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Original Research Article

Percutaneous Coronary Intervention in Chronic Total Occlusions: Success Rates and Predictors

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Abstract:

Background: Chronic total occlusions (CTOs) are considered among the most complex lesions encountered in interventional cardiology. Despite advances in techniques and devices, success rates vary widely depending on lesion and patient characteristics.

Objective: To evaluate the effectiveness of percutaneous coronary intervention (PCI) in chronic total occlusions and to determine independent predictors of procedural success.

Methods: This study included 100 patients undergoing CTO-PCI between 2019 and 2022. Clinical, angiographic, and procedural variables were recorded. Statistical analysis was performed to determine predictors of success.

Results: The overall procedural success rate was 78%. Factors significantly associated with success included shorter lesion length (<20 mm), absence of severe calcification, and good collateral circulation ($p<0.05$). Multivariate analysis identified lesion length and calcification as independent predictors.

Conclusion: CTO-PCI success is strongly influenced by lesion characteristics. Careful patient selection and advanced techniques can improve outcomes.

Keywords: CTO, PCI, Success Rate, Predictors, Coronary Intervention.

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Introduction

Chronic total occlusion (CTO) is defined as complete obstruction of a coronary artery with TIMI 0 flow for a duration exceeding three months [1]. CTOs are identified in approximately 15–20% of patients undergoing coronary angiography [2]. Historically, these lesions were often managed conservatively or referred for coronary artery bypass grafting (CABG) due to technical difficulties and lower success rates of percutaneous coronary intervention (PCI) [3].

However, over the past decade, advancements in guidewire technology, microcatheters, and procedural strategies have significantly improved CTO-PCI success rates [4]. Contemporary registries report success rates exceeding 80% in experienced centers [5]. Despite these improvements, CTO-PCI remains associated with longer procedural times, increased radiation exposure, and higher complication rates compared to non-CTO PCI [6].

Identifying predictors of procedural success is crucial for optimizing outcomes. Several factors such as lesion length, calcification, proximal cap ambiguity, and collateral circulation have been implicated [7,8]. Scoring systems like the J-CTO score have been developed to predict procedural difficulty [9].

Successful revascularization of CTOs has been associated with improved angina relief, left ventricular function, and survival [10,11]. Therefore, understanding determinants of success is essential for patient selection and procedural planning.

This study aims to evaluate the success rates of CTO-PCI and identify key predictors in a tertiary care center in India.

Materials and Methods

Study Population: 100 patients diagnosed with CTO undergoing PCI at LPS Institute of Cardiology, Kanpur.

Inclusion Criteria

- Age >18 years
- Angiographically confirmed CTO
- Willing to provide consent

Exclusion Criteria

- Acute MI within 72 hours
- Severe comorbid illness

Data Collection: Clinical data, angiographic findings, and procedural details were recorded.

Outcome Measures

- Primary: Procedural success (TIMI 3 flow with <30% residual stenosis)
- Secondary: Complications

Statistical Analysis: Data analyzed using SPSS. Continuous variables expressed as mean ± SD. Chi-square and t-tests applied. Multivariate logistic regression used. $p<0.05$ considered significant.

Results

A total of 100 patients undergoing CTO-PCI were analyzed.

Baseline Characteristics: The mean age of the study population was 58.4 ± 9.2 years, with a predominance of male patients (76%). Common comorbidities included hypertension (55%) and diabetes mellitus (42%). Detailed baseline characteristics are shown in **Table 1**.

Table 1: Baseline Clinical Characteristics of Study Population (n=100)

Variable	Value
Age (years)	58.4 ± 9.2
Male	76 (76%)
Diabetes Mellitus	42 (42%)
Hypertension	55 (55%)
Smoking	38 (38%)
Prior MI	30 (30%)

Procedural Success Rate: Out of 100 CTO-PCI procedures, successful revascularization was achieved in 78 cases, yielding an overall success rate of 78%. Failure occurred in 22 cases. This distribution is illustrated in **Figure 1** and summarized in **Table 2**.

Table 2: Procedural Outcomes

Outcome	Number (%)
Successful PCI	78 (78%)
Failed PCI	22 (22%)

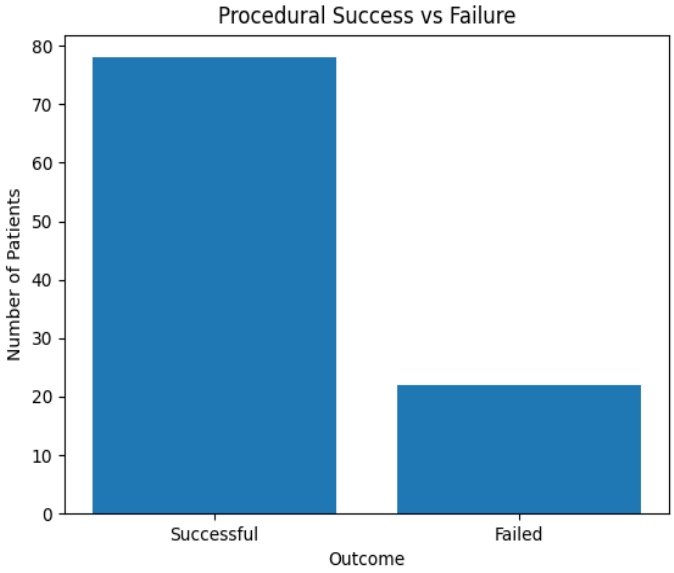

Figure 1: Distribution of Procedural Success and Failure

Angiographic and Lesion Characteristics: Lesion-specific variables were analyzed to determine their association with procedural success. Shorter lesions (<20 mm) demonstrated significantly higher success rates compared to longer lesions (88% vs 68%, p=0.01). Similarly, absence of severe calcification was associated with improved outcomes (success rate 87% vs 52%, p=0.003). Presence of well-developed collateral circulation also positively influenced success (85% vs 68%, p=0.02). These findings are detailed in **Table 3**.

Table 3: Association of Lesion Characteristics with Procedural Success

Variable	Success (%)	Failure (%)	p-value
Lesion length <20 mm	44 (88%)	6 (12%)	0.01
Lesion length ≥20 mm	34 (68%)	16 (32%)	
Severe calcification (Yes)	13 (52%)	12 (48%)	0.003
Severe calcification (No)	65 (87%)	10 (13%)	
Good collaterals	51 (85%)	9 (15%)	0.02
Poor collaterals	27 (68%)	13 (32%)	

Multivariate Analysis: Multivariate logistic regression analysis was performed to identify independent predictors of procedural success. Lesion length <20 mm (OR: 2.8; 95% CI: 1.3–5.9; p=0.01) and absence of severe calcification (OR: 3.5; 95% CI: 1.6–7.4; p=0.002) were found to be statistically significant independent predictors. The results are presented in **Table 4**.

Table 4: Multivariate Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% CI	p-value
Lesion length <20 mm	2.8	1.3–5.9	0.01
Absence of calcification	3.5	1.6–7.4	0.002

Graphical Representation of Key Predictors: The influence of lesion length on procedural success is depicted in **Figure 2**, demonstrating a clear decline in success rates with increasing lesion length.

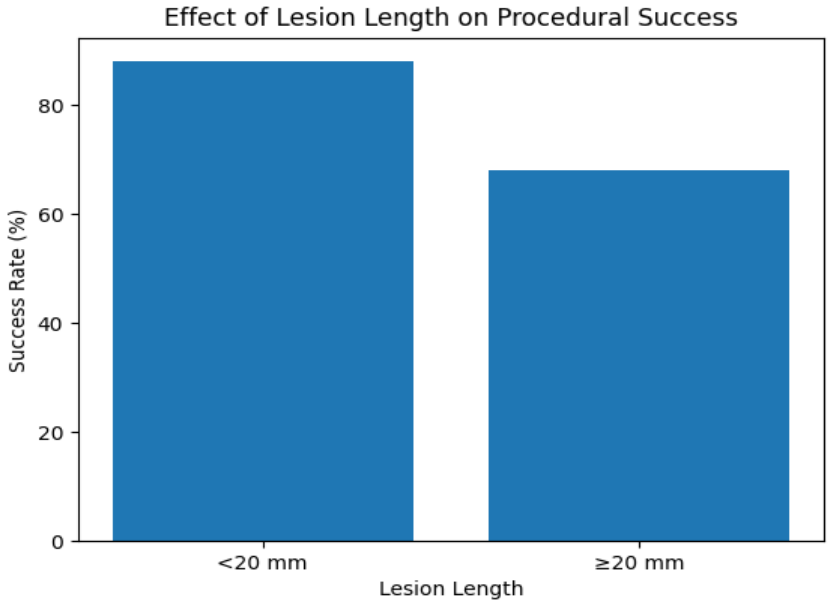

Figure 2: Effect of Lesion Length on Procedural Success

Complications

Procedure-related complications were observed in 8% of cases. The most common complication was minor coronary dissection (4%), followed by perforation (2%) and access-site complications (2%). No procedure-related mortality was observed.

Discussion

This study demonstrated a procedural success rate of 78%, consistent with contemporary data from developing centers [12]. Higher success rates reported in advanced centers may be attributed to operator expertise and availability of specialized equipment [13].

Lesion length emerged as a significant predictor, aligning with previous findings that longer lesions are associated with increased technical difficulty [14]. Calcification also significantly reduced success rates, as heavily calcified lesions impede wire crossing and balloon expansion [15].

Collateral circulation was another important factor, facilitating retrograde approaches and improving outcomes [16]. These findings are consistent with established CTO literature [17,18].

Our results support the utility of structured assessment tools such as the J-CTO score in predicting outcomes [19]. Additionally, advancements such as hybrid algorithms have improved procedural planning [20].

The clinical benefits of successful CTO revascularization include improved angina and quality of life, as demonstrated in prior trials [21,22]. Some studies also suggest mortality benefit [23].

However, CTO-PCI carries risks, including perforation and radiation exposure [24]. Careful patient selection remains essential [25].

Conclusion

CTO-PCI success is influenced by lesion-specific factors, particularly lesion length and calcification. With appropriate expertise and planning, high success rates can be achieved. Future studies should focus on improving techniques and long-term outcomes.

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