



Contrast-induced acute kidney injury; possible ameliorative effect of sodium-glucose co-transporter 2 inhibitors

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Abstract

Contrast-associated acute renal injury is a common complication that occurs after the administration of contrast media for diagnostic or therapeutic purposes. It is characterized by a sudden decline in kidney function within 48-72 hours after the administration of contrast media. The incidence of contrast-associated acute renal injury varies depending on the patient's risk factors and the type and amount of contrast media used. Sodium-glucose co-transporter 2 (SGLT2) inhibitors are a group of antidiabetic drugs that inhibit the reabsorption of glucose in the nephrons, running to raise urinary glucose excretion and improve glycemic control. Recent studies have shown that SGLT2 inhibitors may have a protective effect against contrast-associated acute renal injury. Preventive measures for contrast-associated acute renal injury include hydration, minimizing contrast volume and rate of administration, and avoiding contrast in high-risk patients. The administration of SGLT2 inhibitors may also be a useful preventive measure in patients at risk for contrast-associated acute renal injury.

Keywords: Renal injury, Kidney function, Acute kidney injury, Contrast-induced acute kidney injury, Computed tomography, Angiography, Acute tubular necrosis, Chronic kidney disease, Sodium-glucose co-transporter 2 inhibitors

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Introduction

Contrast-induced acute kidney injury (CI-AKI) is a form of acute renal injury that occurs as a result of the injection of contrast media, frequently administered in diagnostic procedures like computed tomography (CT) scans or angiography (1). Contrast-induced acute kidney injury is a significant concern, as it can lead to kidney damage and further complications in vulnerable individuals, particularly those with pre-existing kidney disease or other risk factors (2). This condition is characterized by a sudden decline in kidney function, which is defined as an increase in serum creatinine levels of at least 0.5 mg/dL or a 25% increase from baseline within 48-72 hours after contrast administration (3). Sodium-glucose co-transporter 2 (SGLT2) inhibitors are a group of medications conducted primarily to treat type 2 diabetes. They work by inhibiting glucose reabsorption in the kidneys, increasing glucose excretion through urine (4). However, SGLT2 inhibitors also have additional effects on renal physiology that may impact CI-AKI (5).

Search strategy

For this review, we searched PubMed, Web of Science, EBSCO, Scopus, Google Scholar, Directory of Open

Access Journals (DOAJ), and Embase, using different keywords including renal injury, acute kidney injury, contrast-induced acute kidney injury, end-stage renal failure, contrast media, kidney function, computed tomography, angiography, acute tubular necrosis, chronic kidney disease and sodium-glucose co-transporter 2 inhibitors.

A short look at the CI-AKI

CI-AKI is a critical complication that can occur after certain medical procedures involving the use of contrast agents such as gadolinium or iodine-based contrast dyes during magnetic resonance imaging (MRI), angiography, or computed tomography (CT) (1). It occurs when these substances accumulate in the kidney and cause damage to the kidneys, leading to decreased renal function. The risk of CI-AKI increases with age, diabetes mellitus, chronic kidney disease, hypertension, and preexisting renal insufficiency (6).

Morphologic lesions of CI-AKI

Acute tubular necrosis is the most common morphologic finding in contrast-induced acute renal injury. It is described by tubular cell injury and necrosis due to the

■ Implication for health policy/practice/research/medical education

Sodium-glucose co-transporter 2 (SGLT2) inhibitors may positively reduce the risk of contrast-induced acute kidney injury through their renal protective effects. The mechanism is thought to be related to the hemodynamic effects of SGLT2 inhibitors. These drugs can reduce intra-glomerular pressure and improve renal blood flow, which may help to prevent renal injury after contrast exposure.

toxic effects of contrast agents (7). The extent of tubular necrosis can vary from focal to widespread involvement, depending on the intensity of the damage. Pathologic findings are loss of epithelial cells lining the renal tubules, leading to tubular dilation, luminal obstruction, and cast formation. Contrast-induced renal injury can also involve the renal vasculature (8). This condition may also manifest as vasculitis, vascular congestion, thrombosis, or endothelial damage. These vascular lesions can further contribute to renal ischemia and exacerbate tubular injury (1,9). In some cases, CI-AKI may lead to interstitial inflammation, edema, and infiltration of immune cells, such as lymphocytes and macrophages. This condition is known as contrast-induced interstitial nephritis. It is thought to be an allergic or hypersensitivity reaction to the contrast agent (10,11). Although less common, contrast-induced glomerular injury can occur. This can manifest as glomerular endothelial or mesangial cell injury, leading to glomerular dysfunction and proteinuria (12). In severe cases, CI-AKI can lead to cortical necrosis, which is characterized by extensive ischemic necrosis of the renal cortex. This can result in permanent kidney damage and even end-stage kidney failure (13).

Administration of SGLT2 inhibitors in preventing CI-AKI

Several studies have suggested the potential benefits of SGLT2 inhibitors in preventing CI-AKI. These medications have been shown to have renal protective effects by reducing oxidative stress inflammation and improving endothelial function (14,15). Additionally, SGLT2 inhibitors may improve renal blood flow and reduce intra-renal oxygen demand, potentially attenuating CI-AKI risk (14). One of the mechanisms through which SGLT2 inhibitors may provide kidney protection is by increasing urinary sodium and water excretion, which facilitates the dilution of contrast media and reduces its concentration within the renal tubules. This could potentially reduce the toxic effects of contrast on the kidneys (15,16). Furthermore, SGLT2 inhibitors have been shown to induce a mild diuretic effect, potentially aiding in the prevention of contrast-induced volume overload, which is another risk factor for CI-AKI (17,18). However, SGLT2 inhibitors have also been correlated with a strengthened risk of AKI when used concurrently with contrast agents during medical procedures. Hence, careful

monitoring of renal function test during administration of these agents is necessary (5,19). A propensity-matched analysis by Hua et al, did not suggest a raised risk of CI-AKI associated with SGLT2 inhibitor administration in cases with coronary artery disease and type 2 diabetes undergoing percutaneous coronary intervention (18). The meta-analysis by Gong et al showed SGLT2 inhibitors have a positive consequence in decreasing the risk of all-cause death and acute kidney injury (20). Likewise, a network meta-analysis by Menne et al demonstrated that these agents abridged the odds of suffering acute kidney injury with and without hospitalization in the randomized trials (21). However, further investigations are required to confirm these findings and determine the optimal dosing and timing of SGLT2 inhibitors in patients at high risk for CI-AKI (22). More recently, Özkan et al showed that SGLT2 inhibitors might be protective against the development of contrast-induced nephropathy, especially in individuals with comorbid circumstances like diabetes (23).

Preventive strategies

Preventing CI-AKI involves implementing various preventive measures. Maintaining proper hydration and electrolyte balance is one of the most effective prevention strategies for CI-AKI. This modality can be achieved by administering intravenous fluids before and after the procedure (24). Minimizing the use of iodinated contrast agents and opting for low or iso-osmolar contrast media can help reduce CI-AKI risk. Low-osmolar or iso-osmolar contrast media are less nephrotoxic than high-osmolar CM (25). Careful attention to procedural technique can minimize the contrast load and reduce CI-AKI risk. Identifying and managing risk factors for CI-AKI is crucial. These risk factors include baseline renal dysfunction, dehydration, older age, congestive heart failure, and chronic kidney disease (26,27).

Conclusion

SGLT2 inhibitors may have a protective effect against CI-AKI. This is thought to be due to their ability to increase renal blood flow and oxygenation, reduce inflammation, and improve endothelial function. In addition, SGLT2 inhibitors may reduce the risk of CI-AKI by reducing the amount of contrast media needed for imaging procedures.

Conflicts of interest

The author is affiliated with Nickan Research Institute as a researcher; nevertheless, his professional role did not influence the peer-review process.

Ethical issues

Ethical issues (including plagiarism, data fabrication, and double publication) have been completely observed by the author.

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