Gadolinium-guided Transcatheter Aortic Valve Implantation in a Patient with Renal Impairment and a History of Severe Allergic Reaction to Iodinated Contrast Media

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Abstract

Iodinated contrast media is integral to the evaluation for transcatheter aortic valve implantation; however, some patients may have contraindications to the use of iodinated contrast media. The study reports successful use of a gadolinium-based contrast agent in a patient with severe symptomatic aortic stenosis, contrast allergy and post-contrast acute kidney injury.

Keywords

Gadolinium-guided transcatheter aortic valve implantation, contrast nephropathy, symptomatic aortic stenosis

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Transcatheter aortic valve implantation (TAVI) is a well-established alternative therapy to surgical aortic valve replacement in patients with severe, symptomatic aortic stenosis (AS).[1,2] The use of iodinated contrast media (ICM) is an integral part of the pre-TAVI evaluation and the procedure.[3,4] However, some patients may have contraindications to the use of ICM due to previous severe allergic reactions or post-contrast acute kidney injury (PC-AKI), previously known as contrast-induced nephropathy.[5]

Gadolinium exhibits a different chemical structure and does not have cross-reactivity with ICM. Furthermore, at recommended doses, it is less nephrotoxic than ICM.[6–8] Gadolinium has been used successfully for coronary angiography in patients at high risk of contrast-induced nephropathy.[8–11] Hence, in patients with contraindications to ICM, gadolinium may be an alternative approach to reduce the burden of ICM.

We report on the use of a gadolinium-based contrast agent (gadobutrol; Gadavist, Bayer HealthCare Pharmaceuticals) in a patient with severe symptomatic AS, severe contrast allergy and PC-AKI.

Case Report

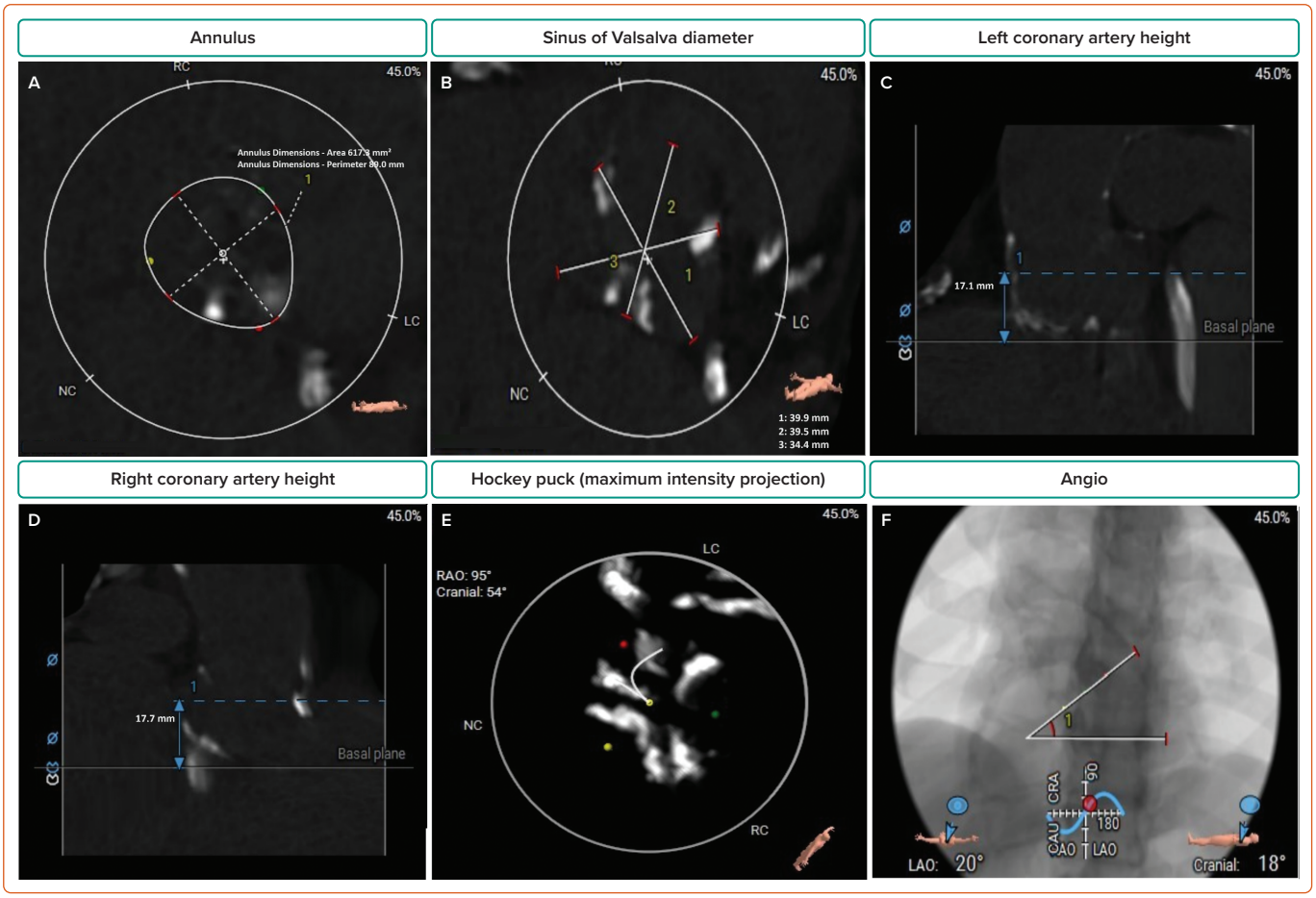
A 90-year-old man was admitted for evaluation and management of severe symptomatic AS. He presented with exertional dyspnea (New York Heart Association class III) and recurrent syncope. He was known to have diabetes that required insulin, hyperlipidaemia, hypertension, benign prostate hyperplasia and chronic kidney disease (creatinine 150 µmol/l; estimated glomerular filtration rate: 38 ml/min/1.73 m^2; creatinine clearance was 28 ml/min as his body weight was 68.6 kg). In 1998, the patient underwent coronary artery bypass grafting with left internal mammary artery (LIMA) to left anterior descending artery (LAD) and saphenous vein graft (SVG) to first diagonal artery and first obtuse marginal artery (OM1). In 2020, he underwent percutaneous coronary intervention with stenting to LIMA-LAD, right coronary artery (RCA), and SVG to OM1.

The ECG showed normal sinus rhythm and a heart rate of 55 BPM. Transthoracic echocardiography revealed an ejection fraction of 55%, a severely calcified trileaflet aortic valve, an aortic valve with an area of 0.9 cm^2, a peak gradient of 66 mmHg, a mean gradient of 36 mmHg and a dimensionless index of 0.22.

During the pre-TAVI evaluation, he underwent coronary angiography, which was complicated by a severe allergic reaction and PC-AKI. Allergy symptoms ranged from diffuse urticaria and pruritus to wheezing and bronchospasm, accompanied by haemodynamic instability requiring prolonged admission and treatment.

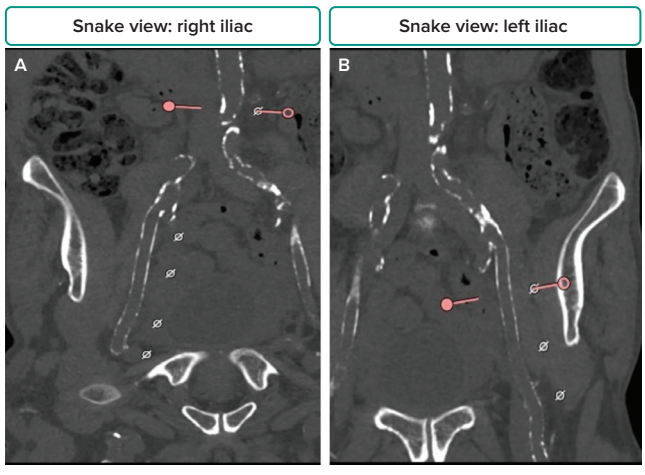
After a multidisciplinary team discussion, the patient was prepared for TAVI using gadobutrol based on his advanced age, comorbidities, Society of Thoracic Surgeons (STS) Predicted Risk of Mortality score of 17.6%, STS mortality and morbidity score of 46.6%, previous severe contrast allergy and high risk of PC-AKI. The risk and benefits of TAVI with ICM after premedication, zero-contrast TAVI technique and gadolinium-contrast TAVI were explained to the patient and his family as they opted for it.

Figure 1: Multidetector CT Aortic Annulus Evaluation



The aortic annulus was defined as a virtual ring formed by joining the basal attachments of the aortic leaflets. A: The transverse plane was aligned at the lowest level of the valve until the hinge points of the aortic leaflets were depictable; B shows the transverse plane of sinus of Valsalva measurements. C and D represent coronary sinus height. E shows cusps' degenerative calcifications. F: Cusp coplanar view: left anterior oblique 20° and cranial 18°.

Figure 2: Calcification Assessment



Preprocedural CT scan performed to assess iliac and femoral artery calcification and evaluate transcatheter aortic valve implantation access. A: CT longitudinal image of the severely calcified right common, external iliac and right common femoral arteries; B: Left external iliac artery.

The pre-TAVI evaluation included a non-contrast cardiac CT, transoesophageal echocardiogram and femoral Doppler ultrasound. The CT scan revealed an aortic valve area of 617 mm^2, an annulus perimeter of 89 mm, an average annulus diameter of 28.3 mm (26.4 mm × 30.2 mm), a left main height of 17.1 mm, an RCA height of 17.7 mm and a mean sinus of Valsalva and sino-tubular junction of 34 mm and 33.9 mm, respectively (*Figure 1*). The femoral arteries were heavily calcified, with moderate tortuosity and a minimal lumen diameter of 8.4 mm (*Figure 2*).

After obtaining informed consent, the TAVI procedure was performed in a hybrid cath lab following the standard transfemoral approach. The femoral sheaths were inserted under ultrasound guidance. The aortic valve was crossed, and a Confida Brecker guidewire (Medtronic) was placed in the left ventricle. The pigtail was placed in the non-coronary cusp, and a baseline aortogram was performed using gadobutrol via an automated injector. After the gadobutrol-enhanced aortogram, a 29 mm Sapien 3 Ultra Resilia valve (Edwards Lifesciences) was deployed (*Supplementary Video 1 and Figure 3*).

The image quality obtained was comparable to that achieved using ICM, and the procedure was successfully performed with no adverse reactions to gadobutrol.

Subsequent evaluation through aortogram indicated that the valve was in a good position, with only a minor para-valvular leak observed (*Supplementary Video 2*). The access sites were effectively closed using proglides. A total of 50 ml of gadobutrol was administered. A pre-discharge transthoracic echocardiogram demonstrated a favourable transcatheter heart valve position, no para-valvular leak and a peak gradient of 6 mmHg. ECGs before and after TAVI were normal, with a QRS duration of 104 ms and QT interval of 445 ms. Renal function tests

Figure 3: After Valve Deployment

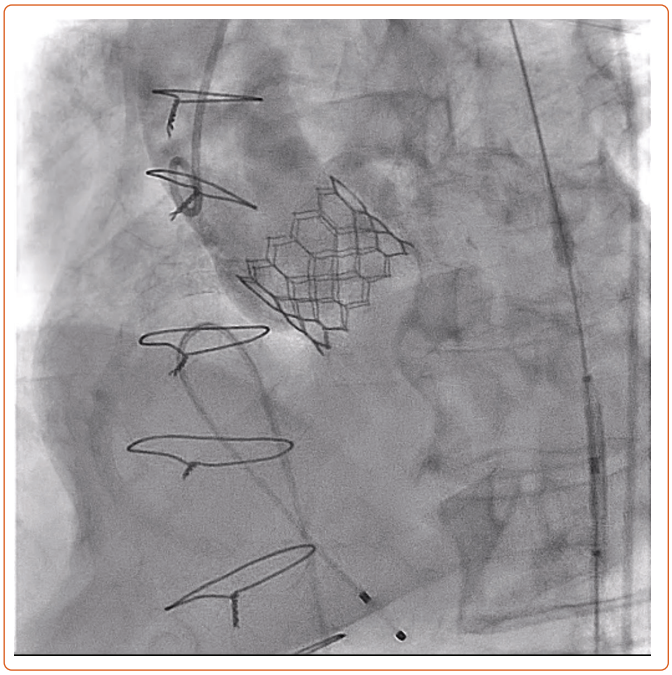


Image comparable to that of iodinated contrast media.

performed 1 week later showed no deterioration, with a creatinine level of 156 µmol/l.

Discussion

We report on a case of gadolinium-contrast-based TAVI in a patient with a severe ICM allergic reaction and PC-AKI. To our knowledge, this is the second report on gadolinium contrast-guided TAVI.[12]

Gadobutrol, administered via a power injector as in our case, provided excellent image quality and facilitated successful fluoroscopic guidance for the TAVI procedure. There was no adverse reaction, and kidney function was stable at discharge after 1 week and at 1-month follow-up. This report encourages the expansion of gadolinium-based contrast in patients undergoing TAVI who have contraindications to using ICM. Furthermore, a non-contrast CT was used for pre-TAVI aortic root evaluation, and measurements were accurate and equivalent to transoesophageal echocardiogram measurements.

Gadolinium-based contrast agents have primarily been developed for use in magnetic resonance imaging.[13] Gadobutrol is a second-generation, extracellular, non-ionic contrast media excreted unchanged in the urine.

Gadobutrol is formulated at a higher concentration (1 mmol/ml) than other gadolinium-based contrast agents, resulting in a lower administration volume.[14,15] The higher concentration of gadobutrol reduces its injection volume by 50%, providing a narrower bolus, thereby improving dynamic image enhancement.[16–18] The maximum dose of gadobutrol tested in healthy volunteers – 1.5 ml/kg body weight (1.5 mmol/kg), which is 15 times the recommended dose – was tolerated as well as lower doses.

Gadobutrol is primarily excreted in the urine, with >50%, >90% and 100% of the dose eliminated in the urine within 2 hours, 12 hours and 72 hours, respectively.[19]

Adverse reactions associated with the use of gadobutrol are rare, usually mild to moderate in severity and transient in nature.[8] Adverse reactions that have occurred with a frequency <0.1% in subjects who received gadobutrol include hypersensitivity or anaphylactoid reactions (hypotension, urticaria, flushing and pallor), loss of consciousness, convulsion, parosmia, tachycardia, palpitation, dry mouth, malaise and feeling cold.[8]

In patients with impaired renal function, the serum half-life of gadobutrol is prolonged and correlated with a reduction in creatinine clearance. Complete recovery was detected in the urine of patients with mild or moderate renal impairment within 72 hours. In patients with severely impaired renal function, at least 80% of the administered dose was recovered in the urine within 5 days.

For patients receiving haemodialysis, physicians may consider the prompt initiation of haemodialysis following the administration of gadobutrol to enhance its elimination. A total of 68% of gadobutrol is removed from the body after the first dialysis session, 94% after the second and 98% after the third.[18,19]

Gadobutrol has a low propensity to be associated with nephrogenic systemic fibrosis.[20–22] It is associated with a significantly lower risk of allergic reaction and nephrotoxicity than ICM.[6–8,23] In a recent systematic review and meta-analysis in patients with stage 4 or 5 chronic kidney disease receiving a group II gadolinium-based contrast agents, the risk of developing nephrogenic systemic fibrosis was <0.07%.[22] It has been safely used as an alternative to iodinated contrast agents in patients with severe contrast-related reactions or PC-AKI undergoing coronary angiography and TAVI.[9–13]

Conclusion

Gadolinium is a safe alternative for guiding TAVI procedures in patients with contraindications to iodinated contrast media. It offers adequate image quality, particularly when administered with a power injector, and has a favourable safety profile. ❑

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