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ORIGINAL ARTICLE

Factors Contributing to Acute Kidney Injury and the Impact on Mortality in Patients Undergoing Transcatheter Aortic Valve Replacement

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Background Transcatheter aortic valve replacement (TAVR) patients are at a high risk of acute kidney injury (AKI). This study aimed to investigate AKI and the relationship with iodinated contrast media (ICM), whether there are significant pre- or peri- procedural variables predicting AKI, and whether AKI impacts on hospital length of stay and mortality.

Methods Serum creatinine (SC) levels pre- and post- (peak) TAVR were recorded in 209 consecutive TAVR patients. AKI was defined by the Valve Academic Research Consortium 2 (VARC2) criteria. Baseline characteristics, procedural variables, hospital length of stay (LOS) and mortality at 72 hours, 30 days and one year were analysed.

Results Eighty-two of 209 (39%) patients suffered AKI. Mean ICM volume was 228cc, with no difference between patients with AKI and those with no AKI (227cc (213-240(95%CI)) vs 231cc (212-250) p=0.700)). Univariate and multivariate analysis demonstrated that chronic kidney disease, respiratory failure, previous stroke, the need for blood transfusion and valve repositioning were all predictors of AKI. Acute kidney injury increased LOS (5.6 days (3.8 - 7.5) vs 3.2 days (2.6 - 3.9) no AKI (P=0.004)) but was not linked to increased mortality. Mortality rates did increase with AKI severity.

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Conclusion Acute kidney injury is a common complication of TAVR. The severity of AKI is important in determining mortality. Acute kidney injury appears to be independent of ICM use but pre-existing renal impairment and respiratory failure were predictors for AKI. Transcatheter aortic valve replacement device repositioning or retrieval was identified as a new risk factor impacting on AKI.

Keywords TAVR • Acute kidney injury • Contrast media • Renal failure • Chronic kidney disease • Co-morbidities

Introduction

Elderly patients with significant aortic stenosis have a poor prognosis without surgery to replace the valve [1]. However, they are often deemed too high risk for an operation because of frailty or significant comorbidities [1–3]. Transcatheter aortic valve replacement (TAVR) is an alternative to conventional open heart surgery in the treatment of severe symptomatic aortic stenosis in this patient group [4–6]. These patients are at an increased risk of complications, particularly acute kidney injury (AKI). The incidence of AKI in patients undergoing TAVR is reported to be as high as 41.7% [7] and post TAVR renal failure was listed as the most common complication at 30 days in the local SOURCE ANZ registry [8]. Acute kidney injury has been associated with increased length of hospital stay [9,10], 30-day [11] and one-year mortality [12].

Iodinated contrast media (ICM) may adversely affect renal function, termed contrast-induced nephropathy (CIN) [13]. Iodinated contrast media causes cellular injury and death to renal tubular cells [14]. In patients undergoing TAVR, the relationship between AKI and ICM is not conclusive, with some studies indicating that ICM use impacts on AKI [15] and others reporting that there is no relationship [11,12,16–20]. It is suggested that the high incidence of AKI in this elderly group of patients is multi-factorial, with comorbidities such as age, hypertension [17], peripheral vascular disease (PVD) [7,12] and chronic obstructive pulmonary disease (COPD) [11] being associated with a higher incidence of AKI. To date there are limited local data for AKI incidence and outcomes in patients undergoing TAVR in Australia. This study aimed to investigate AKI in an Australian TAVR centre and investigate how AKI is related to ICM usage, baseline patient characteristics and TAVR procedural data. This study had four aims:

1. Determine the relationship between ICM volume and AKI in this cohort.
2. Determine what risk factors or baseline characteristics are related to patients that suffer AKI during TAVR in this cohort.
3. Determine any procedural factors that have not been previously reported that may predict AKI.
4. Investigate the impact of AKI on hospital length of stay and early, mid and long term-mortality in this cohort.

Materials and Method

209 consecutive patients who underwent TAVR procedures between August 2008 and July 2013 were included. The study encompassed TAVR patients in whom either the CoreValve (Medtronic), Edwards Sapien valve (Edwards Lifesciences) or the Lotus Valve (Boston Scientific) were implanted. It excluded those who had a TAVR device implanted in pre-existing prosthetic aortic valves and those who had presented for repeat TAVR. It included patients who had TAVR devices implanted from the femoral artery, via the trans-apical approach and via the trans-aortic approach.

All patients were imaged with Iopromide Ultravist 370 mg/cc (Schering AG, Berlin, Germany) contrast media, using a Siemens Artis Zee (Siemens AG, Erlangen, Germany) cardiovascular imaging suite in a hybrid operating theatre. All patients were pre-hydrated with 0.9% sodium chloride saline at a rate of 20 cc/hour unless otherwise indicated.

Baseline patient characteristic data and procedural data were collected prospectively and entered into a database. Other measures were collected post-procedure, including post-procedural complications, blood results, hospital length of stay and mortality at 72 hours, 30 days and one year.

Acute kidney injury was defined in each group by the modified RIFLE classification, as published by the updated Valve Academic Research Consortium definitions (VARC 2) [21]. This group defines AKI as an increase in serum creatinine of 150-200% (stage 1), 200-300% (stage 2) or >300% (stage 3). Comparisons were made between patients who did and did not suffer AKI, in terms of baseline patient characteristics, procedural data and outcomes. Approval for this study was granted by the facilities' human research ethics committee.

Statistical Analysis

Univariate analysis was carried out on all baseline, procedural and follow-up patient characteristics. Categorical variables were compared with a Fisher's exact test and continuous variables with a two-tailed Students t-test. Multivariate logistic regression was utilised to compare the variables that demonstrated a p-valve >0.1 and that also had >5 events in either group in the univariate analysis. Stepwise removal of non-significant variables was also performed. ANOVA calculations were performed to determine significance between AKI stages and mortality. Kaplan Meier curves were created to demonstrate mortality between AKI groups. Significance was determined where probability (P-value) was determined to be < 0.05. SPSS version 20 was utilised for the statistical analysis.

Results

Of the 209 patients in this cohort, 82 developed AKI (39%). Of these 82 patients, 65 had stage 1, nine had stage 2 and eight had stage 3 AKI (Figure 1).