



Does the maze procedure predispose to acute kidney injury?

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The maze procedure for surgical ablation of atrial fibrillation (AF) is associated with improved survival, better quality of life and a decrease in thromboembolic events (1,2). Previous studies have demonstrated the safety and efficacy of concomitant maze procedure in AF patients undergoing cardiac surgery (1-5). The society of Thoracic Surgery 2017 Clinical Practice Guidelines provides a Class I recommendation for the maze procedure to be performed concurrently during other cardiac procedures (6).

Potential complications of the maze procedure include an increased incidence of new pacemaker implantation and renal dysfunction (1,2,7). Current consensus criteria such as: (I) Risk/Injury/Failure/Loss/End stage (RIFLE), (II) Acute Kidney Injury Network (AKIN), and (III) Kidney Disease Improving Global Outcomes (KDIGO) list a spectrum of renal dysfunction ranging from acute kidney injury (AKI), renal failure to end-stage/dialysis, in increasing severity.

Various mechanisms have been proposed for the development of renal dysfunction after cardiac surgery. One process by which cardiac surgery may contribute to AKI is by inciting a strong systemic inflammatory response as a sequelae of operative trauma, contact of blood components with the artificial surface of the cardiopulmonary bypass (CPB) circuit, ischaemic-reperfusion injury and endotoxemia (8-11). Cardiac surgery may further heighten the risk of AKI through generation of free haemoglobin and iron from haemolysis that occurs during CPB, resulting in pigment nephropathy (8,10).

While current guidelines suggest that concomitant surgical ablation of AF does not increase the risk of renal

failure (Class IIa, Level B-NR evidence) or dialysis (Class IIa, Level A evidence) (6,12,13), there is paucity of data pertaining specifically to AKI after the maze procedure. Firstly, the definition of AKI is standardized in only a few studies. Secondly, the direct impact of the maze procedure on renal dysfunction is challenging to establish and is often confounded by multiple factors.

The recent study by Hong *et al.* should be commended on their efforts to evaluate the incidence and elucidate risk factors associated with AKI in 203 patients with rheumatic mitral valve disease who underwent mitral valve replacement and concomitant maze procedure (14). Other combined procedures included aortic valve operations (n=64, 31.5%) and tricuspid valve procedures (n=149, 73.4%). In this study, all patients underwent a bi-atrial maze procedure. The authors demonstrated two main findings: First, using the RIFLE criteria, postoperative AKI developed in 76 patients (37.4%). Second, a multivariable analysis showed that age [odds ratio (OR), 95% confidence interval (CI): 1.065, 1.025–1.107; P=0.001], CPB time (1.007, 1.002–1.013; P=0.009) and nadir haematocrit during CPB (0.854, 0.740–0.985; P=0.031) were associated with postoperative AKI. The authors proposed optimization of CPB management to prevent postoperative AKI after the maze procedure. The authors acknowledged important limitations of their study, including its retrospective nature and small sample size. In addition, there was no control (non-maze) group available for comparison as the centre adopted an aggressive approach for AF correction, with almost all patients with rheumatic mitral valve disease

undergoing the maze procedure.

A recent study from one of the pioneering institutions for maze procedure demonstrated a similar incidence of AKI (32%) after surgical ablation for AF (7). Bakir and colleagues conducted a propensity-matched analysis of 308 pairs of maze and non-maze patients. Patients with pre-existing renal impairment were excluded to adjust for the effect of pre-existing renal dysfunction and increased CPB time. Based on the KDIGO criteria, the authors demonstrated that patients who underwent concomitant maze procedure experienced significantly higher rates of postoperative AKI relative to those who did not have surgical ablation [32% (99/308 patients) *vs.* 16% (49/308 patients); $P < 0.001$]. Concomitant maze procedure was identified as an independent risk factor for AKI, after accounting for comorbidities and operative variables. However, it is important to note that the incidence of renal failure or dialysis was statistically similar in both groups.

Although most cases of postoperative AKI following cardiac surgery are reversible, development of renal dysfunction, even when it is relatively modest, confers an adverse prognosis and has been associated with markedly increased risks of both short- and long-term mortality, up to ten years after surgery (15-17). In a previous study of 339 patients who underwent tricuspid valve annuloplasty, Wu *et al.* examined the predictive value of AKI for major adverse cardiovascular events (MACE) by comparing three consensus criteria for AKI, (I) RIFLE, (II) AKIN, and (III) KDIGO (18). For short-term outcomes within 30 days, AKI defined by all three scoring systems was independently associated with MACE and death. For outcomes beyond 30 days, AKI by all three criteria was associated with MACE and heart failure (17). The risk of death associated with AKI after cardiac surgery remains high for 10 years regardless of other risk factors, even for patients with complete renal recovery (16).

While concomitant maze procedure may be associated with an increased risk of postoperative AKI, this needs to be balanced against the marked benefits offered by this operation. Bakir and colleagues demonstrated that although AKI in the acute postoperative period was associated with increased late mortality, this effect was largely offset by the substantial survival benefit of restoring sinus rhythm with surgical ablation. A previous study by the same group showed a markedly improved ten-year survival at 62% versus 42% in patients with AF who underwent surgical ablation, compared to those with untreated AF. Adjusted hazard ratio was 0.47 (95% CI: 0.26–0.86, $P = 0.001$) (2).

Thus, the increased risk of AKI after surgical ablation needs to be balanced against the survival and haemodynamic benefit with restoration of sinus rhythm.

McCarthy provided an insightful expert opinion, stating that the addition of a concomitant maze procedure must be safe, cautioning against prolonged CPB time and increased risks of pacemaker implantation and renal failure. All surgeries require a sound judgement of risk versus benefit. The extent of surgical ablation should take into account each patient's comorbidities and other operative considerations. Hence the maze IV procedure may not always be the best choice for all patients (19).

The recently published study by Hong *et al.* adds to the limited evidence regarding AKI following the maze procedure (14). Further studies are required to investigate this topic in search of effective renal protection strategies. The treatment strategy for each patient needs to be individualized, weighing the potentially increased risk of postoperative AKI against the improved survival and decreased risk of stroke following a successful maze procedure. Patients must be advised appropriately and guided towards informed decisions.

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