Renal Complications in Patients Undergoing Peripheral Artery Interventions

Sachin S. Goel, MD[a], Mehdi H. Shishehbor, DO, MPH, PhD[b,*]

KEYWORDS

• Contrast-induced nephropathy • Peripheral artery intervention • Calculated creatinine clearance • Acute kidney injury

KEY POINTS

- Contrast-induced nephropathy (CIN) is the most important and most frequent renal complication of endovascular interventional procedures.
- The risk factors for CIN in this population are poorly defined. Small studies suggest that chronic kidney disease, diabetes, age older than 75 years, anemia, and volume of contrast used are risk factors for CIN.
- A ratio of contrast volume/calculated creatinine clearance (CV/CCC) that exceeds 3 is associated with significantly increased risk of CIN.
- Minimizing contrast use and adequate preprocedure and postprocedure hydration remains the main preventive strategy for CIN.

Peripheral artery disease (PAD) is a significant problem with increasing incidence and prevalence, particularly in the elderly.[1] The reported prevalence of PAD among individuals older than 70 years is 14.5%, which equals nearly 4 million adults in the United States.[2] The management of patients with severe PAD initially includes appropriate medical therapy and lifestyle changes for prevention of death, stroke, or myocardial infarction, in addition to symptom relief and prevention of amputation. Surgical or endovascular revascularization procedures are typically performed in patients with lifestyle-limiting symptoms or evidence of end-organ ischemia secondary to PAD.[3] The role of endovascular therapy in the treatment of PAD is expanding. Knowledge about complications and their prevention and management is essential for successful outcomes. This article focuses on renal complications during peripheral artery interventions.

CONTRAST-INDUCED NEPHROPATHY

Contrast-induced nephropathy (CIN) is the most important and most frequent renal complication of endovascular interventional procedures. A definition of CIN is given in **Box 1**.

Incidence

CIN is the third leading cause of acute kidney injury (AKI) in hospitalized patients, and is associated with significant patient morbidity.[7,8] It remains a common problem after coronary and peripheral arterial procedures, and occurs in 1% to 5% of low-risk patients; however, the incidence can be as high as 30% to 50% in high-risk populations.[9,10] In a report from the BMC2 PVI (Blue Cross Blue Shield of Michigan Cardiovascular Consortium Peripheral Vascular Intervention) Program, a prospective multicenter observational registry, of 7769 patients undergoing lower extremity

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[a] Interventional Cardiology, Department of Cardiovascular Medicine, Heart & Vascular Institute, 9500 Euclid Avenue, Cleveland, OH 44195, USA; [b] Endovascular Services, Heart & Vascular Institute, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195, USA
* Corresponding author.
E-mail address: shishem@ccf.org

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Box 1
Definition of contrast-induced nephropathy

Contrast-induced nephropathy is usually defined as an increase in serum creatinine concentration of greater than 25% above baseline or greater than 0.5 mg/dL within 48 hours after administration of contrast media.[4–6]

peripheral vascular interventions (LE PVI), the incidence of CIN was about 3% in patients younger than 70 years and 7% in those 80 years and older.[11]

Impact of CIN

Most data on CIN are derived from patients undergoing percutaneous coronary intervention (PCI); the predictors and implications of CIN in patients undergoing endovascular peripheral arterial interventions are poorly defined. However, patients undergoing peripheral arterial interventions often have coexistent atherosclerosis in the coronary and cerebral circulation, and have comorbidities similar to those in patients with coronary disease undergoing PCI. The incidence of CIN requiring dialysis is 0.3% in low-risk populations and as high as 12% to 15% in high-risk populations.[12] Multiple studies have shown the association between CIN and the increased risk of early and long-term adverse events such as myocardial infarction, rehospitalization, and mortality.[8,13] In a study from the Mayo Clinic assessing 7586 patients undergoing coronary interventions, the incidence of CIN was 3.3%, with a 22% in-hospital mortality rate in those who developed this complication.[8] Among survivors of CIN, the long-term rates of myocardial infarction and death were significantly higher in comparison with those without CIN. It is unclear, however, whether CIN is associated with a similar adverse hazard in patients undergoing peripheral interventions.

Pathophysiology

The exact underlying mechanism of CIN is unclear. The 2 main pathophysiologic mechanisms proposed include renal vasoconstriction with medullary hypoxia, leading to acute tubular necrosis (ATN) and direct cytotoxic effects of contrast agents.[14] Renal vasoconstriction is thought to be mediated by changes in the viscosity of blood to the medullary regions of the kidney by the contrast media, and partly by vasoactive mediators such as adenosine, nitric oxide, and endothelin.[15,16] Direct cytotoxic effects of contrast and generation of oxygen free radicals also contributes to the development of CIN.[14,17]

Risk Factors for CIN

Several patient-related and procedural factors have been recognized as risk factors for the development of CIN in patients undergoing PCI (**Box 2**). Risk models have been derived to predict the risk of CIN and to define safe limits of contrast media in patients undergoing PCI.[9,10] These risk models are heavily weighted by cardiogenic shock and hypotension, conditions that are infrequent among patients undergoing peripheral arterial procedures. Patients undergoing peripheral artery interventions, however, share other comorbidities with patients undergoing PCI, such as hypertension, diabetes mellitus, chronic kidney disease, congestive heart failure, and older age. Pending data from PAD-specific interventional procedures, these models developed in PCI patients should not be used in patients undergoing peripheral interventional procedures for risk assessment. Patient risk profiles are nonmodifiable to a large extent during the interventional procedure. Hence, studies have focused on identification of a safe upper limit of contrast volume that can be administered during procedures. In a large study from the BMC2 registry from 2007 to 2008, consisting of 58,957 patients undergoing PCI, the risk of CIN and nephropathy requiring dialysis (NRD) was found to be markedly increased when the ratio of contrast volume/calculated creatinine clearance (CV/CCC) exceeded 3 (odds ratio [OR]

Box 2
Risk factors for contrast-induced nephropathy

Patient related
- Chronic kidney disease
- Congestive heart failure
- Age >75 years
- Hypotension at the time of procedure
- Diabetes mellitus
- Anemia
- Peripheral arterial disease
- History of hypertension
- Concomitant nephrotoxic drug use
- Female gender

Procedure related
- Contrast volume administered
- Use of intra-aortic balloon pump
- Urgent/Emergent procedure
- Repeat contrast exposure in 72 hours
- High osmolar contrast