ORIGINAL ARTICLE

PROCEDURAL SUCCESS AND IN HOSPITAL COMPLICATIONS OF CHRONIC TOTAL OCCLUSION PERCUTANEOUS CORONARY INTERVENTION

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Background: Chronic total occlusion **(**CTO) recanalization had been considered as technically challenging procedure with low chances of successful recanalization. The aim of this study was to find out the rate of procedural success and complications associated with revascularization of CTO. **Methods:** This is a retrospective observational study. Records of 243 patients presenting to Peshawar Institute of Cardiology from 1st April 2021 till 31st March 2024, who had Per Cutaneous Intervention (PCI) for CTO lesions, were analyzed **Results:** Among 243 patients ,70.4% were male and 29.6% were females. Mean J-CTO (Multicenter CTO Registry of Japan) score was used to assess the complexity of the lesion score was 2.4±0.97. LAD was the commonest CTO vessel requiring revascularization. Highest success rate (95%) was seen with "easy" lesions (J-CTO <1) and shows a significant association at *p* value >0.05. Overall complication rate was very low. Two patients (0.82%) had mortality. Coronary perforation was the gravest complication. **Conclusion:** CTO recanalization is a complex procedure which requires different skillset. Our success rate is lower than international figures which emphasizes on the necessity of advanced training in this domain of coronary intervention. Fortunately, our complication rate closely resembles to global data ensuring safety of our procedures.

Keywords: Chronic Total Occlusion; Coronary Arteries; Thrombosis in Myocardial Infarction; Percutaneous Coronary Intervention; Left Ventricular Function

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INTRODUCTION

Chronic total occlusion is defined as obstruction of native coronary artery with Thrombosis in Myocardial Infarction (TIMI) grade 0, or grade 1 antegrade flow for more than 3 months duration.[1] Enormous work has been done to elucidate the histopathology of Chronic total occlusions **(**CTOs), understanding of which is crucial to enable successful crossing of CTOs. Histopathology has shown that there are microchannels and there is hard tissue composed of dense fiber and calcium.[2]

CTOs are common and the frequency ranges from 20–50% in patients with significant epicardial coronary artery disease[3,4] and they represent 10–15% of all Per Cutaneous Intervention (PCI) procedures[5]. In the past, the chances for successful revascularization were markedly low and failure was high. However, with advent of modern inventory and improved techniques, success of CTO recanalization is more than 90%.[6-8] With increasing understanding of intricate histopathological details and intravascular ultrasound (IVUS) findings, the treatment of CTO has been further optimized. Major complications of CTO intervention are rare, but there are specific complications which should be known to the CTO operators to improve the safety profile of CTO procedures. It is a known fact that CTO is associated with higher 1 year mortality and morbidity.[9,10] CTO is responsible for angina, shortness of breath and poor quality of life. Presence of CTO lesions has been described as a main reason of cardiogenic shock in acute myocardial infarction as in shock registry. Previously medical management was considered as reasonable approach for treatment of CTOs. However, with growing evidence of improved LV function and survival associated with CTO recanalization, CTO PCI is now considered a viable option for patients with medically refractory symptoms. There are various risk scores that help in predicting the success of percutaneous intervention, like J-CTO (Multicenter CTO Registry of Japan), Progress CTO and a new ABCDE score. The J-CTO score is the sum of the 5 binary parameters namely blunt proximal cap, calcification, bending >45°, and length of occluded segment >20 mm plus previously failed PCI attempt) [11,12] CTO PCI is a demanding procedure and requires not only patience but a very methodical approach. Due to complexity of the lesion, the procedure of revascularization is associated with various complications. These complications can be cardiac and extracardiac. Cardiac complications are

vessel occlusion, dissection, perforation or device entrapment and extracardiac are CVA, vascular, renal and radiation injury.[13,14] The aim of this study was to evaluate the procedural success and associated complications of revascularization procedures of CTOs.

MATERIAL AND METHODS

It was a retrospective observational study, conducted in Peshawar Institute of Cardiology from 1st April 2021 to 31st March 2024. A total of 243 consecutive patients were included who underwent CTO revascularization. Patients were included if they had at least one CTO lesion. Patients must have had any compelling indication for revascularization, as medically refractory symptoms, impaired LV function or poor quality of lite attributable to CTO lesion. Patients were excluded if they had anginal symptoms associated with any other significant non-CTO lesion requiring revascularization. Other medical conditions increasing the risk of procedure as significantly impaired creatinine clearance, very frail, elderly patient unable to tolerate the procedure owing to increased amount of dye and time required for CTO procedures were also excluded. Patients with involvement of left main stem and significant multivessel disease requiring CABG were also excluded. Procedural success was defined as achieving TIMI III flow after successful stent placement with a residual diameter stenosis of <30%.[11] Data was collected from hospital database (Hospital Management Information System-HMIS and EMR – Electronic Medical Record) after approval form the hospital ethical review board, which provided information about the baseline characteristics and risk factors. Coronary angiographic clips were reviewed by two independent consultant interventional cardiologist. J-CTO score was calculated, and various complications were noted. Data was collected meticulously to mitigate bias. However, the inherent bias associated with retrospective nature of the study cannot be ruled out. The data was analyzed through IBM SPSS statistics version 22. Mean and standard deviation are computed for continuous variables i.e., age, J-CTO score. Percentages are computed for categorical variables i.e., hypertension, diabetes mellitus, smoking, vessel with CTO lesion and complications. All the results are displayed in the form of tables

RESULTS

A total of 243 patients were included in the study. Mean age of the study population was 58±7.97 years. One hundred and seventy-one (70.4%) were male and 72 (29.6%) were females. 136 (56.0%) were diabetic and 131 (53.9%) were hypertensive (Table 1). Mean J-CTO score was 2.4±0.97. majority patient had intermediate J-CTO score. 98 (40.3%) patients had single vessel disease, while 76 (31.3%) and 64 (26.3%) patients had double vessel and triple vessel disease. 52.7% patients had LAD CTO and 32.5% had RCA involvement followed by LCX which was a CTO lesion in 14.8% patients. and shows a significant association at *p* value >0.05.

Successful recanalization achieved in around 76.5%. Highest rate of successful revascularization was achieved in "easy" lesions, i.e., 42 out of 44 patients (95.45%) had successful revascularization, followed by intermediate lesions (93.75%) (Table-2). Two mortalities were recorded as in hospital complication. One patient died because of coronary perforation despite receiving treatment and one had stent thrombosis related death. Besides, 8 patients had coronary perforation. Out of which 3 patient developed cardiac tamponade. Subintimal dissection was the predominant complication, afflicting 12 patients. 8 patients had no reflow, which was successfully managed with intracoronary nitrates and adrenaline.

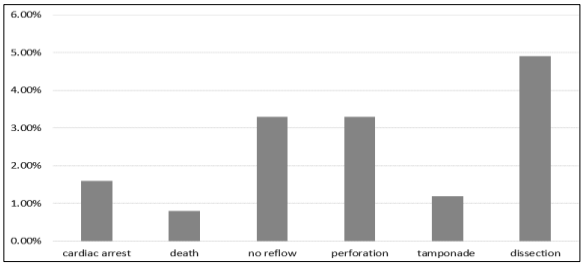

Figure-1: Rate of complications associated with CTO recanalization.

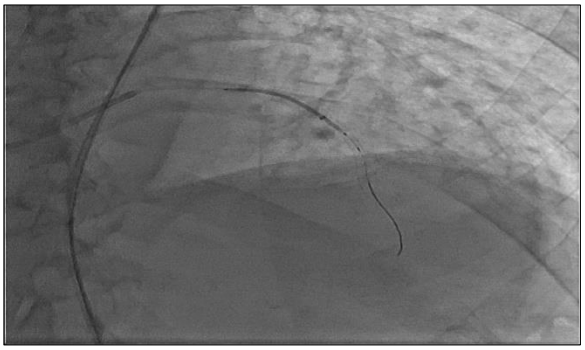

Figure-2: Guide Liner used to Deliver Stent across tortuous and Calcified LAD in CTO

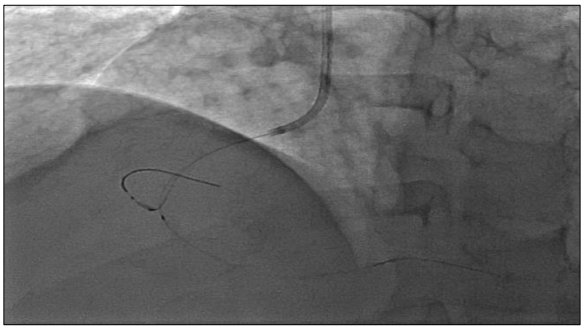

Figure-3: Anchor Guide for delivering CTO Balloon

Table-1: Baseline characteristics: (n=243)

Characteristics	Frequency (n)	Percentage (%)	
Gender			
Male	171	70.4	
Female	72	29.6	
Mean Age	58±7.97 years	***p*-value**	
Risk factors			
Hypertension	131	53.9	.012
Diabetes	136	56.0	.063
Smoking	47	19.3	.009
History of MI	109	44.9	
SVCAD	98	40.3	
DVCAD	76	31.3	
TVCAD	64	26.3	
LMS involvement	5	2.1	
Location of CTO lesion			
LAD	128	52.7	
RCA	79	32.5	
LCX	36	14.8	
Mean J-CTO score	2.4±0.97		
Easy (0)	44	18.1	.056
Intermediate (1)	80	32.9	.041
Difficult (2)	78	32.1	.002
Very difficult (≥3)	41	16.9	.000

Table-2: Procedural characteristics. (n=243)

Characteristics	Frequency (n)	Percentage (%)	*p*-value
Procedural success	186	76.5	.000
J-CTO score			
Easy	46		.093
Intermediate	75		.086
Difficult	52		.008
Very difficult	17		.009
Complications			.009
Cardiac arrest	4	1.6	
Death	2	0.8	
No reflow	8	3.3	
Perforation	8	3.3	
Tamponade	3	1.2	
Dissection	12	4.9	
Stroke	0	0	

DISCUSSION

Percutaneous intervention for chronic total occlusion has now become as a widely acceptable and preferred method of recanalization. With the advent of modern inventory and improved operator's skill, the success rate of CTO revascularization has reached to 90%.[11] This marked improvement in successful CTO recanalization, underscores the effectiveness and viability of percutaneous coronary intervention for the treatment of CTO. Currently there are four techniques for CTO recanalization: antegrade wire escalation, antegrade dissection and re-entry, retrograde wire escalation, and retrograde dissection and re-entry. Also, hybrid algorithm has markedly improved the success rate of CTO recanalization, i.e., starting with dual injection and then switching between different techniques depending on lesion complexity.[15]

In our study, overall, we achieved successful recanalization in around 76% of patients, with more than 90% success rate in easy and intermediate lesions. Most of the cases were done with antegrade technique, while retrograde approach was employed very infrequently. Also, use of specialized CTO equipment and other advanced techniques were limited in our cases. This highlights the importance of procedural approaches and utilization of equipment necessary for the improvement in CTO revascularization procedures.

Most of the cases were done with dual injection to delineate the lesion length and estimate the course of the missing segment. Dual injection also helps understanding the course of the guidewire while crossing the lesion. J-CTO score was used to assess the lesion complexity. Like other studies, our study showed the highest success rate in cases of "easy" lesion. While the lowest success rate was found with very difficult lesions. This again, highlights the impact of operator's skills and experience on procedural success. This also suggests the importance of continued training to improve the operator's skills and proficiency especially for complex procedures.

In our study LAD was the predominant vessel constituting the CTO lesions followed by RCA and LCX. Interestingly, our observation deviates from the international data, where RCA is the most common vessel having CTO lesion.[16,17] Selection of cases may be responsible for this difference because LAD is associated with greater benefit which may have dictated our clinical decision.

Despite advancements in techniques, hardware and operator's expertise, the intricate and complex nature of CTO can cause various procedural complications and harm to the patient. The spectrum of complications can range from subintimal dissections to massive perforations and subsequent mortality. In our study incidence of coronary artery perforation is 3.3% which corresponds to international data.[18,19] Out of which 3 patients developed tamponade and 1 had fatal outcome. Though a devastating complication, if managed successfully with prompt pericardiocentesis and sealing of perforation one can save the patient from having bad outcome. It also shows a significant association at p-value <0.05. Only 2 patients (0.8%) had in hospital mortality which aligns closely with international figures.[4] CTO recanalization procedure is inherently associated with complexities and technical challenges. Though the rate of successful revascularization is low in our study, but overall rate of major complications is similar to international data. Our study asserts that operator's experience, availability of dedicated CTO equipment and prompt treatment of procedural complications are of paramount importance in ensuring successful CTO recanalization.

Limitations:

This is a single center study, so the generalizability of the results is not possible. Furthermore, it's a retrospective study so, the biases associated with case selection and data collection cannot be excluded.

CONCLUSION

Our study highlights that CTO recanalization is a difficult procedure but if performed by experienced operators, it is associated with very low complication rate. Moreover, continued training is essential to improve operator's proficiency and use of dedicated CTO equipment and advanced techniques may increase the rate of successful revascularization.

Conflict of interest:

None

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None

AUTHORS' CONTRIBUTION

MW: Review. AR: Conceptualization. S: Data interpretation. SA: Write-up. A: Proof reading. MM: Write-up. RJ: Study design, data analysis, proof reading.

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