ORIGINAL RESEARCH PAPER

Volume-7 | Issue-12 | December-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CLINICAL AND ANGIOGRAPHIC PROFILES OF CHRONIC TOTAL OCCLUSION LESIONS IN THE THREE MAJOR CORONARY ARTERIES: RETROSPECTIVE ANALYSIS FROM A TERTIARY CARE CENTRE IN INDIA

Cardiology

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ABSTRACT

Objective: To study the clinical and angiographic characteristics of chronic total occlusion (CTO) in the three major coronary arteries.

Methods and Results: A retrospective, single-center study of the clinical and angiographic profiles of patients with coronary CTO . Out of 362 lesions, 60 (16.6%), 95 (26.2%), and 207 (57.2%) were located in LAD, LCx and RCA respectively. Patients with CTO in RCA had significantly lower mean left ventricular ejection fraction, significantly more common involvement of ostial segment and bridging collaterals. Patients with CTO in LAD had significantly more frequent presence of blunt stumps and calcification. Patients with CTO in LCx had significantly more common presentation as inferior-wall MI and involvement of distal segment.

Conclusion: Clinical and angiographic differences in the CTO lesions of three major coronary arteries should be subjected to prospective studies to compare the long-term clinical outcomes.

KEYWORDS

Chronic total occlusion (CTO), LAD, LCx, RCA.

INTRODUCTION

Coronary chronic total occlusion (CTO) is a frequent condition encountered in catheterization laboratory.[1] Its prevalence is estimated to be 12–20% among patients undergoing coronary angiography.[2,3] However, very low percentages of these patients undergo recanalization with percutaneous coronary intervention (PCI). In this regard, a study of 8,004 patients evaluating the effect of chronic total coronary occlusion on treatment strategy had revealed that among patients with significant coronary artery disease and a CTO, 11% were treated with PCI, 40% with coronary artery bypass grafting (CABG), and 49% with medical therapy. On the other hand, among patients with significant coronary artery disease without a CTO, 36% were treated with PCI, 28% with CABG and 35% with medical therapy (P<0.0001).[4]This findings indicates that PCI is highly underutilized in the management of patients with CTO. This may be due to a historical belief that PCI may have minimal clinical benefit and poor success rates in managing CTO lesions. However, with technical innovations in recent years, highly experienced operators have demonstrated that CTO-PCI can be successfully performed in majority of patients.[5]In this milieu, there is a need to estimate the effect of CTO lesions on treatment strategy in the current scenario, especially in the Indian context where data are scarce.

It has also been noted that success rate of recanalization of CTO lesion may depend on various clinical and angiographic characteristics.[6] Presence of multiple lesions, blunt occlusion stump, calcification, tortuosity, bridging collaterals are found to be associated with undesirable outcomes.[6,7] In addition, the success in managing CTO lesions may be influenced by their location in the three major coronary arteries, i.e. left anterior descending artery (LAD), left circumflex artery (LCx), and right coronary artery (RCA).[6] Previous studies have demonstrated a trend towards lower success rate for CTO-PCI of RCA lesion.[6] However, the reason for this trend has been rarely mentioned. With this background, we conducted the present study to estimate the clinical and angiographic characteristics of CTO lesions in the three major coronary arteries. We also aimed to report the management modalities and in-hospital clinical outcomes for these patients with CTO lesions.

METHODOLOGY

Study Design and Patient Population

This was a retrospective, single-center study conducted at our tertiary-care center between January 2016 and January 2018. Of all patients undergoing diagnostic angiography at our center, the clinical and angiographic profiles of patients who were diagnosed with CTO coronary lesions were examined in this study. Patients with previous history of PCI or CABG were excluded from the analysis. Here, a CTO was defined as a complete obstruction of the vessel with Thrombolysis In Myocardial Infarction (TIMI) flow grade 0 and an estimated duration of >3 months.[8] Age of the occlusion was determined by the interval from the last episode of acute coronary syndrome or myocardial infarction consistent with the location of the occlusion. The CTO patients were grouped according to the involvement of LAD, LCx, and RCA. Subsequently, the clinical and angiographic characteristics of CTO lesions were compared based on their presence in three major coronary arteries.

Data Collection and Outcome Measures

Demographic, clinical, and angiographic data were collected from all patients included in the study. Demographic variables included age and gender. In addition, presence of various cardiovascular risk factors including hypertension, diabetes mellitus, dyslipidaemia, smoking and tobacco-chewing habits, renal insufficiency, dilated cardiomyopathy, and previous stroke were recorded. Diagnosis of acute coronary syndrome, including stable angina, unstable angina, non-ST segment elevation myocardial infarction (MI), was made based on the criteria established by the American Heart Association (AHA) guidelines.[9,10]

All patients had underwent diagnostic coronary angiography through femoral/radial route. Based on the angiographic data, presence of CTO lesion and involved vessel was identified. Further, the distribution of CTO lesions in ostial, proximal, mid, and distal segments of the vessels was also noted. The coronary arterial dominance was defined by the vessel which gives rise to the posterior descending artery (PDA) and the patients were identified as right dominant, left dominant or co-dominant. Additionally, severity of coronary artery disease was noted by presence of significant coronary occlusion and the patients were classified to have single-vessel disease or multi-vessel disease. Other angiographic features of CTO lesions, including presence of blunt stumps, calcification, tortuosity, and bridging collaterals were also recorded.

The choice of management modality for the patient with CTO coronary lesions was at the discretion of operating cardiologist. Accordingly, patients were managed medically or by PCI or CABG. All patients were evaluated for in-hospital complications and mortality.

Statistical Analysis

Continuous variables were presented as mean±standard deviation and compared using student's t test. Categorical variables were presented as frequencies with percentages and compared using the chi square test. A P value<0.05 was considered statistically significant. All

statistical analyses were done using Statistical Package for Social Sciences (SPSS; Chicago, IL, USA) program, version 15.

RESULTS

A total of 4,877 patients underwent diagnostic coronary angiography at our institute during the study period. Of them, 362 patients (mean age: 57.3±7.9 years) were identified to have CTO coronary lesions, indicating a prevalence of 7.4%. Of these lesions, 60 (16.6%) were located in LAD, 95 (26.2%) were located in LCx and 207 (57.2%) were located in RCA.

Clinical Characteristics

The differences in clinical characteristics of patients with CTO in each of three major arteries are shown in **Table 1**. Age at presentation, male gender, angina status, and presence of diabetes, hypertension, dyslipidaemia, tobacco chewing, and history of previous stroke was comparable among patients with CTO lesions in LAD, LCx, and RCA. However, patients with CTO lesions in RCA displayed significantly lower levels of mean ejection fraction as compared to that in patients with CTO lesions in LCx (45.5±14.0% vs. 48.9±12.0%; P<0.05). Further, the type of myocardial infarction was significantly different between the LCx and the RCA groups, with anterior-wall MI present in 14 (14.7%) patients with CTO lesions in the LCX as compared to 72 (34.8%) of patients with CTO lesions in the RCA (P<0.001). Smoking habits were more common among patients with CTO lesions in the RCA as compared to that in patients with CTO lesions in the LAD (33.8% vs. 13.3%; p<0.01). Conversely, presentation with renal insufficiency was more common among patients with CTO lesions in the LAD as compared to that in patients with CTO lesions in the RCA (13.3% vs. 3.9%; p<0.01).

Table 1. Clinical characteristics

Variables	Overall (n=362)	LAD (n=60)	Lcx (n=95)	RCA (n=207)	P Value		
					LAD vs. LCx	LAD vs. RCA	LCx vs. RCA
Age, years	57.3±9.1	58.9±7.9	56.2±10.1	57.4±8.9	0.078	0.227	0.307
Male	299(82.6%)	49(81.7%)	74(77.9%)	176(85.0%)	0.572	0.529	0.128
Ejection fraction, %	46.7±13.4	47.5±13.5	48.9±12.0	45.5±14.0	0.507	0.321	<0.05
Acute Coronary Syndrome							
Unstable Angina	37(10.2%)	5(8.3%)	9(9.5%)	23(11.1%)	0.308	0.066	0.797
Stable Angina	168(46.4%)	37(61.7%)	43(45.3%)	88(42.5%)			
NSTEMI	36(9.9%)	6(10.0%)	11(11.6%)	19(9.2%)			
Myocardial Infarction							
AWMI	102(28.2%)	16(26.7%)	14(14.7%)	72(34.8%)	0.255	0.357	<0.001
IWMI	71(19.6%)	13(21.7%)	32(33.7%)	26(12.6%)			
AWMI+IWMI	16(4.4%)	2(3.3%)	2(2.1%)	12(5.8%)			
Generalized	7(1.9%)	1(1.7%)	3(3.2%)	3(1.4%)			
Cardiovascular Risk Factors							
Diabetes	150(41.4%)	25(41.7%)	40(42.1%)	85(41.1%)	0.957	0.933	0.864
Hypertension	198(54.7%)	33(55.0%)	50(52.6%)	115(55.6%)	0.773	0.939	0.636
Dyslipidemia	139(38.4%)	21(35.0%)	34(35.8%)	84(40.6%)	0.920	0.436	0.449
Smoking	103(28.5%)	8(13.3%)	25(26.3%)	70(33.8%)	0.054	<0.01	0.192
Tobacco	120(33.1%)	17(28.3%)	31(32.6%)	72(34.8%)	0.573	0.351	0.714
Renal insufficiency	25(6.9%)	8(13.3%)	9(9.5%)	8(3.9%)	0.454	<0.01	0.050
Previous Stroke	11(3.0%)	1(1.7%)	4(4.2%)	6(2.9%)	0.649	1.000	0.513

Angiographic Characteristics

Of 362 patients with CTO coronary lesions examined in the study, 345 (95.3%) patients were right dominant, where the PDA was supplied by the RCA. Further, 344 (95%) of them had multi-vessel disease. The differences in angiographic characteristics of patients with CTO in each of three major arteries are shown in **Table 2**. There were no significant differences among patients with CTO lesions in LAD, LCx, and RCA for coronary arterial dominance or for severity of coronary artery disease. **Figure 1** illustrates the distribution of CTO lesions in ostial, proximal, mid, and distal segments of the three major vessels. Majority of CTO lesions were located in the proximal segment of the coronary vessels in all three groups of patients [RCA (56.5%), LAD (61.7%), and LCX (47.4%)].

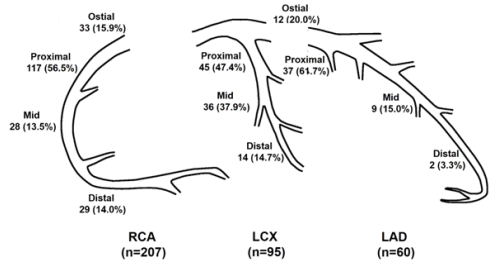

Figure1. Angiographic findings and management

Table 2. Angiographic findings and management

Variables	Overall (n=362)	LAD (n=60)	LCx (n=95)	RCA (n=207)	P Value		
					LAD vs. LCx	LAD vs. RCA	LCx vs. RCA
Dominance							
Right	345(95.3%)	57(95.0%)	90(94.7%)	198(95.7%)	1.00	0.544	0.422
Left	13(3.6%)	2(3.3%)	3(3.2%)	8(3.9%)			
Co	4(1.1%)	1(1.7%)	2(2.1%)	1(0.5%)			
Severity of coronary artery disease							
Single vessel disease	18(5.0%)	2(3.3%)	8(8.4%)	8(3.9%)	0.318	1.000	0.101
Multi vessel disease	344(95.0%)	58(96.7%)	87(91.6%)	199(96.1%)			
CTO lesion Distribution							
Ostial segment	45(12.4%)	12(20.0%)	0(0.0%)	33(15.9%)	<0.001	0.460	<0.001
Proximal segment	199(55.0%)	37(61.7%)	45(47.4%)	117(56.5%)	0.082	0.478	0.139
Mid segment	73(20.2%)	9(15.0%)	36(37.9%)	28(13.5%)	<0.01	0.771	<0.001
Distal	45(12.4%)	2(3.3%)	14(14.7%)	29(14.0%)	<0.05	<0.05	0.867
CTO lesion characteristic							
Blunt	37(10.2%)	14(23.3%)	4(4.2%)	19(9.2%)	<0.001	<0.05	<0.05
Calcification	40(11.0%)	30(50.0%)	2(2.1%)	8(3.9%)	<0.001	<0.001	0.730
Tortuosity	6(1.7%)	1(1.7%)	1(1.1%)	4(1.9%)	1.000	1.000	1.000
Bridge collaterals	15(4.1%)	1(1.7%)	0(0.0%)	14(6.8%)	0.387	0.203	<0.01

Management Modality							
PCI	104(28.7%)	20(33.3%)	26(27.4%)	58(28.0%)	0.701	0.567	0.431
CABG	230(63.5%)	35(58.3%)	59(62.1%)	136(65.7%)			
Medical	28(7.7%)	5(8.3%)	10(10.5%)	13(6.3%)			

Presence of blunt occlusion stumps were significantly higher among patients with CTO lesions in the LAD (23.3%) as compared to that in the LCx (4.2%; P<0.001) and the RCA (9.2%; P<0.05). Further, calcification was found to be more common in CTO lesions in the LAD (50%) than that in the LCx (2.1%; P<0.001) and RCA (3.9%; P<0.001). Tortuosity with CTO lesions was comparable among three vessel groups, while presence of bridging collaterals circulation was more frequent among patients with CTO lesions in RCA (6.8%).

Management and In-hospital Outcomes

Majority of patients with CTO coronary lesions were managed with CABG (63.5%). PCI was chosen as method of reperfusion in 28.7% patients, while medical management was opted in 7.7% patients with CTO coronary lesions. The distribution of patients with respect to management modality showed no significant difference among patients with CTO lesions in LAD, LCx, and RCA. Procedure was successful in all cases. There were no instances of procedural complications. All patients remained event free at the time of discharge and noin-hospital mortality was reported in any patient.

DISCUSSION

In our study, CTO lesions were identified in 7.4% of patients undergoing diagnostic coronary angiography at our institute. This finding is comparatively lower as compared to 10.9% of patients undergoing coronary angiography in the SCAAR registry involving in 2,15,836 patients.[3] However, similar to other studies,[6,11,12] CTO lesions mostly involved RCA vessels in our study. Further, the mean age at presentation with CTO lesions in our study was 57.3 years, which is in lines with studies involving Indian population[11] but is comparatively younger than the mean age of 62–68 years reported in studies involving western population[1,3,6,12]. Further, there was a male predominance (82.6%) among patients with CTO lesions. This is in lines with global trend.[1,3,7,11,12]. We also observed that 95% of patients included in our study had multi-vessel disease. This finding is similar to previous published reports,[3,6,7,11] confirming that CTO lesions are associated with an extensive atherosclerosis burden. In addition, our study also observed that patients with CTO lesions were more likely to have the presence of cardiovascular risk factors. In our study population, hypertension, diabetes, dyslipidemia, tobacco chewing habits, and smoking were present in 54.7%, 41.7%, 38.4%, 33.1%, and 28.5% patients respectively.

Analysis of clinical and angiographic characteristics of CTO lesions based on involved vessels revealed that patients with CTO lesions in RCA had significantly lower mean left ventricular ejection fraction as compared to those with LAD. Further, anterior-wall MI was the most common presentation among patients with CTO lesions in RCA. Distribution-wise, involvement of ostial segment was more common among patients with CTO lesions in RCA as compared to that in patients with CTO lesions in LCx. Presence of bridging collaterals was also significantly more common among patients with CTO lesions in RCA as compared to that in patients with CTO lesions in Lcx.

On the other hand, patients with CTO lesions in LAD had significantly lesser number of smokers as compared to that in patients with CTO lesions in RCA. However, renal insufficiency was significantly more common among patients with CTO lesions in LAD as compared to that in patients with CTO lesions in RCA. Involvement of ostial, mid, and distal segments was also more common among patients with CTO lesions in LAD as compared to that in patients with CTO lesions in LCx. Lastly, the presence of blunt stumps as well as calcification was significantly higher among patients with CTO lesions in LAD as compared to that in patients with CTO lesions in LCx and in RCA.

Patients with CTO lesions in LCx had inferior-wall MI as the most common presentation. CTO lesion in the distal segment of the vessel was also significantly more common among patients with CTO lesions in LCx as compared to that in patients with CTO lesions in LAD. Presence of blunt stumps, calcification, tortuosity, or bridging collaterals were least common among patients with CTO lesions in LCx.

In our study, all patients with CTO received appropriate treatment according to the operating cardiologists. We observed that 63.5% patients were referred for CABG, while 28.7% patients were opted for PCI and 7.7% patients on medical therapy. This finding indicates that there has been rise in performing CTO-PCI. Although the current indications and benefit of CTO-PCI remain a topic of controversy and debate, there is a growing body of evidences from various studies reporting favourable short-term and long-term outcomes of CTO-PCI.[5,13]Successful CTO-PCI offers better tolerance in case of future acute coronary syndromes and can significantly improve angina and left ventricular function.[13] However, appropriate patient selection becomes essential.[14] In this regard, a large-scale prospective study comparing the clinical outcomes with PCI and CABG in patients with CTO lesions is warranted to confirm the prognostic benefits of CTO-PCI over CABG in certain patients .

The distribution of patients with respect to management modality showed no significant difference among patients with CTO lesions in LAD, LCx, and RCA. Procedure was successful in all cases. There were no instances of procedural complications. All patients remained event free at the time of discharge and no in-hospital mortality was reported in any patient.

Previously, Hasegawa et al. had conducted a similar retrospective study to report the differences in the clinical and angiographic characteristics of 708 patients with CTO lesions, who underwent PCI of CTO lesions. They observed that RCA was most commonly involved vessel having a CTO lesion. Notably, patients with CTO in LAD exhibited lower incidence of previous history of PCI and CABG. Further, blunt occlusion stump were more common among patients with CTO lesions in LAD. The CTO lesions in LCx presented more frequently as a part of multi-vessel disease. In addition, CTO lesions were significantly longer, more severely angulated, and calcified. Good collateral circulations were more often encountered in the RCA. Further, the PCI was successful in 79% of patients with CTO lesions in LCx, 74.8% in patients 71.8% patients with RCA. This finding indicates relatively lower success rate of PCI in patients with CTO lesions in RCA. As compared to the study by Hasegawa et al., our study did not include patients who underwent PCI only as the management modality. We opine that our study provides real-world clinical scenario not only in terms of angiographic and clinical characteristics but also for management strategies and in-hospital outcomes in an Indian setting.

Retrospective study design can be considered as a major limitation of the present study. A long-term clinical follow-up would also have provided useful insights regarding the influence of CTO vessel location on individual management modalities.

CONCLUSION

Certain clinical and angiographic characteristics of CTO lesions were different among three major coronary arteries. Future studies should be conducted to compare the long-term clinical outcomes for different management modalities, with respect to vessel involved in CTO lesions.

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