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CASE REPORT: BEST TCT CASE

BEGINNER

CLINICAL CASE

Zero-Contrast Multivessel Revascularization for Acute Coronary Syndrome in a Patient With Chronic Kidney Disease

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ABSTRACT

Patients with chronic kidney disease are at elevated risk for adverse events after traditional coronary angiography and percutaneous intervention with contrast media. The case presented in this report highlights the potential benefits of zero-contrast multivessel percutaneous coronary intervention in a patient presenting with a non-ST-segment elevation acute coronary syndrome. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2019;1:774–80)

LEARNING OBJECTIVES

- Patients with CKD presenting with NSTEACS are at high risk for subsequent adverse events.
- The use of contrast dye as part of coronary angiography in the evaluation and treatment of these patients increases the risk for contrast nephropathy and the need for subsequent renal replacement therapy.
- Zero-contrast PCI using coronary physiology and intravascular imaging is a strategy that can be used to safely treat this high-risk patient population and may help avoid or delay the need for future renal replacement therapy.

HISTORY OF PRESENTATION

A 66-year-old man with a history of coronary artery disease (CAD) with previous percutaneous coronary intervention (PCI), myasthenia gravis with previous tracheostomy, and end-stage renal dysfunction with 2 renal transplants now with chronic kidney disease (CKD) stage 5 on the second grafted kidney (in part due to antibody mediated rejection, hypertension, and diabetes mellitus) presented with chest pain to the emergency department. The patient has a history of 3-vessel CAD and previous PCI with known in-stent restenosis (ISR) in the left circumflex and right coronary arteries (LCX and RCA, respectively).

Figure 1 presents an angiogram from an outside hospital. The patient was refusing complete revas-

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Informed consent was obtained for this case.

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cularization as he developed significantly worsening renal function after his most recent PCI. Due to continuing exertional chest pain, but planned contrast dye avoidance, he was referred for evaluation for potential zero-contrast PCI at our institution. However, before his planned evaluation, he presented to our emergency department with worsening exertional chest pain progressing to symptoms at rest. Given the clinical history, presentation, and electrocardiogram findings (**Figure 2**), the myocardial infarction pager was activated in the emergency department. On the cardiology team's evaluation, the patient's examination was notable for hemodynamic stability, and the patient looked uncomfortable with mildly elevated jugular venous distension. The remainder of the examination was largely within normal limits. Laboratory analysis was notable for elevation in both point-of-care troponin I at 1.74 ng/ml and serum creatinine at 4.1 mg/dl. The decision was made to take the patient to the cardiac catheterization laboratory for zero-contrast diagnostic assessment and PCI for non-ST-segment elevation acute coronary syndrome (NSTEACS).

MEDICAL HISTORY

In addition to the history noted earlier, the patient has gout and hepatitis B.

DIFFERENTIAL DIAGNOSIS

In addition to chest pain due to acute coronary syndrome (potentially due to type 1, 2, or 4 myocardial infarction), other potential etiologies for presentation include myocardial injury due to CKD, Takotsubo cardiomyopathy, myocarditis, nonischemic myocardial injury, and noncardiac reasons for the symptoms (1–3).

INVESTIGATIONS AND MANAGEMENT

The patient's outside-hospital angiogram films were available to use as a reference (**Figure 1**). Using the instantaneous wave-free ratio (iFR) and intravascular ultrasound (IVUS), and fluoroscopy without contrast (**Figure 3**), stents in the proximal and mid-RCA, mid and distal LCX, and distal left anterior descending (LAD) coronary arteries were deemed to be patent. Distal RCA (iFR 0.30; cross-sectional area [CSA] 1.7 mm^2; minimal lumen diameter [MLD] 1.5 mm) and LCX were found to have evidence of ISR. Lesions were also found in the first obtuse marginal branch (OM1; iFR 0.40; CSA 1.6 mm^2; MLD 1.1 mm) and distal left main/proximal LAD (iFR 0.81; CSA 6.9 mm^2; MLD 2.7 mm). Representative IVUS runs from the RCA and OM1 lesions are presented in Supplemental Figure 1. Zero-contrast PCI was performed in the distal RCA (iFR 0.92; CSA 5.2 mm^2; MLD 2.2 mm^2), OM1 (iFR 0.94; CSA 5.0 mm^2; MLD 2.2 mm), and distal left main/proximal LAD (iFR 0.92; CSA 7.4 mm^2; MLD 2.7 mm) with kissing balloon angioplasty between LAD/LCX; the results were excellent as assessed according to hemodynamic variables (**Figure 4**) and IVUS parameters.

DISCUSSION

Contrast-induced nephropathy is associated with an elevated risk for adverse events, including sustained reduction in renal function, requirement of renal replacement therapy, and mortality (4). Given concerns regarding increased risk for contrast-induced nephropathy, patients with CKD are oftentimes less likely to be referred for appropriate diagnostic and therapeutic procedures. As shown by Han et al. (5) in a cohort of 45,343 patients presenting with NSTEACS, patients with CKD were significantly less likely to be referred for invasive angiographic assessment compared with individuals without CKD (47.6% vs. 73.8%; adjusted odds ratio: 0.52; 95% confidence interval: 0.34 to 0.80). In-hospital mortality for NSTEACS in patients with CKD was 2.5 times higher than those without CKD in this analysis. In addition, previous data suggest that even low volumes of contrast dye administered during angiography (~14 to 23 ml) can be associated with development of contrast-induced acute kidney injury in 4% to 11% of patients with advanced kidney disease (6).

Taking this into consideration, it is clear that better strategies for the treatment of this high-risk group of patients are needed. The present case offers an example of complete revascularization and clinical stabilization with zero-contrast PCI for NSTEACS in an individual with multivessel disease. Although ultralow contrast angiography is the preferred diagnostic strategy before planned zero-contrast intervention (7,8), it is important to note that recent diagnostic angiogram films were available in this patient who also had previous coronary stents and extensive coronary calcification. The use of what would be considered adjunctive modalities in other clinical circumstances (i.e., physiological assessment and intravascular imaging) is critical in this setting. In this regard, there is a growing body of literature to

ABBREVIATIONS AND ACRONYMS

CAD = coronary artery disease
CKD = chronic kidney disease
CSA = cross-sectional area
iFR = instantaneous wave-free ratio
ISR = in-stent restenosis
IVUS = intravascular ultrasound
LAD = left anterior descending
LCX = left circumflex
MLD = minimal lumen diameter
NSTEACS = non-ST-segment elevation acute coronary syndrome
OM = obtuse marginal
PCI = percutaneous coronary intervention
RCA = right coronary artery

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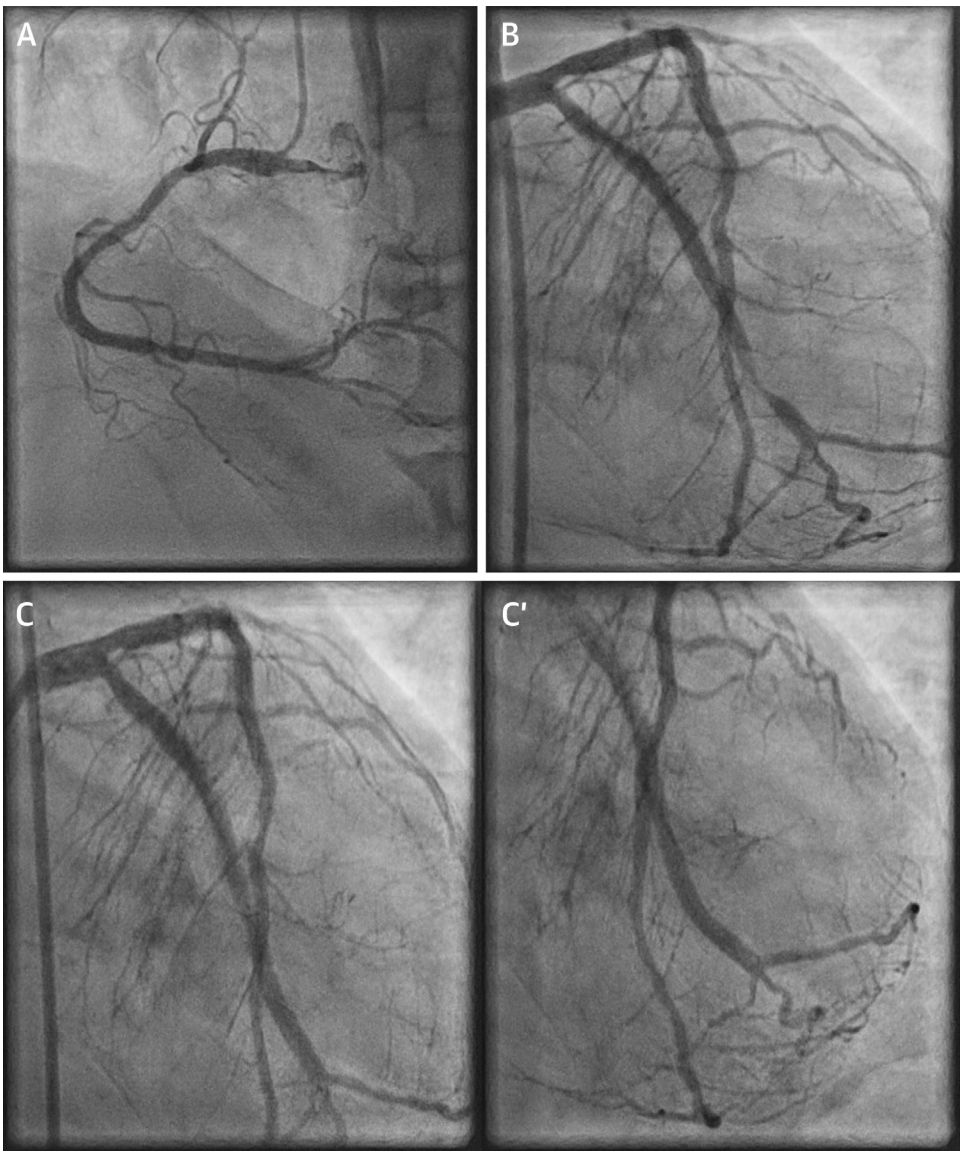
FIGURE 1 Outside-Hospital Angiogram

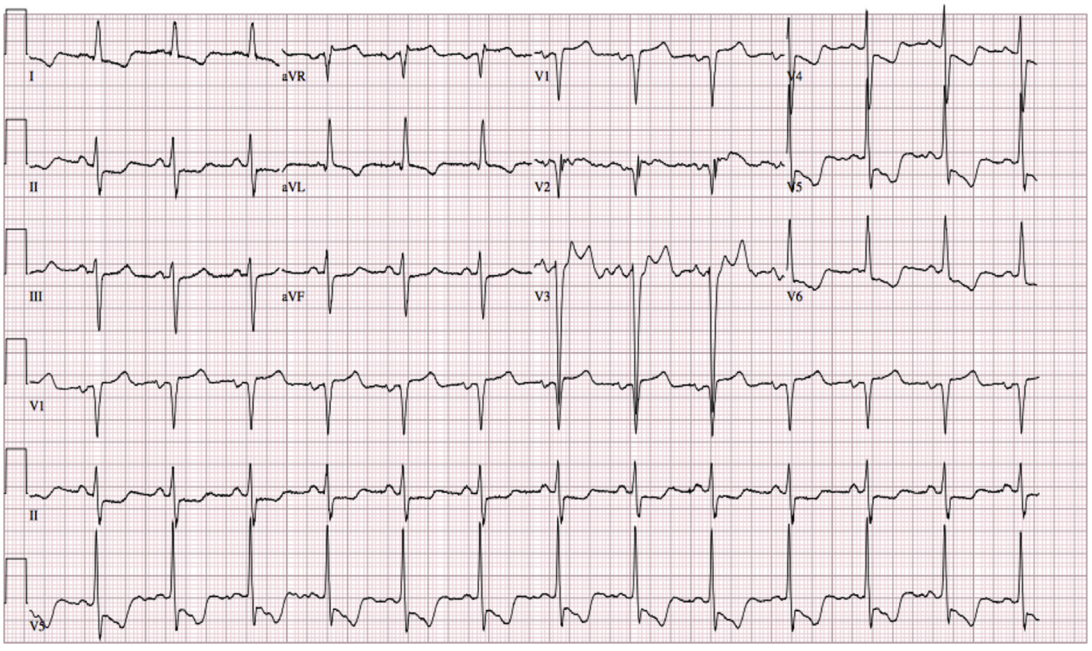


Images of the patient's previous angiogram from the outside hospital. Images show severe in-stent restenosis of the distal right coronary artery stent **(A)**, mid left circumflex stent and distal circumflex stenosis **(B)**, and proximal, mid, and distal left anterior descending lesions, and distal circumflex now visualized after stent placement **(C and C′)**.

suggest that even complex interventions, such as chronic total occlusions and bypass graft occlusions, are feasible and safe in patients with advanced renal dysfunction under the guidance of coronary physiology and intravascular imaging (7,9–11). Although previous studies have suggested that these modalities may reduce risk for subsequent clinical events in more stable patient populations (12–14), this topic requires further study in the setting of CKD.

The current patient's intervention used transfemoral artery access, partially due to the fact that he had previous upper extremity arteriovenous fistula placement. Zero-contrast interventions have been successfully performed via radial and femoral access (7), and although radial access has the potential to reduce vascular complications, there is a need for further assessment of the optimal access strategy in patients undergoing zero-contrast PCI.

FIGURE 2 **Emergency Department Electrocardiogram**



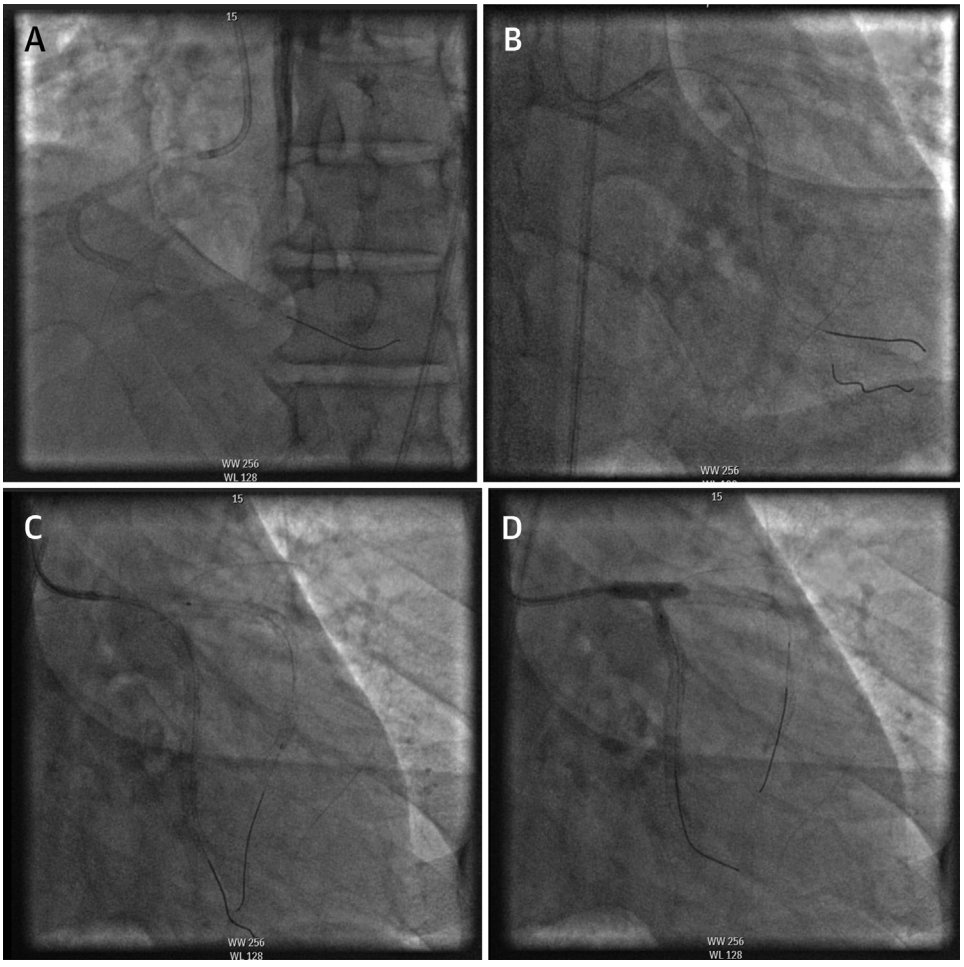
Patient's electrocardiogram from the emergency department, which shows sinus rhythm, left-axis deviation, ST-segment depressions in the inferior and lateral leads, and evidence of septal infarct.

Last, although risk scores are available to predict risk for contrast-induced acute kidney injury and renal replacement therapy, better risk modeling is needed for patients with advanced CKD with regard to both ultralow diagnostic angiography and zero-contrast PCI strategies. Limitations of zero-contrast PCI include the fact that such interventions require operator expertise with intravascular imaging and physiology; also, recent previous coronary angiography with contrast is typically needed for use as a reference, and select complex lesion types may be more suitable for coronary artery bypass graft surgery.

FOLLOW-UP

The patient's symptoms improved after intervention, and he was discharged with close follow-up. However, over the subsequent several months, he developed recurrent symptoms. Renal graft function gradually worsened over time, and the patient progressed to needing hemodialysis. He returned to the cardiac catheterization laboratory and was found to have developed recurrent ISR in several distributions. He ultimately was referred for and underwent coronary artery bypass graft surgery ~6 months after the initial zero-contrast intervention.

FIGURE 3 Fluoroscopic Evaluation of the Coronary Artery Tree

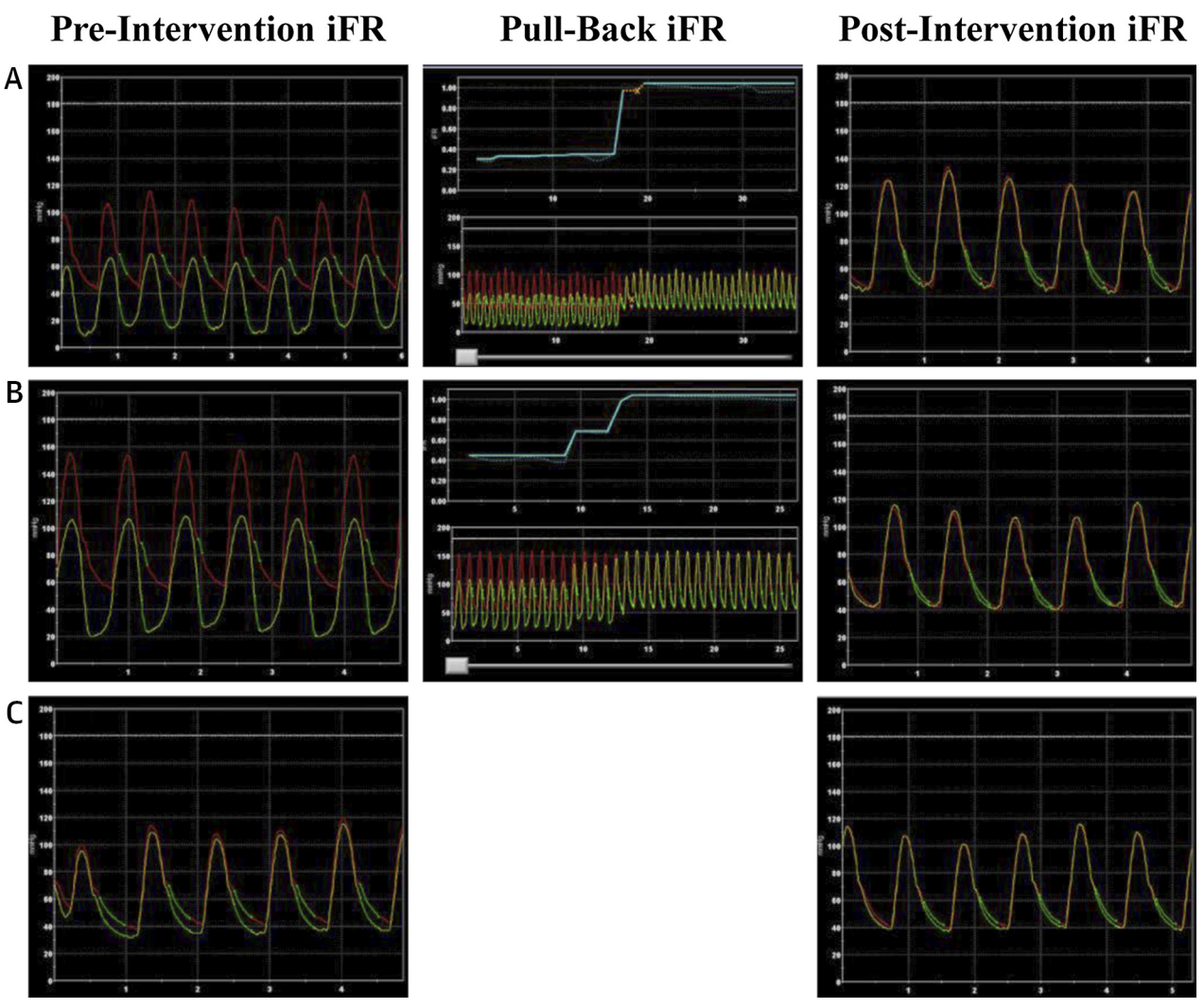


Example of the patient's fluoroscopic images performed during evaluation and treatment of right coronary artery **(A)**, first obtuse marginal branch **(B)**, and left anterior descending coronary and left circumflex coronary arteries **(C and D)**.

CONCLUSIONS

Zero-contrast PCI is safe and feasible in patients with significant CKD presenting with multivessel CAD and NTEACS. Such a strategy may contribute to better outcomes by helping avoid or delay the requirement for renal replacement therapy in this vulnerable patient population.

FIGURE 4 iFR and Intravascular Ultrasound Measurements Pre- and Post-Multivessel Intervention



(A and B) Hemodynamically significant instantaneous wave-free ratio (iFR) values for distal right coronary artery (pre-intervention iFR of 0.30) and first obtuse marginal (pre-intervention iFR of 0.40), significant pull-back studies, and post-intervention iFR showing improved ischemia in the right coronary (0.92) and left circumflex (0.94) coronary arteries, respectively. **(C)** Similarly, improved iFR is shown in the proximal left anterior descending coronary artery from 0.81 in the pre-procedure setting to 0.92 in the post-procedure setting. See Videos 1, 2, 3, 4, 5, and 6.

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KEY WORDS coronary angiography, intravascular ultrasound, percutaneous coronary intervention

APPENDIX For a supplemental figure and videos, please see the online version of this paper.