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Short Communication

The principles of ultra-low contrast percutaneous coronary intervention

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ABSTRACT

Ultra-low contrast percutaneous coronary intervention (ULCPCI) can be performed electively in advanced chronic kidney disease. Engage guide catheter and advance guidewire into the coronary artery without using contrast. IVUS-guided PCI can reduce the contrast load. Perform co-registration of distal and proximal radio-opaque marker bands of intravascular ultrasound (IVUS) catheter. Deploy the stent at the target lesion under fluoroscopic guidance of these co-registered position of the IVUS-marking images. Complete the ULCPCI procedure with a final angiography using minimal contrast. Newer contrast sparing techniques and intravascular imaging technologies provide opportunities to perform ULCPCI efficiently with good results and the least complications.

Contrast-induced acute kidney injury (CI-AKI) is a serious issue following coronary angiography (CAG) and percutaneous coronary interventions (PCI) in patients with chronic kidney disease (CKD). The development of CI-AKI prolongs the duration of hospitalization, increases the financial burden and adversely affects both short-term and long-term mortality rates especially in those with advanced CKD (estimated glomerular filtration rate <30 ml/min).[1] Ultra-low contrast PCI (ULCPCI) can be a solution for this situation; this technique is also known as Zero Contrast PCI.[2–5]

The following are the general principles for performing ULCPCI in advanced CKD patients:

1. Pre-procedural hydration of the patient is very essential.[1] Perform baseline coronary angiography (CAG) with non-ionic iso-osmolar contrast (iodixanol) prior to the elective ULCPCI on a different day with the least possible contrast volume (CV) preferably less than the estimated glomerular filtration rate (eGFR) value. Maintain a CV/eGFR ratio <1.[4] In order to reduce the volume of contrast, preferably use small diameter catheter (5 Fr or less) without side holes, small syringes (3–5 cc) and biplane imaging system.[6] Dilute the contrast with saline and optimally engage the vessel to make the most use of contrast. Use increased acquisition rates (30 frames/sec) to improve vessel visualization with minimal contrast load during CAG and to evaluate the final result after ULCPCI.[4]
2. Whenever possible, perform ULCPCI as a staged procedure 7 days after CAG to allow complete washout of contrast from the body.[7] Transfemoral approach may preserve radial artery for fistula and dialysis in the future in CKD patients.[4] 7F guide catheter allows simultaneous passage of multiple guidewires and intravascular ultrasound (IVUS) catheter.[4,5] Smaller French guide catheters including slender PCI technique may reduce the contrast volume.[6] Confirm successful engagement of the guide catheter by noting transient ST segment depression in the ECG monitor by injecting 10 ml of saline or by-passing coronary guidewire down into the coronary artery.[8] Take additional guidance from fluoroscopic markers like coronary calcification, post-surgical clips etc.[7] Avoid frequent contrast puffs and eliminate the contrast in the diagnostic/guiding catheter by aspiration or back-bleeding prior to exchanging the hardwares or administering drugs.[4,9]
3. With previous baseline CAG as reference, advance guidewire distally into the coronary artery and cross the target lesion without using contrast.[9] Park another guidewire in any adjacent side branch as a landmark. If possible, park two coronary guidewires in the side branches proximal and distal

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to lesion and these will serve as landmarks for the stenotic coronary segment; this is called 'metallic silhouette technique'.[4,5,7] Another technique to get orientation of coronary artery is using the 'marking wire technique' wherein two wires (operating wire and marking wire) are inserted through a double Y connector. The operating wire is advanced through the main port of this connector while the marking wire advanced via the side port serves as a guide for positioning the stent. Using IVUS, the distal landing zone is determined and marked with the tip of this marking wire. Then, secure this marking wire by screwing the connector's side port and attach a torquer on this wire close to the side port. The proximal landing zone is determined by IVUS and the stent length is estimated with the help of the marking wire.[4]

4. Contrast-sparing strategies such as dual axis rotational angiography, dynamic coronary roadmap, stent enhancement techniques (StentBoost or ClearStent), intracoronary imaging and co-registration techniques can help in reducing the contrast load.[9]
5. IVUS-guided PCI can reduce the contrast load to a great extent. Perform automated IVUS pullback to assess the length of lesion, reference lumen size and the landing zones (percent plaque area less than 50%). Based on these measurements choose a suitable stent preferably a little longer stent.[2,3,5]
6. Reintroduce IVUS catheter manually and perform a 'dry cine' angiogram for at least two heartbeats without panning the cath table. This allows co-registration of distal and proximal radio-opaque marker bands of IVUS catheter as reference segments for stent placement.[4,11] After acquiring these IVUS-marking images do not move the flat panel detector arm or the cath table until the procedure is completed.[5] Avoid breath-holding during ULCPCI as it may alter the reference position.[4]
7. Deploy the stent at the target lesion under fluoroscopic imaging with reference to the position of the IVUS-marking images displayed on the auxiliary monitor. This stent deployment is performed without injecting any contrast or occasionally with only a tiny amount of contrast.[2]
8. After stenting, perform a final IVUS imaging and post-dilatation as required.[2,5]
9. Perform a final angiography with less than 3 ml of contrast particularly to recognize any guidewire/dilatation induced coronary artery perforation, slow-flow/no-reflow phenomena, and side branch occlusion.[4]
10. Optical Coherence Tomography (OCT) with dextran has been used instead of IVUS by some operators.[2,10] Coronary flow physiology assessments like Fractional Flow Reserve (FFR), Coronary flow Reserve (CFR) or instantaneous wave-free ratio (iFR) can also be performed to determine functional outcome post-stenting.[4,9]
11. Flush the catheter with heparinized saline at regular intervals to reduce the risk of clot formation. Look for pericardial effusion in post-procedure echocardiography to rule out any significant perforation.[5,9]
12. Although not optimal for beginners, a few experienced operators have been successful in performing ULCPCI in situations like chronic total occlusion lesions that requite contralateral injection, calcified lesions that require debulking with Rotational atherectomy or severe stenotic lesions that will not allow IVUS to pass through.[11,12]

CKD patients are definitely high-risk patients but cannot be ignored. ULCPCI is better performed electively as a planned procedure in advanced CKD patients. Newer contrast sparing techniques and intravascular imaging technologies provide opportunities to perform ULCPCI efficiently with good results and the least complications.

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Declaration of competing interest

None to be declared for all the authors of this study.

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