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Original Article

Risk scoring system to predict contrast induced nephropathy following percutaneous coronary intervention

Suma M. Victor [a,*], *Anand Gnanaraj* [a], *VijayaKumar S.* [a], *Rajendra Deshmukh* [a], *Mani Kandasamy* [b], *Ezhilan Janakiraman* [a], *Ulhas M. Pandurangi* [a], *K. Latchumanadhas* [a], *Georgi Abraham* [c], *Ajit S. Mullasari* [a]

[a] *Institute of Cardio Vascular Diseases, Madras Medical Mission, Chennai, India*
[b] *Norwich Clinical Services, Bangalore, India*
[c] *Institute of Kidney Diseases, Urology and Organ Transplantation, Madras Medical Mission, India*

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ABSTRACT

Background: Contrast induced nephropathy (CIN) is associated with significant morbidity and mortality after percutaneous coronary intervention (PCI). The aim of this study is to evaluate the collective probability of CIN in Indian population by developing a scoring system of several identified risk factors in patients undergoing PCI.

Methods: This is a prospective single center study of 1200 consecutive patients who underwent PCI from 2008 to 2011. Patients were randomized in 3:1 ratio into development ($n = 900$) and validation ($n = 300$) groups. CIN was defined as an increase of $\geq$25% and/or $\geq$0.5 mg/dl in serum creatinine at 48 hours after PCI when compared to baseline value. Seven independent predictors of CIN were identified using logistic regression analysis - amount of contrast, diabetes with microangiopathy, hypotension, peripheral vascular disease, albuminuria, glomerular filtration rate (GFR) and anemia. A formula was then developed to identify the probability of CIN using the logistic regression equation.

Results: The mean (±SD) age was 57.3 (±10.2) years. 83.6% were males. The total incidence of CIN was 9.7% in the development group. The total risk of renal replacement therapy in the study group is 1.1%. Mortality is 0.5%. The risk scoring model correlated well in the validation group (incidence of CIN was 8.7%, sensitivity 92.3%, specificity 82.1%, *c* statistic 0.95).

Conclusion: A simple risk scoring equation can be employed to predict the probability of CIN following PCI, applying it to each individual. More vigilant preventive measures can be applied to the high risk candidates.

* *Corresponding author*. Madras Medical Mission, 4-A, J.J Nagar, Mogappair East, Chennai, Tamil Nadu 600037, India. Tel.: +91 9940277703; fax: +91 44 26565859.
E-mail address: sumavictor@yahoo.com (S.M. Victor).
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1. Introduction

Contrast induced nephropathy (CIN) occurs due to acute kidney injury caused by the contrast media and is a common cause of hospital-acquired acute renal failure.[1] It is associated with increased morbidity and mortality as well as prolonged duration of hospital stay, need for renal replacement therapy and major cardiac events.[2] CIN is defined as a 25% increase in serum creatinine from the baseline value, or an absolute increase of at least 0.5 mg/dL (44.2 μmol/L), 48–72 hours after the administration of radiographic contrast media that is not attributable to other causes.[3,4] At least two significant processes are known to be involved in the pathophysiology of CIN- vasoconstriction resulting in medullary hypoxia and direct toxicity caused by the contrast media to renal tubular cells.[5] The mechanisms that have been implicated in these processes are dehydration, decreased prostaglandin and nitric oxide induced vasodilatation, impaired endothelial function, increase in renal adenosine concentration, increase in oxygen free radicals in response to hyperosmotic load, increased intratubular pressure owing to contrast induced diuresis, increased urinary viscosity and obstruction of the tubules.

Percutaneous coronary intervention (PCI) is a life saving procedure in the management of acute coronary syndrome and improves the quality of life in patients with stable coronary artery disease. However, PCI poses a risk of CIN due to the exposure to contrast media during the procedure. Various risk factors were identified based on studies conducted previously. Advanced age, female gender, anemia, pre-existing renal impairment, diabetes mellitus, reduced intravascular volume, congestive cardiac failure, presence of hypotension, presence of cardiogenic shock, use of intra aortic balloon pulsations (IABP), type of contrast media, large volumes of contrast media, co-administration of nephrotoxic drugs such as angiotensin-converting enzyme inhibitors (ACEI), angiotensin II receptor blockers (ARB), proteinuria (including nephrotic syndrome), multiple myeloma, hypercholesterolemia, hyperuricaemia, hypercalcemia, sepsis, atopic allergy are some of the recognized risk factors.[6–8] Application of risk scoring systems can prognosticate the high risk patients for CIN after the exposure to contrast.[9]

Though there are various risk scoring systems available for prediction of CIN, the risk factor profile and their cumulative effect in Indian patients has never been considered in large studies, to our knowledge. This has prompted us to conduct this prospective study with an aim to detect the incidence of CIN, to identify the predictors and to determine their collective effect in the development of CIN in an unselected population of consecutive patients undergoing PCI in our institution. This risk scoring system is unique to the Indian subcontinent and may also form a model for other countries across the world with similar disease patterns.

2. Materials and methods

2.1. Aims

To evaluate the collective risk of CIN in Indian population by developing a scoring system of several identified risk factors, in patients undergoing PCI.

2.2. Objectives

1. To determine the incidence of CIN in the study group following PCI.
2. To identify the risk factor profile for CIN in Indians and to compare it with the results of studies conducted elsewhere.
3. To estimate the cumulative risk rendered by individual risk factors and to develop a simple risk score model to predict CIN.
4. To validate this model in a sample patient population.

2.2.1. Study population

This is a prospective single center observational study, conducted in Madras Medical Mission, Chennai, which is a tertiary cardiac referral center, from March 2008 to December 2011. 3152 patients underwent PCI during this period. Patients who were other than Indians, patients in whom the required data is missing were excluded from the study, apart from the defined exclusion criterion. Majority of the patients were excluded (approximately 80%) because PCI was performed within 14days of coronary angiogram (CAG). The remaining 1200 patients were analyzed for the study. Written informed consent was obtained from patients and the study is cleared by the institutional ethics committee.

2.2.2. Study protocol

Patients' age, history including diabetes, hypertension, hypothyroidism, liver disease, multiple myeloma, cerebro vascular accident (CVA), congestive heart failure (CHF), chronic kidney disease (CKD), nephrotoxic drugs and presence of acute coronary syndrome (ACS) were noted. Detailed clinical examination was done for all patients including testing for the presence of peripheral vascular disease (PVD), neuropathy or retinopathy. Diabetic microangiopathy was considered to be present when either retinopathy (fundus examination) or neuropathy (monofilament examination) was present. Patients with diabetic nephropathy were included in the CKD group. Presence of PVD was confirmed using Doppler ultrasound if the physical examination including ankle-brachial index was suggestive of the diagnosis. Hemoglobin, total and differential white cell count, erythrocyte sedimentation rate (ESR), serum bilirubin levels, plasma glucose levels, albuminuria, electrolytes, lipids and thyroid profile (if there is a clinical suspicion) were assessed before the procedure by standardized tests in our laboratory.