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EDITORIAL

Pros and Cons of Use of Contrast Media in Coronary Angiography and Percutaneous Coronary Intervention – an editorial

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Iodinated contrast media remain central to coronary angiography and percutaneous coronary intervention (PCI), enabling visualisation of coronary anatomy and real-time procedural guidance. Despite major advances in imaging technology and catheter-based techniques, contrast-enhanced angiography continues to underpin invasive diagnosis and revascularisation strategies. However, increasing procedural complexity and an ageing population with substantial comorbidity have brought renewed attention to the risks associated with contrast exposure. The clinical challenge is no longer whether contrast should be used, but how to optimise its use to maximise benefit while minimising harm.

The principal advantage of contrast media lies in their ability to provide high spatial and temporal resolution of the coronary vasculature. Contrast angiography allows precise assessment of lesion severity, distribution, and morphology, supporting accurate diagnosis and informed procedural planning[1]. During PCI, contrast injections facilitate device navigation, stent sizing, deployment assessment, and immediate identification of complications such as coronary dissection, perforation, or distal embolisation[2]. These functions remain critical, particularly in acute coronary syndromes, where rapid anatomical definition and timely reperfusion are strongly associated with improved survival[3].

Contrast use also underpins contemporary adjunctive techniques. Although physiological assessment with fractional flow reserve and intravascular imaging modalities such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT) reduce reliance on angiographic estimation alone, contrast is still required for lesion localisation, image acquisition, and procedural orientation[4]. Evidence indicates that imaging- and physiology-guided PCI improves procedural precision and long-term outcomes, reinforcing the continued relevance of contrast-based angiography in modern practice[5].

Against these benefits must be weighed the well-established risks of contrast exposure. Contrast-associated acute kidney injury (CA-AKI) remains the most clinically significant complication, particularly in patients with chronic kidney disease, diabetes mellitus, heart failure, anaemia, or haemodynamic instability[6]. CA-AKI is associated with increased morbidity, prolonged hospitalisation, higher costs, and excess short- and long-term mortality[7]. Although recent observational studies have questioned the magnitude of contrast's independent nephrotoxic effect, evidence from high-risk populations undergoing coronary angiography and PCI suggests that contrast exposure remains a relevant contributor to renal injury[8].

The mechanisms underlying CA-AKI are complex and multifactorial, involving renal vasoconstriction, medullary hypoxia, oxidative stress, and direct tubular toxicity[9]. Importantly, risk appears to be dose-dependent. Higher contrast volume relative to renal function predicts not only renal complications but also adverse cardiovascular outcomes and mortality[10]. As PCI increasingly involves multivessel disease, chronic total occlusions, and complex anatomical substrates, cumulative contrast exposure has become a growing concern.

Hypersensitivity reactions represent an additional limitation. The widespread adoption of low-osmolar and iso-osmolar contrast agents has substantially reduced the incidence of severe reactions, yet mild-to-moderate allergic responses remain common, and rare life-threatening anaphylactoid reactions still occur[11]. These risks, while infrequent, necessitate vigilance and preparedness during invasive procedures.

Recognition of these hazards has driven the development of contrast-sparing strategies. Procedural discipline—minimising unnecessary injections, avoiding redundant angiographic views, and tailoring contrast volume to renal function—remains fundamental[12]. More recently, "ultra-low contrast" and "zero-contrast" PCI techniques, often guided by IVUS, have emerged as viable options for patients with advanced chronic kidney disease[13]. Early studies suggest that such approaches can achieve acceptable procedural success while substantially reducing renal risk, although broader adoption will require operator expertise and further validation.

Preventive strategies remain largely supportive. Adequate periprocedural hydration is the cornerstone of CA-AKI prevention, endorsed by international guidelines[14]. In contrast, pharmacological interventions such as N-acetylcysteine and sodium bicarbonate have shown inconsistent benefit, and their routine use is not supported by robust evidence[15]. Effective risk stratification before coronary angiography or PCI is therefore essential, allowing targeted preventive measures and informed clinical decision-making.

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Technological innovation may further shift the risk–benefit balance. Advances in imaging software, artificial intelligence–assisted image optimisation, and the development of safer contrast agents may reduce contrast requirements without compromising diagnostic accuracy[16]. In parallel, improved non-invasive testing and functional assessment may help limit unnecessary invasive procedures, indirectly reducing population-level contrast exposure.

In contemporary cardiology, contrast media remain indispensable to coronary angiography and PCI. For most patients, the diagnostic and therapeutic benefits substantially outweigh the risks. However, in an era defined by procedural complexity and rising comorbidity, indiscriminate contrast use is no longer acceptable. Individualised decision-making, meticulous technique, and adoption of contrast-sparing strategies where appropriate are essential. The goal is not to eliminate contrast use, but to use it judiciously—ensuring that its undeniable benefits are realised while preventable harm is minimised.

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