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Impact of point-of-care pre-procedure creatinine and eGFR testing in patients with ST segment elevation myocardial infarction undergoing primary PCI: The pilot STATCREAT study☆

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ABSTRACT

Background: Contrast-induced acute kidney injury (CI-AKI) is a recognised complication during primary PCI that affects short and long term prognosis. The aim of this study was to assess the impact of point-of-care (POC) pre-PPCI creatinine and eGFR testing in STEMI patients.
Methods: 160 STEMI patients (STATCREAT group) with pre-procedure POC testing of Cr and eGFR were compared with 294 consecutive retrospective STEMI patients (control group). Patients were further divided into subjects with or without pre-existing CKD.
Results: The incidence of CI-AKI in the whole population was 14.5% and not different between the two overall groups. For patients with pre-procedure CKD, contrast dose was significantly reduced in the STATCREAT group (124.6 ml vs. 152.3 ml, $p = 0.015$). The incidence of CI-AKI was 5.9% ($n = 2$) in the STATCREAT group compared with 17.9% ($n = 10$) in the control group ($p = 0.12$). There was no difference in the number of lesions treated (1.118 vs. 1.196, $p = 0.643$) or stents used (1.176 vs. 1.250, $p = 0.78$). For non-CKD patients, there was no significant difference in contrast dose (172.4 ml vs. 158.4 ml, $p = 0.067$), CI-AKI incidence (16.7% vs. 13.4%, $p = 0.4$), treated lesions (1.167 vs. 1.164, $p = 1.0$) or stents used (1.214 vs. 1.168, $p = 0.611$) between the two groups.
Conclusions: Pre-PPCI point-of-care renal function testing did not reduce the incidence of CI-AKI in the overall group of STEMI patients. In patients with CKD, contrast dose was significantly reduced, but a numerical reduction in CI-AKI was not found to be statistically significant. No significant differences were found in the non-CKD group.

1. Introduction

Contrast induced acute kidney injury (CI-AKI) is a recognised complication of coronary angiography and percutaneous coronary interventions (PCI) [1]. Although its incidence in low-risk patients undergoing elective procedures is <3.5% [2], it dramatically increases to 16% to 19% in ST-elevation myocardial infarction (STEMI) patients undergoing primary PCI (PPCI) [3,4]. Left ventricular systolic dysfunction and systemic hypotension in the context of STEMI, along with difficulties in implementation of renal prophylactic measures before exposure to contrast media probably explain the increased incidence compared to stable patients [5,6]. Its development is not a benign condition but is associated with increased short-term and long-term morbidity and mortality, prolonged hospitalisation, and long-term renal impairment [7,8,9]. In patients with STEMI undergoing PPCI, correlation with adverse prognosis is even stronger [4,10]. Several risk factors for CI-AKI have been identified such as old age, chronic kidney disease (CKD), diabetes mellitus, anaemia, impaired left ventricular systolic function, hemodynamic instability and contrast media volume used [11]. Its pathogenesis is not completely understood, but there is evidence that CI-AKI occurs as a combination of oxidative stress, ischemic injury, direct toxicity, and obstruction of the renal tubular epithelium [12]. Based on this knowledge multiple strategies for CI-AKI risk reduction have been tested in clinical studies: various hydration protocols, ministration of *N*-acetylcysteine, use of ascorbic acid, different contrast agents, haemofiltration protocols and statin

☆ All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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therapy [13–19]. The results for most of these studies are mixed and conflicting. Hydration with normal saline starting 12 h pre and continuing up to 24 h post procedure is the only recommended intervention for prevention of CI-AKI in the recent ESC/EACS guidelines on myocardial revascularisation, while pre-treatment (starting 12–48 h pre-procedure) with high dose statins should be considered [20]. It is obvious that none of these pre-planned interventions can be implemented in the acute setting of PPCI, making prevention of CI-AKI in STEMI patients a challenge. Alternative ways of preventing CI-AKI in this particular population are needed.

Over the last few years there has been miniaturisation of devices measuring biochemical parameters and now creatinine and estimated glomerular filtration rate (eGFR) can be estimated rapidly at point-of-care with a near patient device [21]. The aim of this study was to assess the impact of point-of-care pre-procedure creatinine and eGFR measurements with immediate feedback to the operator on patients presenting with ST segment elevation myocardial infarction undergoing primary PCI.

2. Methods

2.1. Study design and population

This is a pre and post interventional study comparing two cohorts of STEMI patients who underwent primary PCI in a high volume tertiary centre. In the intervention group, point of care pre-primary PCI creatinine and eGFR were measured with the results available instantly and feedback to the operator (STATCREAT group). This group was then compared with a retrospective group used as control (Control group). We expected a benefit from point-of-care testing in patients with pre-PCI renal dysfunction, so for the purpose of the analysis patients were further divided into subjects with or without pre-existing CKD.

2.2. STATCREAT group

Patients presenting with chest pain for >30 min and ST elevation ≥2 mm in ≥2 contiguous chest leads or ≥1 mm in ≥2 contiguous limb leads or new left bundle branch block (LBBB) due to undergo primary PCI were enrolled. Recruitment took place in a period of 5 months (March to August 2014) depending on availability of point-of-care testing. Patients with cardiogenic shock were excluded. Routine blood samples were taken at the time of sheath insertion as per hospital protocol. Creatinine and eGFR were tested using the Nova Biomedical STAT SENSOR (MA, USA). The amount of blood required with this device is 1.2 μl, while processing time is 30 s. The operator was informed of the result and continued with the procedure. Patients in whom angiography showed no significant atherosclerotic lesions or were referred for emergency coronary artery bypass grafting (CABG) were excluded from the analysis. PCI was performed according to international guidelines. Radial access was used as the default approach. Patients were loaded with 300 mg aspirin and 600 mg clopidogrel or 60 mg Prasugrel or 180 mg Ticagrelor. They received a bolus of 70–100 IU/kg of unfractionated heparin at the start of the procedure. Use of glycoprotein IIb/IIIa inhibitors was at the discretion of the PCI operators on the basis of the clinical condition. Creatinine and eGFR were measured on admission and at 24, 48 and 72 h.

2.3. Control group

The Control group consisted of consecutive STEMI patients undergoing PPCI in a previous 6 month period (June 2013 to December 2013). The same inclusion and exclusion criteria applied. For these patients a point of care blood test was not performed and the operator was unaware of the baseline creatinine and eGFR. PCI procedure and subsequent patient's management followed the same standards as the STATCREAT group.

STATCREAT and control groups were further divided into subjects with chronic kidney disease (CKD) prior to PCI (eGFR < 60 ml/min) or subjects with normal renal function (eGFR > 60 ml/min). For both groups the diagnosis of CKD was based on the blood results from the sample taken immediately prior to PPCI during their index admission: the point-of-care tested sample for the STACREAT group and the laboratory values were made available later for the control group.

2.4. Definitions

CI-AKI was defined as an absolute increase of serum creatinine ≥ 0.5 mg/dl (44 mmol/l) or relative increase ≥25% from baseline value at 72 h post intervention [22]. CKD was defined as eGFR < 60 ml/min per 1.73 m^2 pre-PCI [23].

2.5. Study outcomes

Primary endpoints were total volume of contrast media used and incidence of CI-AKI. Number of lesions treated and number of stents implanted were used to assess impact of pre-procedure renal function measurements in interventional treatment strategy. Procedure duration and fluoroscopy time was also documented.

2.6. Statistical analysis

Categorical variables are expressed as percentages and were compared by Fisher's exact test. Continuous variables are presented as mean with standard deviation. Differences between means have been tested using a two-sample, two-sided *t*-test, and the *p*-values have been obtained using a Monte Carlo approach with 10,000 permutations, using the R package perm. This approach avoids strong distributional assumptions, such as the normality of data, in the statistical inferences. A *p*-value of <0.05 was considered as statistically significant. All statistical analyses have been carried out using the computer program R (R CRAN 2016).

3. Results

A total of 454 patients were included, 160 in the STATCREAT group and 294 in the control group. Baseline characteristics for the two cohorts are shown in Table 1. Mean age was 64 years and 20% of patients were above 75 years for both groups. In both cohorts the patients were predominantly male (73.1% vs. 71.2%, $p = 0.662$). There was no statistically significant difference in the presence of major cardiovascular risk factors. For both groups, the door to balloon time was 39 min. Left anterior descending artery (LAD) was the culprit vessel in 38.4% of patients in the control group and in 43.1% in the STATCREAT group ($p = 0.367$). Both groups had similar numbers of patients with pre-procedure CKD (19% vs. 21.3%, $p = 0.622$). The incidence of CI-AKI in the whole population of our study was 14.5% and it was not different between the two groups (14.4% vs. 14.6%, STATCREAT and control groups respectively $p = 0.942$). For the overall STATCREAT group, contrast dose was 162.2 ml compared to 157.2 ml for the overall control group ($p = 0.869$).

3.1. Patients with CKD

Results for patients with pre-procedure CKD are shown in Table 2. 34 (21.2%) patients in the STATCREAT group and 56 (19.0%) in the Control group were found to have CKD pre-procedure. Contrast media volume used was reduced in the STATCREAT group by 27.7 ml (124.6 ml vs. 152.3 ml, $p = 0.015$). The incidence of CI-AKI in the STATCREAT group was 5.9% ($n = 2$) compared with 17.9% ($n = 10$) in the control group ($p = 0.12$). Similar numbers of lesions were treated (1.118 vs. 1.196, $p = 0.643$) and similar numbers of stents were placed (1.176 vs. 1.250, $p = 0.78$) in the two groups. There was no statistically significant

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