions of AKI have been used in the literature, creating much confusion and making inter-study comparisons difficult [13–15]. A unifying definition is very important and two attempts to define AKI have been made. In 2004, the Acute Dialysis Quality Initiative (ADQI) Group, comprising experts in nephrology and critical care medicine, published their consensus definition for AKI: the Risk, Injury, Failure, Loss, and End-stage kidney disease (RIFLE) classification [16]. In 2007, the Acute Kidney Injury Network (AKIN) Group, an international collaboration of nephrologists and intensivists, proposed a modified version of the RIFLE criteria: the AKIN criteria [17].

We wished to estimate the prevalence and prognosis of CI-AKI according to these two CI-AKI definitions in patients with AMI who underwent primary PCI. We also wished to evaluate which CI-AKI definition was most effective for prediction of the long-term prognosis.

* Corresponding author.
E-mail address: okuboyama@yahoo.co.jp (O. Kuboyama).

http://dx.doi.org/10.1016/j.ctrsc.2015.11.004

2. Methods

The study protocol was approved by the ethics committee of our institution. Written informed consent was obtained from all patients.

2.1. Study population

Between 1 July 2006, and 31 December 2011, we enrolled 274 consecutive patients admitted to our hospital with ST-elevation acute myocardial infarction (STEMI) treated with primary PCI within 12 h of STEMI onset. The definition of STEMI was an increase in creatine kinase (CK) level and creatine kinase MB (CK-MB) greater than 2 × 99th percentile of the upper limit together with evidence of MI-like symptoms of ischemia, ST-elevation, and development of a pathologic Q wave in the electrocardiogram. Exclusion criteria were end-stage renal failure necessitating dialysis, an estimated glomerular filtration rate (GFR) < 30 mL/min/1.73 m^2, death within 72 h, and PCI-related MI.

2.2. Study protocol

After primary PCI, patients received 0.9% sodium chloride (i.v.) for ≥12 h. The rate of infusion was 0.5–1.5 mL/kg/h according to left-ventricular function. Initially, all patients received aspirin and clopidogrel. Use of beta blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, support with diuretics or inotropic drugs, or the indication of intra-aortic balloon pump (IABP) was left to the discretion of the interventional cardiologist and Coronary Care Unit (CCU) cardiologists. sCr was measured at the time of hospital admission, just after PCI, at least every 24 h for the following 3 days, discharge from the CCU and hospital, each outpatient visit, and upon re-hospitalization. The eGFR was calculated using the Modification of Diet in Renal Disease study equation for Japanese subjects:

$$eGFR = 194 \times \{age\}^{-0.287} \times \{sCr\}^{-1.094} \times \{0.734\, if\ the\ patient\ is\ female\}$$

2.3. Primary PCI

Primary PCI was carried out by a 24-h on-call interventional team according to standard clinical practice. The recommended intervention was coronary stenting. Heparin was injected via the intravenous route. The activated clotting time (ACT) during PCI was 250–300 s. The contrast media used for all patients was Iohexol 350.

2.4. Clinical definition

We used three definitions of CI-AKI in the present study. The first definition of CI-AKI was the most widely used, and was based on absolute or percent increase in sCr after intervention procedures (the "traditional" CI-AKI definition): an increase of sCr ≥0.5 mg/dL or ≥25% above baseline values within 72 h.

The second definition of CI-AKI was derived from RIFLE criteria. RIFLE criteria defines AKI as an increase in sCr ≥150% from baseline or a decrease in the GFR ≥25% using sCr criteria, or <0.5 mL/kg/h for ≥6 h using urine-output criteria. In the present study, CI-AKI derived from RIFLE criteria was an increase in sCr ≥150% from baseline or a decrease in the eGFR ≥25% within 72 h (CI-AKI derived from RIFLE definition).

The third definition of contrast-induced nephropathy (CIN) was derived from AKIN criteria. AKIN criteria defines AKI as an increase in sCr ≥0.3 mg/dL or 1.5-times the baseline using sCr criteria, or <0.5 mL/kg/h for ≥6 h using urine-output criteria, within 48 h. In the present study, CI-AKI derived from AKIN criteria was an increase in sCr ≥0.3 mg/dL or 150% from baseline within 72 h (CI-AKI derived from AKIN definition).

In the present study, sCr upon hospital admission was used as baseline sCr. We calculated the prevalence of CI-AKI using these three criteria (traditional CI-AKI definition; CI-AKI derived from RIFLE; CI-AKI derived from AKIN).

Cardiovascular events comprised in-hospital death, sudden death, cerebral infarction, heart failure necessitating hospitalization, and acute coronary syndrome (AMI and unstable angina pectoris).

The prevalence of cardiovascular events in patients with CI-AKI and without CI-AKI using these three definitions was calculated. We ascertained the most effective CI-AKI definition for the long-term prognosis.

2.5. Statistical analyses

Continuous variables with a normal distribution were reported as the mean ± SD. Categorical variables are presented as absolute values and percentages. Comparison of continuous variables was undertaken using the Student's *t*-test. Chi-square and Fisher exact tests were used for comparison of categorical variables as appropriate. $P < 0.05$ was considered significant. Analyses were conducted using SPSS v11.0 (IBM, Armonk, NY, USA).

3. Results

3.1. Clinical and procedural characteristics

Of the 274 consecutive patients with AMI who underwent primary PCI from July 2006 to December 2011, 27 patients were excluded (3 patients had already received hemodialysis, 2 patients had undergone coronary bypass surgery, 13 patients had died within 72 h, and 9 patients did not return for follow-up visits). Hence, 247 patients (189 men and 58 women; mean age, 66.7 ± 9.1 years) formed the study cohort.

Baseline characteristics of patients and laboratory data of the entire population are shown in Table 1. The baseline sCr was 0.87 ± 0.25 mg/dL and eGFR was 73.9 ± 19.5 mL/min/1.73 m^2. Culprit lesions were 52.2% (129/247) at the left anterior descending artery (LAD), 37.2% (92/247) at the right coronary artery (RCA), 9.7% (24/247) at the left circumflex artery (LCX) and 0.8% (2/247) at the left main trunk artery (LMT).

The volume of contrast media as well as infusion during PCI and after PCI for 1 day was 152.1 ± 51.5 mL, 393.0 ± 190.4 mL, and 1495.8 ± 516.1 mL, respectively. Prevalence of use of an IABP or a distal protection device during PCI was 17.4% (43/247) and 6.9% (17/247), respectively (Table 2).

Table 1
Baseline clinical and biochemical characteristics

Variable	Patients (n = 247)
Age (years)	66.7±9.1
Male	77.0%
Risk factor for CAD	
Diabetes mellitus	36.8%
Hypertension	66.8%
Dyslipidemia	64.4%
Smoking history	70.5%
Obesity (BMI >25 kg/m2)	36.4%
Family history of CAD	24.3%
Baseline laboratory data	
Serum creatinine (mg/dL)	0.87±0.25
eGFR (mL/min/1.73 m^2)	73.9±19.6
LDL-C (mg/dL)	128.4±30.6
HDL-C (mg/dL)	45.9±8.7
Triglyceride (mg/dL)	146.4±73.4
HbA1c (%)	6.4±1.0
Uric acid (mg/dL)	5.5±1.2
Hemoglobin (g/dL)	14.1±1.5

BMI: body mass index; eGFR: estimated glomerular filtration rate; HDL-C, high-density lipoprotein-cholesterol; LDL-C, low-density lipoprotein-cholesterol; CAD, coronary artery disease; HbA1c, glycated hemoglobin