

STUDY OF SUCCESS RATE AND COMPLICATIONS OF PERCUTANEOUS CORONARY INTERVENTION IN CTO INTERVENTION

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Abstract: Chronic total occlusion (CTO) is one of the most complex and challenging forms of coronary artery disease, characterized by the complete obstruction of a coronary artery for more than three months. **Objective:** The primary aim of this study is to assess the success rate of PCI in patients with CTO and to evaluate the frequency and types of complications associated with the procedure. **Methods:** Patients included in the study were diagnosed with CTO using coronary angiography. The PCI procedures were carried out using standard techniques, and the primary endpoints were technical success and clinical success. Technical success was achieved by less than 30% residual stenosis with a TIMI grade 3 flow in the target vessel. In contrast, clinical success was defined as procedural success without the occurrence of major adverse cardiovascular events (MACE) such as death, myocardial infarction, or stroke within 30 days post-procedure and target vessel revascularization. **Results:** Among the 200 patients who underwent PCI for CTO, technical success was achieved in 165 patients, reflecting an overall success rate of 82.5%. Clinical success, defined as the absence of MACE, was achieved in 150 patients (75%). The major complications observed included coronary perforation in 10 patients (5%) and contrast-induced nephropathy in 8 patients (4%). Stent thrombosis occurred in 5 patients (2.5%), while 4 patients (2%) succumbed to procedural complications, leading to mortality within 30 days. Other minor complications such as arrhythmias and vascular access-related complications were seen in 20 patients (10%). Despite these complications, the success rates are consistent with current literature on CTO interventions, highlighting the effectiveness of PCI in these challenging cases. **Conclusion:** The study concluded that PCI for CTO can be performed with a high technical and clinical success rate with an acceptable complication profile. While major complications such as coronary perforation and contrast-induced nephropathy remain a concern, the overall outcomes suggest that PCI is an effective treatment option for CTO patients.

Keywords: Percutaneous Coronary Intervention (PCI), Chronic Total Occlusion (CTO), Success Rate, Complications, Stent Thrombosis.

Introduction

Chronic total occlusion (CTO) is one of the most challenging conditions encountered in coronary artery disease (CAD) (1). It is defined as the complete obstruction of a coronary artery, with no blood flow through the occluded segment, for a duration exceeding three months. CTOs are found in approximately 15-30% of patients undergoing coronary angiography for symptomatic CAD, and they present significant treatment challenges due to their complexity (2). The approach to managing CTOs is crucial because such lesions are characterized by numerous serious manifestations, such as angina, reduced quality of life, and mortality in specific patients (3). Percutaneous coronary intervention for CTOs has evolved in the past decade through technique, devices and operator experience (4). However, the current technical complexity, success rates, and interventional risk of PCI for CTOs have not significantly changed as compared with early reports. In the past, CTO lesions were mainly managed conservatively or medically or intervened with CABG when symptoms failed to improve or even deteriorated (5). However, with the advancement of PCI techniques and devices, the procedure has replaced CABG in many patients with CTO. Advances in guidewires in the past few years, microcatheters, retrograde approaches and hybrid algorithms have enhanced

the success rate of CTO PCI and drawn it into the mainstream of interventional cardiology (6). PCI in CTO aims to recanalise the involved artery, decrease the degree of ischaemia, relieve signs and symptoms and, although speculative, potentially improve patients' prognosis in specific subsets. These objectives, though, are still plagued by profound procedural limitations like difficulty in crossing the occluded segment, higher complication profile and longer duration of the procedure (7). The success of PCI in CTOs is often defined by two key metrics: technical success rate and clinical success rate. The definition of technical success is the creation of <30 % diameter stenosis with normal TIMI 3 flow in the intervened artery following deployment of the stent (8). Technical success means that the intended final result for the procedure was achieved, while clinical success is defined as technical success without serious adverse cardiovascular events such as death, myocardial infarction, or urgent target vessel revascularization within 30 days of the procedure. Even as outcomes with the procedures have demonstrated enhancements in efficiency with developments in methods, the process remains linked to the following complications; coronary perforation, contrast nephropathy, arrhythmias, and sometimes death (9). There are a large number of potential complications associated with CTO PCI and

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although they are not universal, when they do occur, they can have potentially severe consequences. The complication of coronary perforation which is one of the most dreaded is known to occur more often in CTO PCI than in non-CTO PCI because of the application of special wires and techniques in CTO (10). Other concerning side effects of these procedures include contrast-induced nephropathy arising from the large volumes of contrast media necessary in these procedures. Another risk well-known among cardiologists, although relatively infrequent, is stent thrombosis, which may lead to acute coronary syndromes or death. The interventionists need to understand the intricacies of these complications and the methods of their prevention (11).

Objective

The primary objective of this study is to assess the success rate of PCI in patients with CTO and to evaluate the frequency and types of complications associated with the procedure.

Methodology

A prospective observational study was conducted at Hayatabad Medical Complex, Peshawar, from 2019 to 2020, involving 200 patients diagnosed with chronic total occlusion (CTO) who underwent percutaneous coronary intervention (PCI). The patients enrolled in the study were over 35 years of age and had been diagnosed with CTO, defined as 100% occlusion of a coronary artery for more than three months, confirmed through coronary angiography. The patients selected also exhibited symptoms such as angina, dyspnea, or signs of myocardial ischemia on non-invasive tests, including nuclear imaging and cardiac MRI.

Patients with severe comorbidities, such as advanced heart failure (NYHA class IV), chronic kidney disease stage 4 or higher, or terminal illnesses, were excluded from the study. Additionally, patients with non-CTO coronary lesions, those with a prior history of coronary artery bypass grafting (CABG), and those with contraindications to PCI or stent

implantation, such as severe allergic reactions to contrast agents or anticoagulants, were not included.

Data were collected through detailed clinical evaluations, including medical histories, physical examinations, and relevant laboratory tests. Baseline coronary angiography confirmed the presence of CTO, and non-invasive ischemia testing using MRI scans was performed on patients with borderline symptoms to assess the need for revascularization. Each patient was evaluated for PCI appropriateness by a multidisciplinary heart team comprising interventional cardiologists and cardiac surgeons. All patients received standard antithrombotic therapy, including aspirin, P2Y12 inhibitors, and intravenous heparin.

During the PCI procedures, the majority of cases were approached antegradely, while a retrograde approach was used in a few instances. Technical success in the procedures was defined as clinical success without major adverse cardiovascular events (MACE) occurring within 30 days post-procedure. MACE included events such as death, myocardial infarction, stroke, or urgent target-vessel revascularization. These measures were crucial in assessing procedural efficiency and safety, ultimately determining the value of the intervention for patient outcomes.

Data were analyzed using SPSS version 29, and a p-value of less than 0.05 was considered statistically significant.

Results

Data were collected from 200 patients with a mean age of 58.3± 10.4 years, predominantly male (70%). Common comorbidities included hypertension (65%), diabetes mellitus (40%), dyslipidemia (45%), and obesity (35%). Notably, 50% had a history of smoking, and 30% had prior myocardial infarction. Half of the patients presented with multivessel coronary artery disease, while 60% had stable angina and 40% had unstable angina or NSTEMI. The mean left ventricular ejection fraction was 45 ± 8%, indicating moderate cardiac dysfunction. Additionally, 25% had a family history of coronary artery disease, and 10% had chronic kidney disease. (Table 1)

Table 1: Patient Demographic and Clinical Data

Demographic/Clinical Characteristic	Value
Total Number of Patients	200
Mean Age (years)	58.3 ± 10.4
Male (%)	70%
Female (%)	30%
Hypertension (%)	65%
Diabetes Mellitus (%)	40%
Dyslipidemia (%)	45%
Smoking History (%)	50%
Obesity (BMI >30 kg/m ²) (%)	35%
Prior Myocardial Infarction (%)	30%
Multivessel Coronary Artery Disease (%)	50%
Family History of CAD (%)	25%
Chronic Kidney Disease (%)	10%
Stable Angina (%)	60%
Unstable Angina/NSTEMI (%)	40%
Left Ventricular Ejection Fraction (%)	45 ± 8

Shorter lesions (<20 mm) had a higher technical success rate (90%) and lower complication rate (15%) compared to longer lesions (>30 mm), which showed a success rate of

75% and a higher complication rate (28%). Diabetic patients experienced a lower technical success rate (75%) and higher

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complication rate (25%) compared to non-diabetic patients (85% success and 15% complications). (Table 2)

Table 2: Lesion length

Subgroup	Technical Success Rate	Complication Rate
Lesion Length <20 mm	90%	15%
Lesion Length >30 mm	75%	28%
Diabetic Patients	75%	25%
Non-Diabetic Patients	85%	15%

The lesions were primarily located in the right coronary artery (55%), followed by the left anterior descending artery (30%) and left circumflex artery (15%). The average lesion

length was 28.7 ± 9.5 mm. Most procedures employed the antegrade approach (98%), while the retrograde approach was used in 2% of cases. (Table 3)

Table 3: Procedural Characteristics

Characteristic	Value
Lesion Location: Right Coronary Artery (%)	55%
Lesion Location: Left Anterior Descending Artery (%)	30%
Lesion Location: Left Circumflex Artery (%)	15%
Average Lesion Length (mm)	28.7 ± 9.5
Antegrade Approach (%)	98%
Retrograde Approach (%)	2%

Among the 200 patients who underwent PCI for CTO, technical success was achieved in 165 patients, reflecting an overall success rate of 82.5%. (Table 4) Clinical success, defined as the absence of MACE, was achieved in 150 patients (75%).

Major adverse cardiac events occurred in 15 patients accounting for 7.5 percent. Death occurred in 2 patients (1%) while myocardial infarction occurred in 4 patients (2%). Stroke and target vessel revascularization accounted for 1% and 3.5% respectively. (Table 5)

Table 4: Success Rate of CTO Intervention

Success	Percentages
Technical success	82.5%
Clinical success	75%

Table 5: Major Adverse Cardiac Events (MACE) of CTO Intervention

MACE	PERCENTAGES
Death	1%
Myocardial infarction (MI)	2%
Stroke	1%
Target vessel revascularization	3.5%

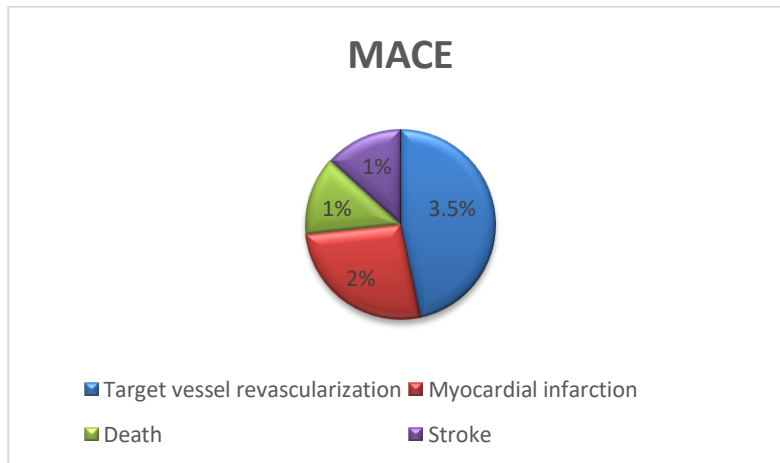


Figure 1:Major Adverse Cardiac Events

The major complications observed included coronary perforation in 10 patients (5%) and contrast-induced

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nephropathy in 8 patients (4%). Stent thrombosis occurred in 5 patients (2.5%). Other minor complications such as

arrhythmias and vascular access-related complications were seen in 20 patients (10%). (Table 6)

Table 6: Major and minor complications

Complication	Percentages (%)
Coronary artery perforation	5%
Contrast-induced nephropathy	4%
Stent thrombosis	2.5%
Cardiac arrhythmias and vascular access-related complications	10%

Discussion

This study aimed to evaluate the success rates and complications associated with percutaneous coronary intervention (PCI) in patients with chronic total occlusions (CTOs) (12). The findings reveal important insights into the demographics of the patient population, procedural characteristics, and clinical outcomes, which can inform future clinical practice and patient management strategies (13). The patient group was mostly middle-aged men (mean age, 58.3 years) with conventionally acknowledged cardiovascular risk factors; the percentages were hypertension 65%, diabetes mellitus 40%, and dyslipidemia 45%. Such data emphasize the importance of addressing comorbid illnesses in this group of patients, as these are known to influence the procedural strategy and further prognosis (14). The percentage of patients with previous myocardial infarction was 30% and multivessel CAD was 50% which highlights that the treated patients are a high risk of adverse events (15). Regarding procedural characteristics, the application of different approaches was identified. The antegrade approach was used in 98% of cases, which is in line with the past and present trends where this approach was found to be safer than the retrograde technique. Still, the retrograde approach was employed in 2 per cent of procedures, highlighting the difficulty of CTO interventions in which case such an approach is frequently required (16). The average lesion length of 28.7 mm speaks of the patients treated in the study experiencing pretty bulkage that otherwise is linked to enhanced technical challenge and danger during the PCI (17). The percentage of technical success is impressive at 82.5%, especially in a high-risk population with challenging coronary morphology. Although the major clinical success was reported as 75% this suggests that even though technical intervention in CTO lesions and others like it can achieve recanalization, they might not translate to health in the patient, which requires patient selection and management post-PCI (18). The common complications noted were evident in a small proportion of patients, the major ones being; coronary perforation and contrast-induced nephropathy. The complication rates that were depicted in this study agree with the rates observed elsewhere, magnifying the importance of care during such procedures (19). Each of the patient subgroups possessed significant patterns concerning lesion features and comorbidities' effect on the result. Lesions smaller than 20 mm produced higher technical success rates (90%) and were associated with fewer complications (15%) compared to those larger than 30 mm (20). This result is consistent with prior studies suggesting that longer lesions are independent predictors of a higher likelihood of procedural difficulties and adverse outcomes.

The findings also pointed out that the outcome of patients, who were free of diabetes, is better when compared to diabetic patients, as the literature also shows diabetes to be an independent predictor of unfavourable outcomes in patients who underwent PCI (21).

Conclusion

It is concluded that percutaneous coronary intervention (PCI) for chronic total occlusions (CTOs) in a high-risk patient population is both feasible and effective, with a technical success rate of 82.5% and a clinical success rate of 75%. The study highlights the significant prevalence of cardiovascular risk factors among patients, such as hypertension, diabetes, and dyslipidemia, which are critical considerations in managing such complex cases. Subgroup analysis revealed that shorter lesions (less than 20 mm) were associated with higher technical success and lower complication rates, while longer lesions (greater than 30 mm) posed greater challenges.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (IRBEC-HMC-031/19)

Consent for publication

Approved

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Conflict of interest

The authors declared an absence of conflict of interest.

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Concept & Design of Study

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