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Contrast-Induced Nephropathy; Prevention Strategies In High-Risk Patients

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Abstract

X Contrast-induced nephropathy (CIN) is a complication which may develop after exposure to iodinated contrast media. Incidence of CIN in the general population is estimated to be less than 2% but in high-risk patients CIN incidences have been reported approximately 50%. The first aim to prevent CIN is identifying high-risk subjects and controlling associate risk factors.

Keywords: Contrast-induced nephropathy, prevention, high risk patient.

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Introduction

Contrast-induced nephropathy (CIN) is a complication which may develop after exposure to iodinated contrast media and one of the major causes of hospital-acquired acute kidney injury (AKI) (1). Incidence of CIN in the general population is estimated to be less than 2%. However, in high-risk patients CIN incidences have been reported approximately 50% (2). The development of CIN is associated with a longer hospital stay, an increased morbidity and mortality and hence increased financial cost. Therefore, to prevent CIN is more reasonable than treatment. The first aim to prevent CIN is identifying high-risk subjects and controlling associate risk factors (3). In this review, we try to summarize strategies for the prevention of CIN in high-risk group patients.

High risk groups

Initially to preventing CIN, baseline renal function and the patient's risk factors must be known. CIN is typically defined as an increase in serum creatinine but only measurement of serum creatinine is not enough to evaluate renal function as this varies with age, muscle mass, and sex (4). Serum creatinine (SCr) and the estimated glomerular filtration rate (eGFR) should be measured before all patients exposed contrast media. Generally patients with an eGFR greater than 60 ml/minute/1.73 m2 do not require special precautions. Nephrotoxic drugs should be withdrawn before contrast media administration in all patients at high risk (5) (Table 1)

Table 1: Nephrotoxic drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs)
Diuretics (Furosemide)
Metformin
Sulphonamides/Penicillin
Aminoglycosides
Amfotericin
Vancomicin
Cisplatin, Cyclosporin A

1. Chronic kidney disease

Pre-existing chronic kidney disease (CKD) with an elevated level of SCr is the most crucial risk factor in the development of CIN. In patients with severe chronic renal failure (creatinine clearance <30 mL/min) a nephrology consult should be done to consider the use of hemofiltration before PCI (6-8). Hemofiltration allows an aggressive fluid replacement (1,000 mL/hour) and may be initiated 4–8 hours before PCI and continued for 18–24 hours after the procedure (7, 8). Hemofiltration is most useful in patients with severe renal insufficiency with an acute myocardial infarction undergoing urgent PCI (8).

2. Diabetes mellitus

Diabetes mellitus is also a common cause of CKD and an important risk factor for CIN (4). Diabetic patients have a 20% CIN incidence whereas non-diabetics

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have a 5.5% CIN incidence; incidence of CIN increases to up to 40% in diabetic patients with renal impairment (4). A pre-diabetes status (fasting glucose between 100 and 125 mg/dL) can also increase the risk of CIN among patients with renal failure (9). Insulin-dependence, long term diabetes, acute hyperglycemia, and complications have been reported to increase the risk of CIN (10). Previous studies suggested a highly beneficial effect of NAC in the prevention of CIN, which initiated a trend for clinicians to use NAC in procedures using contrast agents (11-14). However, in the Acetylcyteine in Diabetes (AID) study, there was no benefit in NAC therapy over hydration therapy in diabetic patients (15). There have been doubts raised about the effect of NAC. Indeed, the strong recent meta- analysis does not support the use of NAC to reduce CIN risk (16).

Because of the risk of lactic acidosis in patients receiving contrast media, generally metformin should be interrupted before procedure and reintroduced 48 hour later, only after assessment of renal function. However, there is no evident for such a recommendation. Checking renal function after angiography in patients and then stopping metformin when renal function deteriorates might be an acceptable alternative to suspension of metformin in all patients. In patients with moderate and severe chronic kidney disease, metformin should preferably be stopped before the procedure (17).

3. In acute settings

In urgent settings is not enough time for prophylaxis, the use of more contrast in the process and reasons for the patient is hemodynamically unstable, increase the risk of CIN. Ochoa et al. recommended the administration of 150 mL/hour of isotonic solution followed by the same dose for the next 6 hours when time to contrast media administration is less than 4 hours (18). If only 30 minutes is available before the procedure, they recommended the administration of 500 mL/30 min of isotonic solution IV and 1.000 mL in the next 12 hours (19). The routine use of sodium bicarbonate was not advised in patients with renal insufficiency or during an acute coronary syndrome with renal failure (20), or in those undergoing PCI (21). In emergency PCI, the use of IV bicarbonate can be useful due to its short administration (only 1 hour prior) to PCI (22). CIN reduction can be achieved by a high-dose oral or mix (oral and IV are ideal for emergent cases) of NAC administration (23). Some authors recommended the combination of both antioxidant therapies: bicarbonate and NAC. This combination was used in patients with known renal impairment (SCr ≥ 2 mg/dL or eGFR ≤ 40 mL/min per 1.73 m2) (30) or high-risk patients undergoing an urgent PCI procedure because of an acute coronary syndrome, hemodynamic instability, hypotension, high contrast volume, and the lack of time for prophylaxis (21, 23). Furosemide with matched hydration may be considered over standard hydration in patients where prophylactic hydration before the procedure cannot be accomplished. Initial 250 mL intravenous bolus of normal saline over 30 min (150 mL in heart failure) followed by an i.v. bolus (0.25–0.5mg/kg) of furosemide. Hydration infusion rate has to be adjusted to replace the patient's urine output. When the rate of urine output is >300 mL/h, patients undergo the coronary procedure. Matched fluid replacement maintained during the procedure and for 4 hours post-treatment (24). (Table 2)

Table 2: Recommendations for prevention of contrast-induced nephropathy*

Recommendations	***Class***	***Level***
Patients should be assessed for risk of CIN	IIa	C
Hydration with isotonic saline	I	A
Use of low-osmolar or iso-osmolar contrast media is recommended.	I	A
Short-term, high-dose statin therapy should be considered.	IIa	A
Iso-osmolar contrast media should be considered over low-osmolar contrast media	IIa	A
Volume of contrast media should be minimized.	IIa	B
Furosemide with matched hydration	IIb	A
N-Acetylcysteine administration instead of standard hydration is not indicated	III	A
Infusion of sodium bicarbonate 0.84% instead of standard hydration is not indicated.	III	A
Prophylactic haemofiltration 6 hours before complex PCI may be considered	IIb	B
Prophylactic renal replacement therapy is not recommended as a preventive measure.	III	B

* Adapted from European Society of Cardiology and the European Association for Cardio-Thoracic Surgery 2014 myocardial revascularization guideline.

4. Heart Failure

Previous studies have shown that heart failure and decreased LV functions are risk factors for CIN (9). It is necessary to reduce the rate and volume of IV hydration in patients with ventricular dysfunction. In the event that the ejection fraction is unknown, it is possible to identify the New York Heart Association (NYHA) class. Current guidelines recommend hydration with a reduced dose of isotonic saline (0.5 mL/kg/hour if EF <35% or NYHA >2 dyspnea) (23, 25). Withdrawal of the diuretics is recommended before the procedure in stable patients due to the danger of dehydration (26).

Conclusion

Concisely, before the administration of contrast media baseline renal function of patients must be assessed with eGFR using the MDRD or Cockcroft-Gault formulae. High-risk patients should be determined according to risk factors and eGFR. The amount of contrast media should be as low as possible and low-osmolar contrast media should be used to prevent CIN in high-risk patients. The current guidelines recommend periprocedural hydration only with intravenous administration of isotonic saline. There is a lack of evidence to support the routine use of NAC and other pharmaceutical interventions. Before the procedure in high risk patients withdrawal of potentially nephrotoxic drugs should be noted. Hemofiltration should be considered only in selected patients.

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