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Renal Function–Based Contrast Dosing Predicts Acute Kidney Injury Following Transcatheter Aortic Valve Implantation

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Objectives This study sought to assess whether the volume of contrast media (CM) influences the occurrence of acute kidney injury (AKI) following transcatheter aortic valve implantation (TAVI).

Background The volume of CM has been shown to be associated with increasing risk of AKI; however, in a high-risk elderly TAVI population, the predictive value and optimal threshold of CM dose on AKI remain uncertain.

Methods Data of 415 consecutive transfemoral TAVI patients (age 83.6 ± 6.8 years, logistic EuroSCORE 23.0 ± 12.2%) were analyzed. AKI was defined by Valve Academic Research Consortium criteria. Based on a previous formula, the ratio of CM to serum creatinine (SCr) and body weight (BW) (CM × SCr/BW) was calculated as defining the degree of CM use. The association between CM dose and incidence of AKI, as well as predictive factors and prognosis of AKI, were investigated.

Results AKI occurred in 63 patients (15.2%). Cumulative 1-year mortality showed significant differences between the AKI and non-AKI groups (47.9% vs. 15.7%, $p < 0.001$). Mean CM × SCr/BW ratio was higher in the AKI group than in the non-AKI group (4.1 ± 2.9 vs. 2.9 ± 1.6, $p < 0.001$). By multivariate analysis, CM × SCr/BW per 1.0 increase, ejection fraction <40%, and transfusion were associated with the occurrence of AKI (odds ratio [OR]: 1.16; 95% confidence interval [CI]: 1.03 to 1.20; $p = 0.017$, OR: 3.01; 95% CI: 1.49 to 5.00; $p = 0.001$, OR: 2.73; 95% CI: 1.54 to 6.15; $p = 0.001$, respectively). A threshold value of CM × SCr/BW for predicting AKI was statistically identified as 2.7.

Conclusions Although mechanisms of AKI following TAVI are multifactorial, the present study identified a relationship between CM dose increment and high prevalence of AKI. Therapeutic efforts not to exceed the threshold value may reduce the risk of AKI. (J Am Coll Cardiol Intv 2013;6:479–86) © 2013 by the American College of Cardiology Foundation

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First introduced in 2002, transcatheter aortic valve implantation (TAVI) has emerged as a novel alternative procedure enabling catheter-based treatment of high surgical risk patients with symptomatic aortic stenosis) (1–5). Recent reports have shown that acute kidney injury (AKI) occurs in approximately 10% to 30% of patients undergoing TAVI and is associated with early and late mortality (6–11). AKI has been previously shown to increase midterm mortality in patients undergoing cardiac surgery or interventional cardiovascular procedures (12–16). The volume of contrast media (CM) is considered a major factor of AKI and the association between the occurrence of AKI and CM dosing has long been the subject of study (17–22). Several previous investigations have revealed that CM × serum creatinine (SCr) (in mg/dl)/body weight (BW) (in kg) over 5.0 is associated with an increased risk of kidney injury or of the need for dialysis after percutaneous coronary intervention (19–22). Another ratio, the total amount of CM volume divided by the estimated creatinine clearance (CCr), the CM/CCr ratio, is also considered a useful tool (23,24). Although efforts have been made to identify predictors of AKI in TAVI cohorts (6–11), there still exists a paucity of data due to the relatively small cohort size. Moreover, it remains unclear whether CM volume predicts AKI in this high-risk TAVI cohort composed of very elderly patients (6–11). The purpose of the study reported here was therefore to analyze the influence of renal function–based contrast dosing on AKI.

Abbreviations and Acronyms

AKI = acute kidney injury
AR = aortic regurgitation
BW = body weight
CCr = creatinine clearance
CI = confidence interval
CM = contrast media
Cr = creatinine
eGFR = estimated glomerular filtration rate
Euro SCORE = European System for Cardiac Operative Risk Evaluation
LVEF = left ventricular ejection fraction
OR = odds ratio
RBC = red blood cell
ROC = receiver-operating characteristic
SCr = serum creatinine
STS = Society of Thoracic Surgeons Predictive Risk of Mortality
TAVI = transcatheter aortic valve implantation

Methods

Study population. The study population comprised 446 consecutive patients with symptomatic aortic stenosis who underwent an elective transfemoral TAVI procedure in 2 French centers (n = 183, Henri Mondor University Hospital from December 2007 to January 2012; and n = 263, Jacques Cartier Institution Hospital from October 2006 to January 2012, respectively). Patients were selected for TAVI when considered unsuitable or high risk for surgical aortic valve replacement by consensus between individual centers and heart team discussion. The operative risk was calculated by using the logistic European System for Cardiac Operative Risk Evaluation (Logistic EuroSCORE) and Society of Thoracic Surgeons Predictive Risk of Mortality (STS) score. High surgical risk was defined as Logistic EuroSCORE >20% or STS score >10% and also assessed according to the presence of cardiac or noncardiac comorbidities (25). Thirty-one patients were excluded because they were not eligible to undergo assessment of the incidence of AKI: 12 patients were already receiving regular hemodialysis before TAVI, and 19 patients died within 72 h of TAVI. The analysis was performed in the 415 remaining patients. Clinical data, patient characteristics, echocardiographic data, procedural variables, length of hospital stay, and in-hospital and all-cause mortality rates were prospectively examined. Information about death was obtained from the treating hospital or by phoning the patient's family. The medical ethics committees at both hospitals approved this study protocol, and written informed consent was obtained from all patients before the TAVI procedure.

TAVI details and AKI analysis. TAVI procedures have already been described in detail (1–5,26–28). The Medtronic CoreValve Revalving System (Medtronic, Minneapolis, Minnesota) or the Edwards Sapien valve (Edwards Lifesciences, Irvine, California) were used. The femoral artery was mainly approached percutaneously using a pre-closing technique (ProStar XL, Abbott Laboratories, North Chicago, Illinois) (27). In the early phase of our experience, a surgical approach was chosen in both centers (26,27). The prosthesis size was determined from pre-procedural echocardiographic and multislice computed tomographic findings (28). Rapid right ventricular pacing (range 160 to 200 beats/min) was performed during balloon dilation for native aortic valves or implanted bioprosthetic valves. Iodixanol (320 mg of iodine/ml; 290 mOsm/kg of water [Visipaque, GE Healthcare, Buc, France])—a nonionic, iso-osmolar, dimetric type of CM—and iohexol (Omnipaque, GE Healthcare) or iomeprol (Iomeron, Bracco, Milano, Italy)—a nonionic, low-osmolar, monometric type of CM—were used. Catheterization or any other (invasive, significant) examinations requiring CM use were avoided for 72 h before TAVI. The estimated glomerular filtration rate (eGFR) value was calculated using the Modification of Diet in Renal Disease equation: eGFR (expressed in ml/min/1.73 m^2) = $186 \times SCr^{1.154} \times age^{0.203}$ (× 0.742 in the case of female patients) (29). The estimated CCr was calculated using the Cockcroft-Gault method: CCr (ml/min) = 140 − age (years) × BW (kg)/72 × SCr (mg/dl) × (0.85 in female patients) (29). Patients with impaired renal function (eGFR <60 ml/min/1.73 m^2) received hydration and/or pre-treatment drugs (e.g., *N*-acetylcysteine) before TAVI, depending on the physician's decision. The hydration regimens were administered according to previous recommendations: isotonic 0.9% saline was started with an infusion rate of 1 ml/kg of BW per h, 12 h before and continued 12 h after TAVI (30).