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ORIGINAL ARTICLE

Assessment of estimated GFR and clinical predictors of contrast induced nephropathy among diabetic patients undergoing cardiac catheterization

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KEYWORDS

CIN;
Diabetes;
Contrast media

Abstract *Introduction:* Contrast-induced nephropathy is a leading cause of morbidity and mortality in high-risk patients.
Aim: To study different risk predictors of contrast induced nephropathy, among diabetic patients with normal serum creatinine undergoing cardiac catheterization.
Patients and methods: It involved 250 consecutive diabetic patients who underwent either coronary angiography or PCI. All patients were subjected to thorough history taking and clinical examination, measurement of serial serum creatinine levels and creatinine clearance prior to the procedure, 72 h after and after 7 days, coronary angiography or percutaneous coronary intervention, ECG, echocardiography, follow up during the first seventy-two hours for occurrence of contrast-induced nephropathy, follow up one month later for occurrence of major adverse cardiac events.
Results: 58 patients developed CIN with total incidence of 23.2%. CIN was found to be more among the patients who had PCI (40 patients, 69%, $P < 0.01$). Regarding different predictors of CIN, age, diabetes, ACEIs, anemia, lower LVEF, contrast media volume and lower creatinine clearance, were significantly associated with CIN ($P < 0.01$). Regarding MACE, only 4 patients had complications, with an incidence of 3.4% vs 1.04% among CIN positive and negative patients, respectively.
Conclusion: Creatinine clearance or estimated GFR are important surrogates for assessment of kidney function among diabetic patients undergoing catheterization despite normal serum creatinine. Modifiable risk predictors of CIN should be corrected as possible. Prophylaxis against CIN should be carried out by adequate hydration to all diabetic patients with calculation of the volume of contrast in relation to CrCl or GFR.

Abbreviations: CIN, contrast induced nephropathy; GFR, glomerular filtration rate; CrCl, creatinine clearance; HbA1c, glycated hemoglobin; MACE, major adverse cardiac events; FBS, fasting blood sugar; LVEF, left ventricular ejection fraction

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1. Introduction

Contrast-induced nephropathy is a leading cause of morbidity and mortality in high-risk patients undergoing any procedure

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involving the use of radiographic contrast media.[1] Subjects who develop this complication have higher rates of mortality, longer hospital stays and worse long-term outcomes.[2] The occurrence of contrast-induced nephropathy is related to the number of the patients' co-existing clinical risk factors. Among the many risk factors, pre-existing renal impairment, advancing age, the presence of diabetes mellitus as well as the volume and type of contrast agent administered are the most important.[1] The precise pathophysiologic mechanisms responsible for the development of contrast-induced nephropathy are complex and incompletely understood. At present, the only available tool for reducing the risk of developing contrast-induced nephropathy is prevention. This can be achieved by means of adequate peri-procedural hydration, using *N*-acetyl cysteine as well as the selection of low osmolar or iso-osmolar contrast agents in the least amount possible. Other agents are still being tested for this purpose as well.[3]

2. Aim of study

To study different risk predictors of contrast induced nephropathy, among diabetic patients with normal serum creatinine undergoing cardiac catheterization. To follow up the occurrence of major adverse cardiac events (mortality, reinfarction, stroke, target vessel revascularization) during one month of hospital discharge.

3. Methods

3.1. Study population

The study was conducted on 250 consecutive patients presenting to the Ain Shams University Hospital catheter lab from the period of September 2012 till November 2012 to undergo either coronary angiography or percutaneous coronary intervention. *Exclusion criteria were*: serum creatinine level $\geqslant 1.5$ mg/dL, recent exposure to radiographic contrast within forty-eight hours of the study, allergy to radiographic contrast, administration of *N*-acetyl cysteine, dopamine, mannitol or theophylline during the intended time of the study and patient known to have skeletal muscle disease or myopathy.

3.2. Methods

3.2.1. The suitable patients were subjected to the following

3.2.1.1. Thorough history taking. A full medical history was taken with special emphasis on: the indication of the coronary angiography, history of diabetes mellitus (recognized by the patient giving symptoms suggestive of diabetes mellitus [as polyuria, polydipsia, polyphagia, loss of weight, etc...] and/or the patient's receiving treatment for diabetes mellitus, whether it were insulin or oral hypoglycemic drugs), history of pre-existing renal impairment (recognized by symptoms suggestive of the disease as oliguria, pruritus, anorexia, hiccups, peripheral neuropathy, etc...) or by an elevated serum creatinine level, history of allergy to radiographic contrast media, age and sex of the patient (for purpose of calculation of the creatinine clearance level using the Cockroft–Gault equation).

3.2.1.2. Physical examination. Complete general and local examination with special emphasis on: weight and height of the patient (for purpose of calculation of the creatinine clearance level using the Cockroft–Gault equation), features and skin complexion (in search for evidence suggestive of pre-existing chronic renal impairment) as: yellow–brown complexion, pallor, itching marks...etc.

3.2.1.3. Twelve-lead surface ECG. To identify evidence of any of the following: an old myocardial infarction, ST-T segment deviations suggestive of ischemia, chamber enlargements, conduction disturbances and rhythm disturbances.

3.2.1.4. Coronary angiography. Coronary angiography was done in the standard fashion after gaining femoral artery access puncture using Seldinger's technique. The standard coronary views were obtained, which included an average six left coronary and two right coronary artery injections giving sufficient data to enable quantitative angiography. The type of contrast used was Ioversol (Optiray 300)® which is low osmolar non ionic contrast media.

3.2.1.5. Assessment of serial serum creatinine levels. A baseline venous sample was withdrawn prior to the procedure as well as two other samples, one of which was collected 72 h after the procedure and the other 7 days after the procedure.

It was assessed using a fully automated analyzer Biolis 24i Premium manufactured by Tokyo Boeki Medical Systems.

3.2.1.6. Assessment of serial creatinine clearance levels. The glomerular filtration rate (GFR) is an index of functioning renal mass and it is the best measure of overall kidney function in health and disease.[4] Normal glomerular filtration rates are 120 ± 25 ml/min for males, and 95 ± 20 ml/min for females.[5] The use of prediction equations to estimate GFR from serum creatinine and other variables (age, sex, race, and body size) is therefore recommended by the National Kidney Foundation for the diagnosis and stratification of chronic kidney diseases.[6] According to this foundation, renal function is moderately decreased if GFR is < 60 ml/min $1.73\ m^{-2}$ and severely decreased if GFR is < 30 ml/min $1.73\ m^{-2}$. The proposed equations are the Cockroft–Gault formula,[7] as recommended by the American Diabetes Association,[8] and the Modification of Diet in Renal Disease (MDRD) study equation. The more recent MDRD equation seems more accurate[9], but it has not been validated in diabetic kidney disease. Its superiority over the Cockroft–Gault formula has been mentioned in some, but not all recent reports.[10] A commonly used surrogate marker for estimate of creatinine clearance is the –Gault formula, which in turn estimates GFR in ml/min.[4] It is named after the scientists who first published the formula, and it employs serum creatinine measurements and a patient's weight to predict the creatinine clearance.[11] The formula, as originally published, is:

$$\text{GFR} = (140 - \text{age}) \times \text{weight (kg)}/(72 \times \text{serum creatinine})$$

in women, multiplied by 0.85. This formula expects weight to be measured in kilograms and creatinine to be measured in mg/dL, as is standard in the USA.

3.3. End point

The patients were observed during the forty-eight hours of follow up. It has to be noted that the third sample was mostly obtained on an outpatient basis. The primary end point was