Transcatheter Aortic Valve Replacement and the Kidney

By Mohammed Elsadany, Yifeng Yang, Sonali Gupta, and Joseph Mattana

Until recently, transcatheter aortic valve replacement (TAVR) has been a treatment option for patients with severe symptomatic aortic stenosis who are not candidates for surgical aortic valve replacement (SAVR). It has been used for patients who are at high or intermediate surgical risk, but recent studies have demonstrated the noninferiority and also superiority of TAVR compared with SAVR in patients at low surgical risk (1), and TAVR has found a role in patients with kidney disease as well. The number of TAVR procedures is therefore expected to grow. Whereas kidney disease may have an impact on TAVR outcomes, the effects of TAVR on the kidney encompass several topics, which will be discussed here.

TAVR and AKI

Acute kidney injury (AKI) is one of the important complications of TAVR, with a reported incidence ranging from 6% to 57% (2–10). Patients undergoing TAVR often have multiple comorbidities contributing to an increased AKI risk, such as chronic kidney disease (CKD), hypertension, diabetes mellitus, chronic obstructive pulmonary disease, peripheral vascular disease, congestive heart failure, higher EuroSCORE, and older age (3, 4, 6, 8–11). Intraoperative risk factors for AKI after TAVR include hypotension, use of an intra-aortic balloon pump, procedural bleeding events, blood transfusion, use of nephrotoxic contrast media, and the transapical approach (3, 4, 6, 7). Postoperative risk factors for AKI include hemodynamic instability and congestive heart failure.

As expected, AKI after TAVR is associated with worse outcomes (6–10). In one study, patients who experienced AKI had higher in-hospital mortality (21% vs. 4%, p = 0.007) and 30-day mortality (29% vs. 7%, p = 0.004) in comparison with patients without AKI (7). Another study showed that post-TAVR AKI development is associated with increased in-hospital mortality (odds ratio 4.74, 95% confidence interval 1.39–18.48) and 6-month mortality (odds ratio 4.66, 95% confidence interval 2.32–9.63) (6).

Although some studies have shown that TAVR entails a higher risk for AKI than does SAVR, this may be confounded by selection bias, with patients with more comorbid conditions and therefore higher AKI risk being selected for SAVR rather than TAVR (12). A propensity-matched study in fact, showed no significant difference in the incidence of postoperative AKI (11). In addition to measures such as avoidance of hypovolemia and intraoperative hypotension and minimizing exposure to radiocontrast media, the PROTECT-TAVI study found that use of the RoyalGuard System was associated with a reduced incidence of AKI in comparison with a control group who received normal saline solution (5.4% vs. 25.0%, p = 0.014) (13). Given the adverse impact of AKI, it is of course important to identify those patients who are at high risk for post-TAVR AKI and to use measures to help prevent this serious complication.

TAVR and CKD

CKD is a risk factor for the development of post-TAVR AKI and for increased length of stay and mortality (14–16). A meta-analysis found that patients with CKD and high surgical risk undergoing TAVR had an increased risk of short-term and long-term mortality (hazard ratio 1.51, 95% confidence interval 1.22–1.88; and hazard ratio 1.56, 95% confidence interval 1.38–1.77, respectively, p < 0.01). However, no association was found between CKD and mortality in low-to-intermediate-risk patients (16). Another study reported that those with CKD had significantly increased in-hospital mortality compared with non-CKD/ESRD patients (4.5% vs. 3.7%, adjusted odds ratio 1.34, 95% confidence interval 1.20–1.31, p < 0.001) (15). That same study found that CKD was associated with an increased length of hospital stay, hemorrhea requiring transfusion, and need for permanent pacemaker implantation (p < 0.001) (15). In another study, a total of 540 patients undergoing TAVR were divided into three groups according to GFR before TAVR: group A, normal renal function, i.e., GFR ≥60 mL/min; group B, impaired renal function, i.e., GFR 30–59 mL/min; and group C, severely impaired renal function, i.e., GFR <30 mL/min. Multivariate analysis showed that GFR had a significant impact on mortality (p < 0.0008). Subgroup analysis revealed a significant difference in mortality rates between the three groups at 30 days: (group A, 5.4%; group B, 9.0%; and group C, 25.0%) and at 12 months (group A, 15.0%; group B, 32.0%; and group C, 49%) (17).

TAVR has become a valuable option for the treatment of severe aortic stenosis in patients with CKD and in those with ESRD receiving renal replacement therapy, although caution must be exercised because the outcomes are less favorable than in the general population.

Despite the finding that CKD is associated with higher mortality after TAVR, patients with CKD nevertheless appear to clearly benefit from interventions to treat aortic stenosis. In one study of patients with CKD, aortic valve replacement (AVR) was associated with improved survival (time-dependent hazard ratio 0.63, 95% confidence interval 0.45–0.88, p = 0.006) (18), although the majority of the patients underwent SAVR. Another study that used the National Inpatient Sample reported lower in-hospital mortality and lower rates of AKI, dialysis requiring AKI, and postoperative stroke and also shorter lengths of stay and a nonsignificant difference in cost for CKD patients undergoing TAVR in comparison with SAVR (19).

Although CKD may increase the risk of AKI and other complications in patients undergoing TAVR, there is great interest as to whether TAVR may have a favorable impact on GFR, given its potential to improve arterial filling and renal perfusion among other physiologically relevant consequences. In the study described above (17), it was in fact noted that patients with moderately impaired renal function (group B) demonstrated an increase in GFR (46.17 mL/min vs. 55.72 mL/min, p < 0.0001), and patients with severely impaired renal function (group C) also demonstrated an increase in GFR (19.54 mL/min vs. 27.9 mL/min, p < 0.0001). The increase in GFR was noted in a total of 301 patients (55.7%). The cardiac output of these patients showed a significant increase after TAVR (17). Given these findings, although TAVR carries an increased risk for AKI in CKD patients, it also may lead to improvement in kidney function, likely because of improved cardiac output after replacement of the diseased valve.

TAVR and ESRD

ESRD is associated with higher mortality after TAVR (15, 16). Patients with ESRD have been reported to have significantly increased in-hospital mortality in comparison with non-CKD/ESRD patients (8.2% vs. 3.7%, adjusted odds ratio 2.51, 95% confidence interval 2.02–3.12, p < 0.001) and an increased length of hospital stay, more episodes of hemorrhage requiring transfusion, and greater need for permanent pacemaker implantation (p < 0.001) (15). Another study compared TAVR outcomes between dialysis and nondialysis patients and found the dialysis group to have increased mortality at 30 days (13% vs. 6%, p < 0.01). Multivariable regression revealed that dialysis was independently associated with worse survival after TAVR (hazard ratio 1.73, 95% confidence interval 1.33% to 2.25%, p < 0.01) (20). In comparison with a propensity-matched group of dialysis patients who underwent SAVR, dialysis patients who underwent TAVR had significantly shorter hospital stays and comparable survival (20).

A study that used the National Inpatient Sample between 2012 and 2014 compared in-hospital outcomes of TAVR versus SAVR in ESRD patients undergoing hemodialysis and showed that the in-hospital mortality rate was similar between TAVR and SAVR (8% vs. 10.3%, p = 0.58). Compared with SAVR, TAVR was associated with shorter length of stay (8 vs. 14 days, p < 0.001), lower hospitalization cost ($276,448 vs. $364,280, p = 0.01), fewer in-hospital complications (60.0% vs. 76%, p = 0.003), and a higher rate of discharge to home (31.4% vs. 17.7%, p = 0.004) (21).

Whereas ESRD is associated with higher mortality after TAVR, just as for CKD patients ESRD patients do benefit substantially from AVR. For example, a study that used a Japanese multicenter registry reported that patients using hemodialysis who underwent AVR experienced lower mortality than did those receiving conservative treatment (22). A cumulative 5-year all-cause mortality was 60.0% in the AVR group versus 75.5% in the conservative group (p < 0.001), and sudden death was 10.2% in the AVR group versus 31.7% in the conservative group (p < 0.001), which suggests that hemodialysis patients also benefit from interventions to treat aortic stenosis.

Conclusions

TAVR has become a valuable option for the treatment of severe aortic stenosis in patients with CKD and in those with ESRD receiving renal replacement therapy, although caution must be exercised because the outcomes are less favorable than in the general population.
though it may increase the risk for development of AKI, the potential benefits of TAVR appear to include the possibility that it may ultimately result in an increase in GFR and improve the survival rate. Recently, emerging data on the preferential use of TAVR in low-surgical-risk patients will be important to examine in patients with kidney disease as well.

Mohammed Elsadany, Yifeng Yang, and Joseph Mattana are associated with St. Vincent’s Medical Center, Bridgeport, Connecticut, and the Quinnipiac University Frank H. Noter MD School of Medicine, North Haven, Connecticut. Sonali Gupta is associated with the University of Rochester, Rochester, New York.

References

TRANSCATHETER MITRAL VALVE REPAIR (MitraClip) and the Kidney

By Mohammed Elsadany, Yifeng Yang, Sonali Gupta, and Joseph Mattana

Transcatheter mitral valve repair (TMVR) is a minimally invasive procedure used as a treatment option for patients with symptomatic chronic moderate to severe, or severe mitral regurgitation (MR). The MitraClip is an edge-to-edge leaflet repair device and is currently the only device approved by the U.S. Food and Drug Administration for TMVR. MR is one of the most common valve lesions. Patients with chronic kidney disease (CKD) and MR usually have multiple comorbidities, increasing their surgical risk for valve replacement and making them possible candidates for TMVR by use of the MitraClip. The interaction between MR and the kidney is complex: MR can lead to abnormalities in hemodynamics and congestive heart failure, which may lead to or worsen CKD. Repair of the mitral valve may therefore be expected to have a favorable impact on kidney function in some patients. Conversely, kidney function plays an important role in cardiovascular disease, and it is well known that the outcomes of many procedures such as transcatheter aortic valve replacement (TAVR) are worse in patients with CKD than in the general population. Here we review the use of MitraClip and its application in patients with kidney disease.

MitraClip and CKD

Given the interrelationships between the heart and kidneys, it is plausible that repair of the mitral valve, including repair performed by the transcatheter approach, might have a favorable impact on kidney function in some patients in whom a component of the kidney disease is a consequence of decreased effective arterial volume.

In one such study (1), 854 patients with moderate to severe or severe MR (3+ or 4+, respectively) who underwent TMVR with the MitraClip device in multicenter investigational trials (2, 3) and the REALISM (Real World Expanded Multicenter Study of the MitraClip System) continued access registry were evaluated. The distribution of the estimated GFRs (eGFRs) of the patients at the baseline of the study was as follows: CKD stage 1 or 2 (eGFR 60–89 mL/min per 1.73 m²), n = 438; CKD stage 3 (eGFR 30–59 mL/min per 1.73 m²), n = 364; and CKD stage 4 (eGFR <30 mL/min per 1.73 m²), n = 52. Follow-up evaluation after 1 year revealed improvements in eGFR in patients with more advanced CKD. In the overall cohort with paired baseline and 1-year data (n = 579), the mean change in eGFR was -1.0 ± 15.2 mL/min per 1.73 m² (p = 0.10). For patients with CKD stage 1 or 2 at baseline (n = 319), the eGFR was decreased 1 year after the procedure (-4.1 ± 16.6 mL/min per 1.73 m²). However, patients with CKD stage 3 at baseline (n = 227), the mean eGFR increased (+2.6 ± 12.4 mL/min per 1.73 m²), and among patients with CKD stage 4 or 5 at baseline (n = 33), this

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