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Outcomes of Chronic Total Occlusion Percutaneous Coronary Intervention in Patients with Renal Dysfunction

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Abstract

Although contemporary chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is performed with high success rates, 10-13% of patients presenting with CTOs have chronic kidney disease (CKD), and the comparative safety, efficacy and health status benefit of CTO PCI in these patients, has not been well defined. We examined the association of baseline renal function with periprocedural major adverse cardiovascular and cerebral events (MACCE) and health status outcomes in 957 consecutive patients (mean age 65.3 ± 10.3 years, 19.4% women, 90.3% white, 23.6 CKD [eGFR <60]) in the OPEN-CTO (Outcomes, Patients Health Status, and Efficiency in Chronic Total Occlusions Registry) study. Hierarchical multivariable regression models were used to examine the independent association of baseline eGFR with technical success, periprocedural complications and change in health status, using Seattle Angina Questionnaire (SAQ) over 1-year. Crude rates of acute kidney injury (AKI) were higher (13.5% vs 4.4% p <0.001) and technical success lower (81.8% vs 88.4% p=0.01) in patients with CKD. There were no significant differences in other periprocedural complications. After adjustment for confounding factors, there was no significant association of baseline eGFR with technical success or periprocedural MACCE (death, myocardial infarction, emergent bypass surgery, stroke, perforation), though patients with lower eGFR had higher rates of AKI. The difference in SAQ summary score, between patients on the 10th and 90th percentile for baseline eGFR distribution

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was not clinically significant (1-month: −0.91; 1-year: −3.06 points). In conclusion CTO PCI success, complication rates and the health status improvement after CTO PCI is similar in patients across a range of baseline eGFRs.

Keywords

Chronic Total Occlusion; Percutaneous Coronary Intervention; Chronic Kidney Disease; Health Status

INTRODUCTION

Chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is associated with improved symptoms, improvement in left ventricular function and an increase in exercise tolerance. [1–4] About 10-13% of patients presenting with CTOs have chronic kidney disease (CKD), and the comparative safety and efficacy of treatment in these patients, as compared with patients without CKD, has not been well defined. [3,5,6] Since CTO PCI frequently involves longer procedures and greater iodinated contrast exposure, patients with CKD might experience lower technical success rates, higher periprocedural complication rates. [7–9] Importantly, although the primary indication for CTO PCI is symptom relief, no prior studies have assessed whether CTO PCI in patients with CKD is associated with similar symptom and quality of life (QoL) benefit as compared to those without renal dysfunction. To address these gaps in knowledge, we leveraged the 12-center Outcomes, Patient Health Status and Efficiency in Chronic Total Occlusions (OPEN CTO) registry [10] which included detailed baseline and follow-up health status assessments using Seattle Angina Questionnaire (SAQ) and Rose Dyspnea Scale, as well as corelab adjudicated technical success and detailed periprocedural complication data, among a consecutive series of patients undergoing CTO PCI using the hybrid approach.[10]

METHODS

The OPEN CTO registry is a prospective, single arm study that enrolled consecutive patients with CTOs who underwent attempted CTO PCI at 12 high-volume US centers between January 21,2014 to July 22, 2015. Details of the study have been described previously. [10] Briefly, eligible patients were >18 years of age, had symptoms consistent with ischemic heart disease and had a CTO defined as a lesion with Thrombolysis in Myocardial Infarction antegrade flow grade 0 that was thought to have been present for at least 3 months. Patients were treated according to the hybrid algorithm by all operators. [11] All operators were required to have at least 2 years of experience in performing CTO PCI using the hybrid approach and to have performed at least 100 CTO PCI procedures. [10] All consenting patients at the participating sites were included. Consecutive enrollment was confirmed via an audit of each site's National Cardiovascular Data Registry Cath PCI data to prevent bias related to failure to include all patients undergoing CTO PCI at each institution. [10] The institutional review board at each site approved the study protocol. The OPEN CTO registry enrolled 1000 patients. After exclusion of patients who were missing baseline creatinine assessment (n=1), and those who did not have complete 1-year follow up health status assessment

(n=42), the final analytic cohort for the present analysis included 957 patients. Supplemental Figure 1 describes the final analytical cohort derivation.

Estimated Glomerular Filtration Rate (eGFR) was calculated at baseline for each patient using the Modification in Diet in Renal Disease equation.[12] Patients were categorized as having CKD if their eGFR was less than 60 ml/min/1.73m^2, consistent with prior literature.[13] Outcomes of interest included in-hospital major adverse cardiovascular and cerebral events (MACCE), acute kidney injury (AKI), technical success of the index CTO PCI and health status at 1-month and 12-month after the CTO PCI procedure. MACCE was defined as composite of in-hospital death, periprocedural myocardial infarction, emergency coronary bypass graft surgery, in-hospital stroke and clinically significant perforation. Periprocedural myocardial infarction was defined as type 4a and 5 myocardial infarction according to American College of Cardiology/American Heart Association/European Society of Cardiology universal definition of myocardial infarction.[14] Perforations were classified according to the Ellis classification after review of procedural angiograms by the angiographic core lab (Saint Luke's Mid America Heart Institute, Kansas City, Missouri) using *QAngio XA 7.3* (Medis Medical Imaging Systems, Leiden, the Netherlands) software.[15] Any perforation that required treatment was determined to be clinically significant. Technical success of CTO PCI procedure was defined as <50% residual stenosis and a Thrombolysis in Myocardial Infarction flow grade ≥2 without significant side branch occlusions as assessed by the OPEN CTO angiographic core lab.[3] Post-procedure acute kidney injury was defined as increase in serum creatinine of 0.3mg/dl, in accordance with the Acute Kidney Injury Network definition.[16]

Disease-specific patient reported health status was assessed using the 19-item SAQ. Trained study personnel administered the SAQ during the baseline interview when enrolling each patient. Follow-up health status assessments were completed by a centralized telephone interview conducted by study coordinators at 1, 6 and 12 months after CTO PCI. The SAQ is a valid and reliable 19-item questionnaire with a 4-week recall period.[17] It measures 5 domains of health in patients with coronary artery disease, which are angina frequency (SAQ AF), angina stability, QoL (SAQ QoL), physical limitation (SAQ PL) and treatment satisfaction.[18] Domain scores range from 0-100, with higher scores indicating fewer symptoms and better QoL. Overall health status was summarized using the SAQ summary score (SAQ SS) which reflects the average of SAQ PL, AF and QoL domains.[19] A mean change of ≥ 5 in the SAQ SS is considered clinically meaningful, although individual patients within a population are expected to have much larger changes. [20] Since dyspnea is a common angina equivalent in patients with CTOs [21], it was assessed using the Rose Dyspnea Scale. The Rose Dyspnea Scale is a 4-item questionnaire with a 1-month recall period that assesses the patient's level of dyspnea with common activities.[22] Each activity associated with dyspnea is assigned 1 point, hence scores range from 0-4, with score of 0 indicating no dyspnea and increasing scores indicating greater limitation from dyspnea. The Rose Dyspnea Scale has been used to assess symptoms in patients with coronary artery disease, and has shown to be associated with QoL, rehospitalization, procedure success and long-term outcomes.[23] Complete revascularization was defined by operators as successful treatment of all physiologically significant stenoses.

For descriptive purposes we dichotomized our analytical cohort into patients with and without CKD. Baseline differences in patient characteristics, CTO lesion severity, comorbid conditions and procedural details were compared in patients with and without CKD using independent t tests for continuous variables and chi-square tests for categorical variables. We first conducted unadjusted analyses to compare the crude rates of MACCE, technical success and health status at baseline and follow up for patients with and without CKD. Then we fit hierarchical multivariable regression models, with a random effect for site to account for clustering at the site level, to assess the relationship of baseline eGFR as a continuous variable with outcomes. Using these models, for the outcome of technical success and MACCE, we plotted the odds ratio (with an eGFR of 90 as control) as a function of patient's baseline eGFR. For longitudinal health status outcomes, we plotted the baseline adjusted 1-month and 12-month health status scores as a function of baseline eGFR. All models contained a nonlinear spline term for eGFR and were adjusted for potential confounders known to be associated with outcomes in patients undergoing CTO PCI identified *a priori* from previous studies [24] and clinical experience. These included age, sex, race, diabetes mellitus, congestive heart failure, peripheral arterial disease, use of diuretics, use of angiotensin converting enzyme inhibitors, any non-CTO lesion, complete revascularization, J-CTO score, prior bypass surgery and baseline health status. For the outcome of post-procedure AKI, we fit another hierarchical multivariable regression model adjusting for patients age, history of heart failure, diabetes and contrast volume, to assess the independent relationship of baseline eGFR with acute kidney injury. We plotted the odds ratio (in comparison to an eGFR of 90 as control) of acute kidney injury for each patient based on their baseline eGFR. To aid the clinical interpretability of our results we compared the proportions of patients having improvement in SAQ SS ≥ 5 at 12-months among patients across CKD stages; Stage 4 eGFR <30, Stage 3 eGFR 30-60, Stage 2 eGFR 61-90, and Stage 1 eGFR >90. We also fit a logistic regression model with CKD stage as an independent variable and clinically meaningful improvement in SAS SS (≥ 5) as the dependent variable. We compared the odds ratio of having a clinically meaningful improvement in SAQ SS at 1-year of patients with eGFR <30, 30-60 and 60-90 compared to patients with a baseline eGFR of ≥ 90. This type of responder analysis facilitates interpretation of the mean scores by showing the proportion of population experiencing varying degrees of clinical change in health status. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC). All statistical tests were 2-tailed, and significance was determined using $\alpha = 0.05$. Patients with missing baseline creatinine, health status scores were excluded. Twenty-four% (n=225) of the patients had missing follow-up creatinine. These patients were not included in any analysis to examine the association of baseline eGFR with AKI. For covariates in the multivariable models, data was complete with <1% of the patients having missing data for all covariates.

RESULTS

At baseline, 225 patients (23.6%) had CKD and 732 (76.4%) did not. Overall, the mean age was 65.3 ± 10.3 years, 19.4% were females and 90.3% were Caucasian. Comorbidities were highly prevalent with 40.5% having diabetes, 22.4% having congestive heart failure and 13.2% reporting active smoking. Table 1 compares baseline characteristics in patients with

and without CKD. Patients with CKD had a greater burden of comorbidities including, diabetes mellitus, congestive heart failure, peripheral artery disease and history of bypass surgery.

There was no significant difference between the crude rate of MACCE or any of the MACCE components in patients with and without CKD as depicted in Table 2 (7.1% vs 5.5 % p=0.36). Figure 1 describes the adjusted OR for MACCE as a function of patient's baseline eGFR (with eGFR of 90 as the reference). There was no significant association of odds of MACCE with eGFR at baseline. The crude rate of technical success was lower in patients with CKD (81.8% vs 88.4%, p = 0.01). However, in adjusted models there was no significant association of eGFR with technical success of index CTO PCI (Figure 1). There was no difference in adjusted OR for having technical success of the index CTO PCI, in patients across a range of eGFR (with eGFR of 90 as reference). In patients with follow-up creatinine levels (n=732) AKI rate was 9%. Patients with CKD had higher rates of AKI compared to patients without CKD (13.5 vs 4.4% p<0.001). In the adjusted model, lower eGFR at baseline was associated in a non-linear fashion with higher odds of post-procedure acute kidney injury, with eGFR=90 as the reference (Figure 1). Patients with eGFR <40, had incrementally higher risk of AKI.

Overall, patients with and without CKD experienced large, early (1-month) and sustained (1-year) health status improvements after CTO PCI as measured by each SAQ domain and the Rose Dyspnea Scale (Table 3). Patients with CKD had a greater burden of physical limitation due to angina as reflected in lower baseline and follow up SAQ PL and more symptoms of dyspnea as reflected in higher scores on the Rose Dyspnea Scale (Table 3). Figure 2 and 3 describe the baseline health-status and multivariable adjusted SAQ scores at 1-month and 1-year respectively. There was no clinically meaningful difference in SAQ scores in patients across a spectrum of baseline eGFRs. The difference in SAQ SS, between patients on the 10^{th} and 90^{th} percentile for the eGFR distribution at 1-month and 1-year was −0.91 and −3.06 points. Supplemental Figure 2 describes the multivariable adjusted RDS at 1-month and 1-year after CTO PCI. Patients with lower eGFR had more symptoms of dyspnea at 1-year, with a difference in Rose Dyspnea Scale of 0.49 points between patients in the 10^{th} and 90^{th} percentile of the eGFR distribution. Overall 89% of the eligible patients (baseline SAQ SS <95) had a clinically meaningful improvement in health status (≥ 5-point improvement in SAQ SS) at 12-months. Figure 4 compares the proportion of patients by CKD stage who had a clinically meaningful improvement. There was no significant trend in achieving a clinically significant health status improvement across all stages of CKD. Supplemental Figure 3 describes the odds of patients having a clinically meaningful improvement in SAQ SS (≥ 5-points) at 1-year after CTO PCI, across different stages of CKD (compared to patients with eGFR >90). Patients with stage 4 CKD (eGFR <30) had a borderline significant lower odd of having a clinically meaningful change in SAQ SS. However, patients with stage 2 and stage 3 CKD had similar odds of having a clinically significant health status improvement after CTO PCI.

DISCUSSION

CKD in patients presenting with symptomatic CTOs is common, and comparative safety and effectiveness of PCI in these patients has not been thoroughly described in the prior literature. In the first analysis to examine the association between renal function and health status outcomes in a large, consecutive cohort of patients undergoing CTO PCI, we observed no clinically meaningful association of health status outcomes in patient with lower eGFR. Using coronary-disease specific health status assessments through 12-month follow-up, as well as assessment of dyspnea symptoms, we found that although patients with CKD had slightly lower SAQ SS and PL scores, these differences did not reach the threshold of clinical significance, and the health status improvement following the procedure was robust and sustained over 12-month follow-up in patients across the spectrum of renal function. Importantly, we found that patients with renal dysfunction had similar adjusted rates of technical success and periprocedural complications as patients without renal dysfunction even though patients with CKD had higher rates of AKI. In total, these findings suggest that CTO PCI can be performed safely in patients with CKD, and clinicians can expect similar improvement in health status, physical function and QoL following the procedure.

Rates of periprocedural complications including coronary perforations, in-hospital myocardial infarction and stroke in our experience were low and comparable to other studies.[25] Prior studies of the outcomes of CTO PCI in patients with CKD have shown an association of CKD with worse outcomes including lower technical success, higher periprocedural complications, contrast nephropathy and death.[5–9,26] However, most of those studies were retrospective analyses with the possibility of selective inclusion of patients that could bias the results. By leveraging a unique prospective registry that enrolled consecutive patients, confirmed by an audit of each enrolling center's National Cardiovascular Data Registry CathPCI data [10], we were able to limit selection bias compared to these prior studies. Although the crude rate of technical success was lower in patients with CKD in OPEN CTO, this finding was primarily a reflection of a greater rate of prior bypass surgery in patients with CKD. Prior bypass surgery is a recognized correlate of lower success in patients undergoing CTO PCI [27] , and in multivariable adjusted analysis, technical success, MACCE as well as individual components of MACCE were similar across the range of baseline eGFRs. These data are reassuring, confirming that high rates of success similar to patients without CKD can be achieved in patients with renal dysfunction despite requirements that operators limit contrast exposure in the setting of CKD. As expected, there were higher rates of acute kidney injury following CTO PCI in patients with baseline CKD. Our rates of acute kidney injury were similar to some studies [28] but substantially higher than other reports.[29] It remains critically important that operators focus on safe contrast limits and aggressive periprocedural hydration in these patients to limit the risk of periprocedural acute kidney injury.

No prior study, to our knowledge, has examined the relationship between renal function and health status after CTO PCI using validated instruments such as SAQ and Rose Dyspnea Scale. Since renal dysfunction has been shown to be associated with worse disease specific health status [30], and the principal indication for CTO PCI in most patients is symptomatic relief, our study addresses this critical knowledge gap regarding patient's symptoms,

function and QoL after CTO PCI over 1-year follow up. We found that patients with impaired renal function experienced large, sustained improvements in health status following CTO PCI, of similar magnitude to that experienced by patients without CKD. Additionally, an important clinical question is to understand the association of severity of CKD with outcomes after CTO PCI, since patients with severe CKD might portend poorer outcomes than those with mild or moderate CKD. Our analyses demonstrate that even though patients with markedly reduced eGFR had comparatively lower health status scores (SAQ and RDS) at baseline and follow-up, the recovery in health status and QoL after CTO PCI was substantial, and similar in magnitude to that experienced by patients without CKD.

These results should be considered in the context of the following potential limitations. OPEN-CTO was a prospective single arm registry and did not include patients who were managed with strategies other than PCI. Hence, our study cannot provide any insights into the outcomes experienced by patients with CKD and CTOs who were managed with medical therapy or surgical revascularization. Additionally, since post procedure collection of creatinine was not mandated the rates of post-procedure acute kidney injury may have been underestimated. Furthermore, the trajectories of renal function in follow-up were unknown, and the association between further decline in renal function and outcomes remains unclear. Additionally, operators in OPEN-CTO were highly experienced, and only those with at least 2-years of hybrid CTO experience were selected for participation. Thus, these results may not be generalizable to low-volume operators of CTO-PCI. Finally, our study included a modest number of patients with eGFR <30 (n=21), and whether technical success, complication rates and recovery of health status might be different in these patients with advanced CKD are important areas of further research.

In summary we found that technical success of the CTO PCI procedure, complication rates, and symptomatic benefit and recovery of health status after CTO PCI was consistent across the spectrum of severity of renal dysfunction, and similar to patients who did not have CKD, although patients with renal dysfunction had higher rates of AKI. These findings support of the safety and effectiveness of CTO PCI in appropriately selected patients with renal dysfunction. When performed by experienced operators, CKD should not be considered a deterrent to consideration of CTO PCI for patients with refractory symptoms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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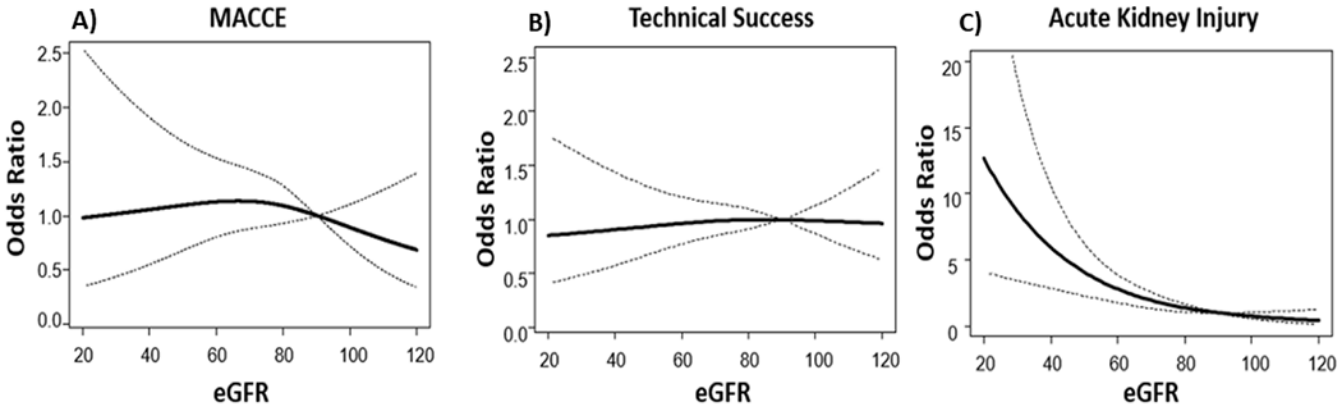

Figure 1.

Multi-variable adjusted odds of having MACCE, technical success and AKI according to eGFR at baseline [eGFR of 90 as control].

(MACCE= Major Adverse Cardiac or Cerebral Event, AKI= Acute Kidney Injury, eGFR= estimated Glomerular Filtration Rate)

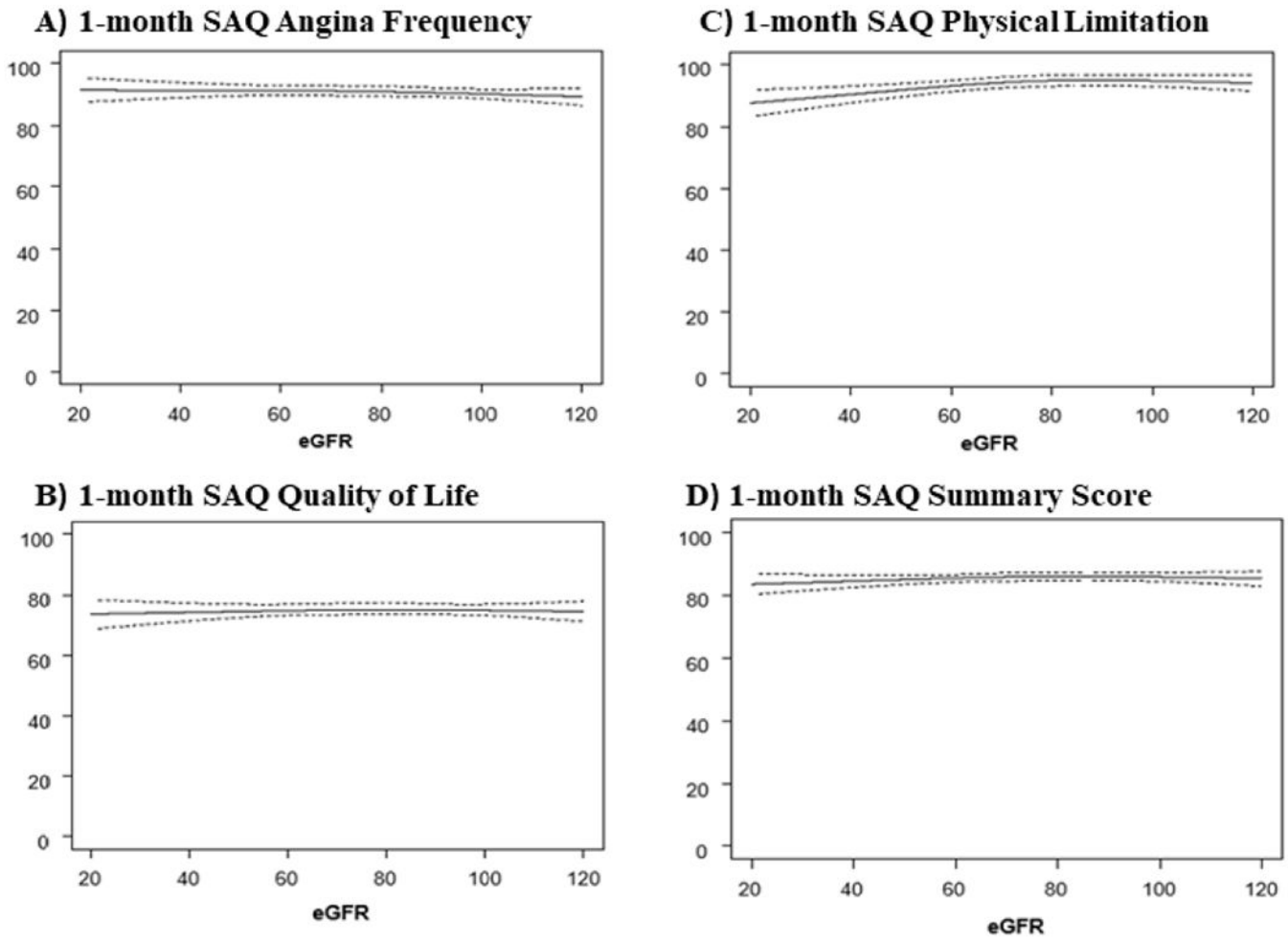

Figure 2.

Baseline health status and multivariable adjusted SAQ scores 1-month after CTO PCI across range of baseline renal function.

(SAQ= Seattle Angina Questionnaire, CTO PCI=Chronic Total Occlusion Percutaneous Coronary Intervention)

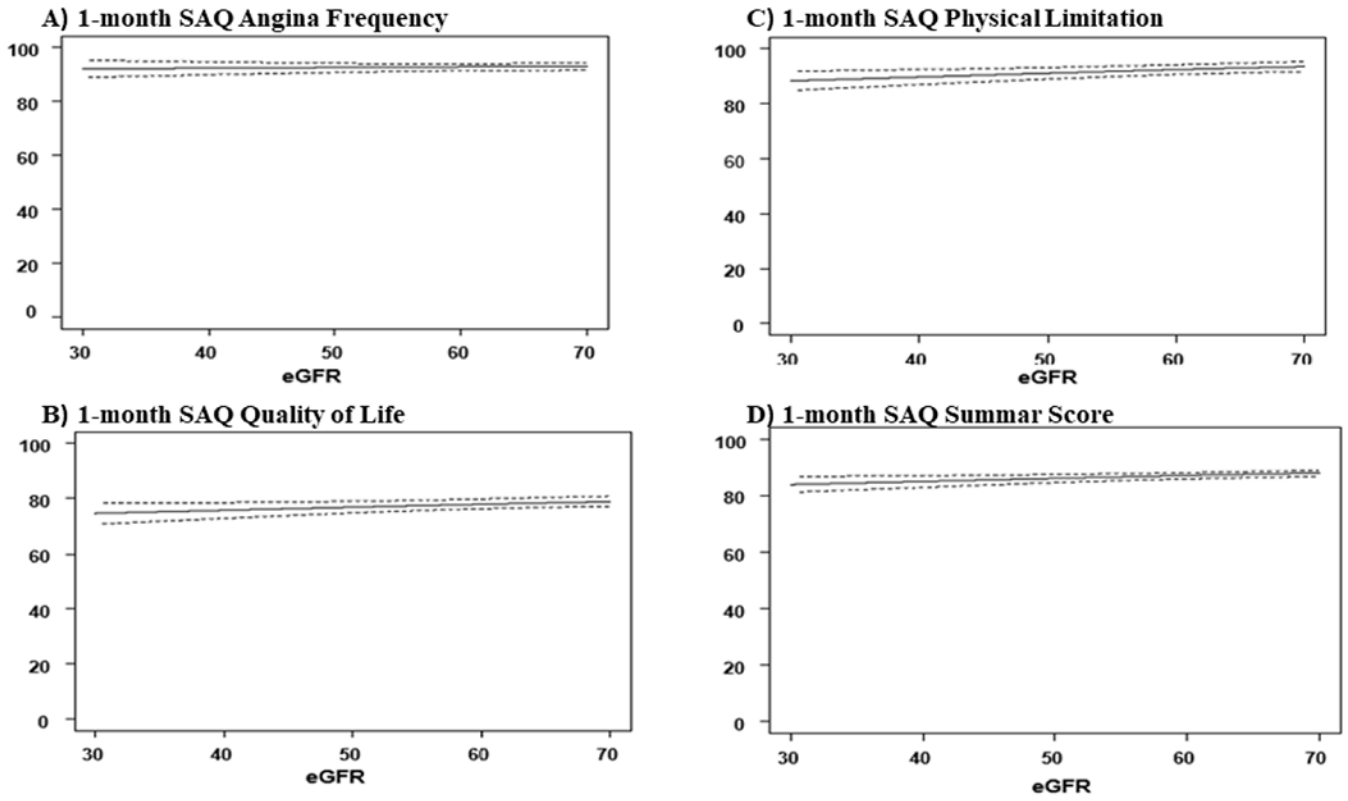

Figure 3.

Baseline health status and multivariable adjusted SAQ scores 1-year after CTO PCI across range of eGFRs.

(SAQ= Seattle Angina Questionnaire, CTO PCI=Chronic Total Occlusion Percutaneous Coronary Intervention)

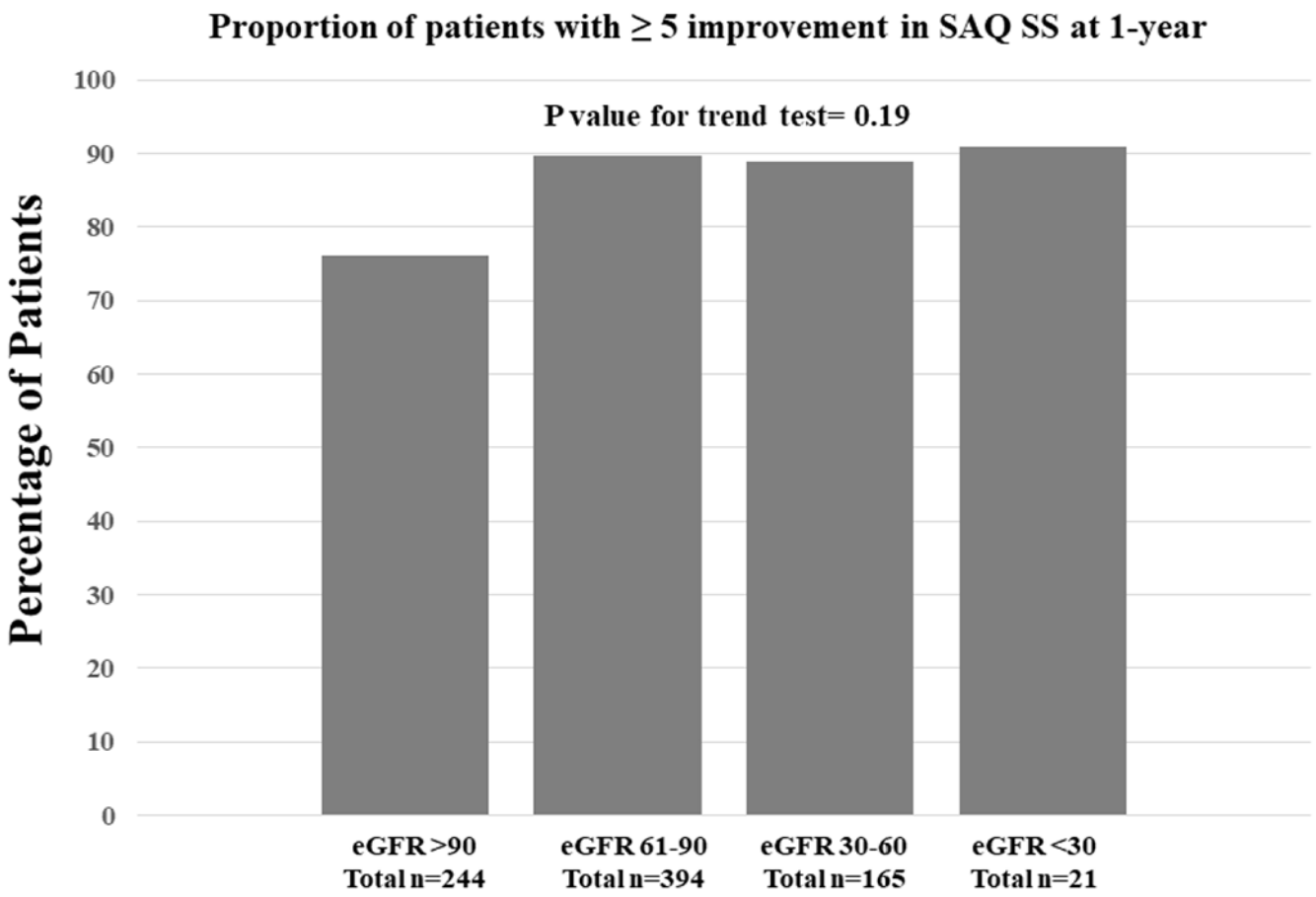

Figure 4.

Responder analysis showing proportion of patients stratified by CKD stage having a clinically meaningful improvement in SAQ SS (≥ 5-points) at 1-year.

(CKD=Chronic Kidney Disease, SAQ SS= Seattle Angina Questionnaire Summary Score)

Table 1

Baseline Characteristics of patients with and without CKD.

	Chronic Kidney Disease		
Variable	**Yes (n=225)**	**No (n=732)**	**P value**
Age [years] (Mean ± SD)	69.2 ± 10.1	64.1 ± 10.0	< 0.001
Women	65 (28.9%)	121 (16.5%)	< 0.001
White	202 (89.8%)	662 (90.4%)	0.30
Diabetes Mellitus	120 (53.3%)	268 (36.6%)	< 0.001
Congestive Heart Failure	84 (37.3%)	130 (17.8%)	< 0.001
Ejection Fraction (Mean ± SD)	48.7 ± 14.3	52.0 ± 13.2	0.002
Current Smoker	21 (9.5%)	104 (14.4%)	0.06
Last HbgA1c (Mean ± SD)	7.2 ± 1.6	6.9 ± 1.6	0.12
History of Myocardial Infarction	118 (52.4%)	337 (46.0%)	0.09
Previous coronary bypass	109 (48.4%)	242 (33.1%)	< 0.001
eGFR [[ml/min/1.73m^2] (Mean ± SD)	44.2 ± 14.5	87.3 ± 19.1	< 0.001
Medications on arrival			
Diuretic	139 (61.8%)	224 (30.6%)	< 0.001
Angiotensin Converting Enzyme Inhibitor	86 (38.2%)	346 (47.3%)	0.02
Procedural Variables			
Initial Crossing Strategy			0.006
Antegrade wire escalation	120 (48.9%)	412 (56.3%)	
Antegrade dissection and reentry	30 (13.3%)	106 (14.5%)	
Retrograde wire escalation	27 (12.0%)	100 (13.7%)	
Retrograde dissection and reentry	58 (25.8%)	114 (15.6%)	
Successful Strategy			0.43
Antegrade wire escalation	76 (37.8%)	280 (41.1%)	
Antegrade dissection and reentry	50 (24.9%)	168 (24.7%)	
Retrograde wire escalation	18 (9.0%)	75 (11.0%)	
Retrograde dissection and reentry	57 (28.4%)	158 (23.2%)	
Target CTO Vessel			0.61
Left Main	3 (1.3%)	5 (0.7%)	
LAD/Diagonal	42 (18.6%)	154 (21.1%)	
LCX/Obtuse Marginal	45 (20.0%)	118 (16.2%)	

	Chronic Kidney Disease		
Variable	**Yes (n=225)**	**No (n=732)**	**P value**
RCA/PDA/RPLV	135 (59.9%)	453 (62.2%)	
Non-CTO-PCI	30 (13.3%)	97 (13.3%)	0.97
Complete Revascularization	162 (72.3%)	566 (77.6%)	0.10
JCTO score (Mean ± SD)	2.3 ± 1.2%	2.3 ± 1.3	0.70
Procedure Time (minutes) (Mean ± SD)	124.6 ± 60.0	118.5 ± 65.0	0.21
Contrast Used (cc) (Mean ± SD)	229.9 ± 124.5	269.5 ± 141.7	< 0.001
Fluoroscopy Time (minutes) (Mean ± SD)	53.0 ± 32.8	49.4 ± 34.7	0.18
Radiation Dose (Air Kerma) (Mean ± SD)	2481.8 ± 1856.1	2531.6 ± 1901.8	0.73

Abbreviations: estimated Glomerular Filtration Rate (eGFR), Chronic Total Occlusion (CTO), Left Anterior Descending coronary artery (LAD), Left Circumflex Coronary Artery (LCX), Right Coronary Artery (RCA), Posterior Descending Coronary Artery (PDA), Right Posterolateral Ventricular Coronary Artery (RPLV)

Table 2.

Periprocedural complications comparing patients with and without CKD

	Chronic Kidney Disease		
	Yes (n-225)	**No (n=732)**	**P value**
Peri-procedural Complications			
Clinical Perforation	9 (4.0%)	27 (3.7%)	0.83
Septal Hematoma	5 (2.2%)	8 (1.1%)	0.20
Pericardial Effusion	7 (3.1%)	12 (1.6%)	0.18
Access Site Hematoma	14 (6.2%)	26 (3.6%)	0.08
Retroperitoneal Bleed	0 (0.0%)	2 (0.3%)	1.00
Death during hospitalization	0 (0.0%)	0 (0.0%)	
Myocardial Infarction	7 (3.1%)	15 (2.0%)	0.35
Emergency surgery	0 (0.0%)	4 (0.5%)	0.58
Stroke	0 (0.0%)	0 (0.0%)	
Technical success	184 (81.8%)	647 (88.4%)	0.01
MACCE	16 (7.1%)	40 (5.5%)	0.36

Abbreviations: Major Adverse Cardiac and Cerebral Events (MACCE)

Table 3.

Unadjusted Health Status at baseline and in follow-up by CKD status.

	CKD (n=225)	No CKD (n=732)	P value
SAQ Quality of Life (Mean ± SD)			
Baseline	49.7 ± 29.0	49.0 ± 26.7	0.72
1-month	73.9 ± 23.6	75.4 ± 21.5	0.38
1 year	76.5 ± 24.1	79.6 ± 21.1	0.08
SAQ Angina Frequency (Mean ± SD)			
Baseline	70.1 ± 29.2	70.1 ± 26.4	0.99
1-month	91.3 ± 18.3	90.7 ± 19.0	0.71
1 year	92.0 ± 19.1	93.4 ± 16.7	0.29
SAQ Physical Limitations (Mean ± SD)			
Baseline	58.0 ± 27.8	67.3 ± 25.3	< 0.001
1-month	91.1 ± 17.0	96.7 ± 11.2	< 0.001
1 year	91.8 ± 17.3	95.6 ± 12.3	0.003
SAQ Summary Score (Mean ± SD)			
Baseline	59.4 ± 24.6	62.1 ± 21.8	0.12
1-month	83.7 ± 16.8	86.1 ± 16.1	0.06
1 year	85.2 ± 17.7	88.7 ± 14.6	0.004
Rose Dyspnea Scale (Mean ± SD)			
Baseline	2.5 ± 1.5	2.2 ± 1.5	0.005
1-month	1.5 ± 1.6	1.0 ± 1.3	< 0.001
1 year	1.7 ± 1.6	1.0 ± 1.3	< 0.001

Abbreviations: Seattle Angina Questionnaire (SAQ)