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Incidence and Outcomes of Chronic Total Occlusion in Acute Coronary Syndrome

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ABSTRACT

Introduction: Chronic total occlusion (CTO) in acute coronary syndrome (ACS) is a very challenging clinical scenario with a higher risk of adverse outcomes. Hence, its management involves accurate assessments and sophisticated treatment methods. **Objectives**: To assess the prevalence, presentation, and prognosis of CTO in ACS to understand how percutaneous coronary intervention (PCI) affects patients. **Materials and Methods:** This study was a retrospective, consecutive, single-center observational analysis carried out in 150 patients with proven ACS who were diagnosed to have CTO at the NICVD Karachi, Pakistan in the duration from January 2024 to December 2024. Demographic data, the initial assessment of suitability for catheter ablation, procedural specifics, and further management were evaluated. A p-value of < 0.05 was used as the level of statistical significance. **Results**: The mean procedural success rate was 68% for PCI to reduce major adverse cardiac events as compared with more conservative treatment (15% vs 34%) and mortality (7% vs 20%). They noticed that collateral circulation was present in 82% of the patients, which brought down the mortality rates. **Conclusion**: PCI is associated with meaningful clinical improvement in CTO-ACS patients, but the procedure is technically demanding and requires proper preparation and experienced personnel. Therefore, these multisectoral approaches are crucial for the purpose of ensuring proper management.

INTRODUCTION

The occurrence and outcomes of CTO in ACS have become a major focus of research interest because of their prognostic implication on the ACS patient and therapeutic strategies. Patients presenting with CTOLS, defined as complete coronary artery occlusion that has lasted for more than 3 months, commonly present with ACS and face several diagnostic and therapeutic challenges (1). These occlusions contribute to a decrease in myocardial perfusion, which aggravates ischemia and raises the risk of adverse cardiovascular outcomes. Possible reasons for CTO in patients with ACS, as well as the dependence of their pathophysiology on the peculiarities of the coronary vessels, require accurate assessment and targeted management to achieve better outcomes (2). The degree of occlusion of culprit arteries in NSTEMI affects the clinical outcomes of the patients. Studies have shown that occlusion of such vessels increases the risks of myocardial infarction, low ejection fraction left ventricle function, and mortality (1). These risks could be managed by mastering sophisticated revascularization techniques like the PCI since the method enhances the rate of blood flow in the involved coronary artery and the efficiency of blood supply to myocardial tissues (3). However, mortality and complications after CTO interventions are still high because the procedure is technically challenging. Thus, proper patient evaluation and management remain vital (4).

The role of revascularization in CTO lesions is still a matter of controversy among clinicians and physicians. Data from multicenter registries demonstrate striking benefits from CTO recanalization by enhancing the signs, quality of life, as well as survival over using optimal medical treatment only (2,5). Nonetheless, these advantages should be balanced with the consideration of PCI technical challenges and deployment risks, including restenosis, stent thrombosis, and procedural failure (6). In this regard, differences in procedural success rates underscore issues of the use of appropriate equipment and operator experience and sensitivity to the condition of patients (7). The revascularization of CTOs in patients suffering from

ACS is still a subject of controversy due to the variety of factors related to prognosis. For example, elderly patients who are vulnerable to complications and have more limited physiological reserves struggle with CTO management in specific ways (9). Likewise, the prognosis of heart diseases in patients with CTOs has been linked to poorly controlled diabetes mellitus, probably because patients with diabetes mellitus have an increased rate of disease progression and microvascular complications (15). These conclusions stress the importance of taking into account patient characteristics in developing treatment plans (5, 10).

Based on the growing number of published data, better practices in performing PCI for CTOs include the use of intravascular ultrasound (IVUS). The use of IVUS as a guide increases the precision of stent placement, decreases the likelihood of stent misplacement, and optimizes long-term outcomes (8). IVUS and other imaging could also prove useful in defining characteristics of the lesion to aid in procedural strategy (7). However, the implementation of such technologies in normal clinical practice is still a challenge due to cost and resource constraints, especially in developing countries (8). The relationship between lipid metabolism profile and CTO outcomes has also drawn interest, with investigations focusing on applying the TGI and atherosclerotic index of plasma. Higher values of these indices have been linked with lower collateralization and unfavorable cardiovascular outcomes, thus promising to serve as predictive indicators when it comes to CTO therapy (11, 12). These results highlight the need for improved risk assessment and identification of new biomarkers for risk stratification in order to improve prognostication and therapeutic management (14).

Another area of study that has significant clinical application is the comparison of other antiplatelet strategies that are utilized on ACS patients with CTOs. New evidence has also been developed for comparing monotherapy with ticagrelor for ischemic and bleeding risk in high-risk patients undergoing PCI, as well as for dual antiplatelet therapy (13). This evidence supports the optimization of personalized antiplatelet therapy strategies for patients with ACS and CTOs (13). Finally, the general supervision of CTOs in relation to ACS is a promising and fast-growing research field focusing on interdisciplinarity. A brief survey of invasive coronary intervention options, imaging techniques, and risk assessment tools improves the perception of a patient population's potential and benefits, making patient care more effective. However, the same challenges remain today, for instance, how best to enhance procedural success, how to avoid complications, and most importantly, who gets equal access to advanced technologies (3, 4). Future studies have to work on these differences and enhance the current therapeutic interventions with the goal of giving patients the best treatment plan in the case of CTO in ACS (1, 5).

Objective

To evaluate the incidence, clinical features, and relevance of CTO in patients with ACS and its impact on procedure success and potential factors affecting survival for patient management.

MATERIALS AND METHODS

Study Design: This was a cross-sectional type of study designed with the aim of evaluating the frequency, manifestation, and prognosis of CTO in patients with diagnosed ACS. Data was collected from patient records, operation reports, and postoperative investigations.

Study Setting: NICVD Karachi, Pakistan.

Duration of the Study: This study was implemented from January 2024 to December 2024.

Inclusion Criteria

Patients aged 18 years and above with a confirmed diagnosis of ACS and need for coronary angiography were included. It included patients with stenosis of the coronary arteries for CTO more than three months, confirmed by angiography. All the patients in the study met the inclusion criteria and had documented medical histories of clinical characteristics, angiograms, and follow-up information.

Exclusion Criteria

Exclusion criteria included significant missing information on the patient chart, prior CABG that involved CTO vessels, and cardiogenic shock at admission. Secondly, patients who had contraindications for coronary angiography or revascularization were excluded.

Methods

Patients' data were extracted from their clinical records of those indicated for coronary angiography after being diagnosed with acute coronary syndrome (ACS) at NICVD Karachi, Pakistan. Patients with angiographically proven CTO, which refers to all levels of blockage in a coronary artery that has remained occluded for more than three months, were recruited. Demographic data, angels, previous medical history, clinical presentation, laboratory data, angiographic results, and details of the procedures were documented. The effectiveness of percutaneous coronary intervention (PCI) was measured using the following factors on the basis of which TIMI grade 3 flow was restored. Further assessment was done through outpatient practices and telephone interviews inquiring more about the major adverse cardiac events (MACE), including myocardial infarction, target vessel revascularization, and all causes of death. Data were analyzed using statistical software to compare the results between patients having successful PCI and the conservative group. A p-value <0.05 was used to determine statistical significance, which established the consistency and reliability of the findings in relation to the prognostic role of CTO in ACS.

RESULTS

The sample comprised 150 patients with ACS and objectively verified CTO by coronary angiography. The participants included 98 males (65.3%) and 52 females (34.7%) with a mean age of 58.6 ± 9.2. It was further observed that 72% of the patients suffered from on-ST segment elevation myocardial infarction (NSTEMI), while the rest, 28 percent, suffered from unstable angina. The most common comorbid diseases found in the cohort include hypertension 65%, diabetes mellitus 54%, and smoking 48%.

Table 1
Baseline Characteristics of Patients

Characteristic	Value (n = 150)
Mean age (years)	58.6 ± 9.2
Male gender (%)	65.3
Hypertension (%)	65
Diabetes mellitus (%)	54
Smoking (%)	48
NSTEMI (%)	72
Unstable angina (%)	28

These were the procedural success rate of PCI in CTO cases and successful restoration of TIMI 3 flow in these patients with a rate of 68%. On the other hand, 32 patients underwent conservative management further to procedure failure or clinical indication. PCI patients had lesser MACE during follow-up compared to conservatively managed patients (15% vs. 34%, $p < 0.05$).

Table 2
Procedural Outcomes

Outcome	Successful PCI (%)	Conservative Management (%)
Procedural success	68	-
MACE during follow-up	15	34
All-cause mortality	7	20
Target vessel revascularization	5	15

An angiographic analysis showed that the right coronary artery was occluded most often in 48% of the cases, the left anterior descending artery in 35%, and LCx in 17%. Collateral circulation was assessed in 63 of 76 patients, with better collateral grading being associated with significantly decreased MACE rates in follow-up.

Table 3
Angiographic Findings

Finding	Frequency (%)
RCA occlusion	48
LAD occlusion	35
LCx occlusion	17
Presence of collateral circulation	82

At one year of follow-up, there was a 21% overall MACE rate. The outcomes based on successful PCI were better as compared to conservative care, with fewer events like recurrent myocardial infarction and target vessel revascularization. The total mortality was 11%, most of which occurred in the conservative group. Finally, this study has shown that there are major clinical consequences from successful PCI in patients with CTO and ACS since this treatment decreases the MACE and increases survival. However, the difficulties with CTO interventions require a proper selection of patients and proper planning of the procedure.

DISCUSSION

The biggest challenge from a clinical perspective can be deemed chronic total occlusion in acute coronary syndromes because of implications for patient management and outcomes. This research offers important findings regarding the prevalence, presentation, and prognosis of CTO in ACS and the potential for PCI to enhance prognosis in patients with CTO. Several features of CTO in ACS are important to underscore based on the findings of the study, including marked procedural success and long-term outcomes depending on the chosen strategy for revascularization. In this study, the overall incidence of CTO was identified to be significantly high in ACS patients. A large proportion of patients with NSTEMI also underlines the significance of the assessment and the management of CTO in these patients. Previous research has established that a totally occluded culprit artery has an impact on the unfavorable clinical prognosis that is characterized by the increased risk of recurrent myocardial infarction, ventricular dysfunction as well as mortality (1, 2). These outcomes are in line with the present study that showed patients with CTO, especially the conservative approach, had a significantly higher rate of MACE.

The overall procedural success rate of PCI in our cohort was 68% which is consistent with the previous studies done in a similar population (3, 4). Thus, successful PCI was significantly linked to a considerable decrease in both MACE and overall mortality within the 12-month follow-up period. This study again emphasizes the significance of revascularization in reducing the ischemic load and enhancing myocardial flow in patients with CTO. Importantly, the restoration of TIMI grade 3 flow in successfully treated patients was associated with significant clinical improvements, such as low rates of target vessel revascularization and recurrent myocardial infarction. This has emphasized the efficacy of PCI in the treatment of this high-risk group of patients with ACS (5, 6). However, it is imperative to remember that the examinations of CTO interventions are not simple endeavors as presented above illustrates. This has been evidenced by procedural failure in 32 % of the cases, proving the technical issues that accompany CTO PCI, particularly in segment crossing and the possibility of procedural complications (7). Operator experience, accessibility of sophisticated instruments, and the specifics of an individual patient's case, including the kind of lesion and concomitant diseases, significantly influence the outcomes of the operation. This highlights the significance of individualized Management of CTO focusing on neurovascular access planning, deselecting appropriate strategy, and using IVUS as a robust tool to enhance procedural success (8).

The angiographic findings of this study contribute to the further understanding of CTO in patients with ACS. This trend of RCA, LAD, and LCx artery occlusion is in accordance with earlier findings (9). The collateral circulation was observed in the majority of cases and was shown to be beneficial in terms of protective effect on the myocardial perfusion due to the total occlusion. These observations raise the possibility that collateral development might act as a prognostic indicator favorable in patients with CTO and ACS and indicate the necessity of future research to identify ways of improving collateral formation. A second difficult task of CTO management in ACS is the interaction between patient characteristics comorbidities, and clinical outcomes. This study also revealed a high proportion of patients with hypertension, diabetes mellitus, and smokers, all of which may predispose them to CAD (12,13). Diabetes mellitus particularly claimed poor outcomes, attributable to the

primary effect on microvascular integrity and nitinol atherosclerosis. These findings also support the need for dealing with all the available data regarding risk factors to improve the outcome of people with CTO (14, 15).

This comparison of outcomes of successful PCI with conservative management underlines the inefficiency of medical therapy only in this population. Despite constituting a vital therapeutic approach in patients with ACS, medical therapy cannot effectively address the issue of CTO in terms of restoring the patency of the coronary vessel and improving ischemia. This calls for the application of a risk-benefit paradigm to revascularization, especially in patients who are at high risk for the procedure or possess comorbid conditions (5, 7). The application of new approaches in CTO treatment and the additional pharmacological methods, including antiplatelet and lipid-lowering therapy, can also improve CTO treatment outcomes (13, 14). Further efforts should also be directed toward ensuring fair distribution of new revascularization procedures in regard to equipment and training, especially in developing countries. Despite the efficacy of CTO PCI, the accessibility of expertise and instruments for carrying out the procedures remains a constraint in many areas, thus making the overall implementation of CTO PCI a challenge. Efforts to train people in healthcare, increase accessibility to newer technologies, and create effective solutions that do not incur exorbitant costs are going to help tackle these issues to ensure patients with CTOs get the right quality of service (4, 9).

Based on the results of the current investigation, there are some important implications for clinical practice. First, they emphasize the significance of initial evaluation and risk assessment of patients with ACS and CTO and subsequent interventions. Second, they emphasize that CTO management should be performed with the involvement of an interventional cardiologist, imaging specialists, and the other members of the managing team. Lastly, they urge further study to shape future revascularization management, discover new therapeutic options, and analyze the prospect of advanced biomarkers (10, 12). Finally, this study gives strong evidence for the role of CTO as a clinical marker predictive of adverse outcomes in ACS and the possible advantages of PCI to reduce the risk of this group of patients. Despite the fact that several imperative issues related to CTO interventions have not altered significantly now, technology, imaging and pharmacological options portray the unexplored potential of CTO intervention to provide upgraded quality for these patients. There is a need to improve the procedural complexity, access disparity, and effects of comorbidities in future research for the improvement of CTO management and patients.

CONCLUSION

The present work aims to demonstrate the crucial role of chronic total occlusion in acute coronary syndrome in terms of outcome prognosis and management complexities. The use of percutaneous coronary intervention (PCI) has now become an important approach to achieving better results, and MACE and total mortality rates were significantly lower among the groups receiving PCI. This study further mandates the need for a proper assessment of the patients alongside the design of medical management plans dependent on patient characteristics like the presence of other chronic diseases, the nature of the lesions, and the risks involved in the procedure. Nonetheless, PCI has numerous advantages despite technical difficulties and comparably low outcomes in some instances, qualified operators, enhanced devices, and preliminary assessment. Thus, the involvement of collateral circulation as a protective factor and comorbidities like diabetes mellitus as indicators of prognosis redefines the concept of interprofessional collaboration. Future directions should be concerned with improving the practice of revascularization, increasing the availability of these procedures, and reducing the disparities to capture the best for these vulnerable patients.

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