



INTRAVASCULAR ULTRASOUND GUIDED WIRING RE-ENTRY TECHNIQUE IN MANAGING COMPLEX CHRONIC TOTAL OCCLUSIONS

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ABSTRACT

Background and Aim: Chronic total occlusions (CTOs) encountered in coronary angiography procedures pose a considerable contemporary challenge. Intravascular ultrasound (IVUS) emerges as a valuable asset in CTO, assisting in the attainment of successful outcomes. The utilization of intravascular ultrasound (IVUS) can prove beneficial in directing the subintimal guidewire back into the true lumen. This current study assessed the IVUS guidance wiring re-entry technique in managing complex chronic total occlusion (CTO) lesions.

Patients and Methods: This study encompassed 18 CTOs patients who underwent the IVUS-guided wiring re-entry technique in the department of cardiology, Lady Reading Hospital, Peshawar from February 2021 to February 2022. All the patients had a minimum of one chronic total occlusion (CTO) lesion and met the criteria for CTO lesion recanalization. A complete occlusion for >3 months within the blocked segment was considered as CTO. It guided the positioning of an additional inflexible wire to return to the genuine inner vessel channel, relying on either the neighboring side branch or the initial wire as points of reference, or utilizing the IVUS-guided parallel wire method.

Results: The overall mean age of the patients was 67.6 ± 10.7 years. Of the total 18 patients, there were 17 (94.4%) male and 1 (5.6%) female. A total of two patients, constituting 11.1% of the study cohort, had experienced prior unsuccessful attempts at vascularizing their chronic total occlusions (CTOs). The left ventricular ejection fraction and mean length of the occluded segment was 50.6 ± 11.4 and 62.8 ± 24.3 mm respectively. Among the patients studied, the morphology of the CTO stump was characterized as blunt in 16 individuals, making up 88.9% of the cases. Additionally, 12 patients (66.7%) exhibited moderate to severe calcification, while 10 patients (55.6%) had bridging collaterals. The IVUS guided wiring re-entry success rate was 88.9% (n=16 cases). The procedure did not result in any complications.

Conclusion: The present study found that the use of the IVUS-guided wire re-entry technique can assist the effective reopening of these CTO lesions while minimizing the occurrence of significant complications. Furthermore, this approach could potentially be related to favorable long-term clinical outcomes.

Keywords: Complex chronic total occlusions, IVUS-guided wiring re-entry technique, percutaneous coronary intervention

INTRODUCTION

Coronary artery disease (CAD) stands as the third leading global cause of mortality [1, 2]. Despite significant advancements in percutaneous coronary intervention (PCI), the presence of chronic total occlusions (CTO) during coronary angiography, which occurs in approximately 16-18% of cases, continues to present a formidable challenge in contemporary medicine. This challenge encompasses both technical and clinical aspects [3, 4]. Over the years, the field has witnessed the evolution of new materials, antegrade and retrograde approaches, and a notable enhancement in operator expertise. As a result, the success rate of CTO-PCI now approaches 90% [5, 6]. Among the array of tools and devices available for percutaneous coronary intervention (PCI), intravascular ultrasound (IVUS) proves to be exceptionally valuable, particularly in the context of chronic total occlusions (CTOs). The advantages of IVUS in CTO cases have been well-established over the years [7, 8].

Percutaneous coronary intervention (PCI) aimed at treating chronic total occlusion (CTO) cases establishes a significant portion, accounting for approximately 15% of all PCI procedures [9]. Numerous studies have highlighted the symptomatic and prognostic advantages associated with the successful reopening of CTO lesions. This success has the potential to enhance angina symptoms and improve long-term outcomes and survival [10]. In terms of achieving success in CTO PCI, an effective wiring technique is pivotal. Nonetheless, an earlier investigation indicated the association of retrograde approach with increasing risk of complications, which might necessitate the use of longer stents [11]. However, the effectiveness and safety of this approach have not been thoroughly investigated. Therefore, this current study assessed the clinical viability and effectiveness of employing IVUS guidance for the wiring re-entry technique in managing CTOs lesions.

METHODOLOGY

This study encompassed 18 CTOs patients who underwent the IVUS-guided wiring re-entry technique in the department of cardiology, Lady Reading Hospital, Peshawar from February 2021 to February 2022. All the patients had a minimum of one chronic total occlusion (CTO) lesion and met the criteria for CTO lesion recanalization. A complete occlusion for >3 months within the blocked segment was considered as CTO. It guided the positioning of an additional inflexible wire to return to the genuine inner vessel channel, relying on either the neighboring side branch or the initial wire as points of reference, or utilizing the IVUS-guided parallel wire method. The revascularization criteria included: angina that did not respond adequately to pharmacological therapy; symptoms induced by physical exercise; or evidence of myocardial ischemia triggered by exercise. Patients with no MI and experiencing ACS (acute coronary syndrome) opted for surgical intervention were excluded.

SPSS version 27 was used for the descriptive statistics. Numeric variables were presented as mean and standard deviation (SD), while categorical variables were expressed as counts and percentages. Comparisons of continuous variables between different groups were performed using Student's t-test. For categorical data, comparisons between two groups were made using the Chi-square test when appropriate. A statistical significance threshold of $p < 0.05$ was applied to determine significance in the results.

RESULTS

The overall mean age of the patients was 67.6 ± 10.7 years. Of the total 18 patients, there were 17 (94.4%) male and 1 (5.6%) female. A total of two patients, constituting 11.1% of the study cohort,

had experienced prior unsuccessful attempts at vascularizing their chronic total occlusions (CTOs). The left ventricular ejection fraction and mean length of the occluded segment was 50.6 ± 11.4 and 62.8 ± 24.3 mm respectively. Among the patients studied, the morphology of the CTO stump was characterized as blunt in 16 individuals, making up 88.9% of the cases. Additionally, 12 patients (66.7%) exhibited moderate to severe calcification, while 10 patients (55.6%) had bridging collaterals. The IVUS guided wiring re-entry success rate was 88.9% (n=16 cases). The procedure did not result in any complications. Table-1 shows the baseline characteristics of patients. Figure-1 illustrates the types of IVUS-guided wiring technique. Calcified lesions (mild, moderate, and severe) are depicted in Figure-2. Figure-3 illustrate the CTOs lesion sites. The angiographic characteristics of the lesions and specific details of the percutaneous coronary intervention (PCI) is shown Table-II.

Table-I Baseline details of patients

Parameters	Mean ± SD
Age (years)	67.6 ± 10.7
Gender N (%)	
Male	17 (94.4)
Female	1 (5.6)
BMI (kg/m ²)	24.8 ± 3.8
Smoking status N (%)	11 (61.1)
Co-morbidities N (%)	
Diabetes	4 (22.2)
Hypertension	12 (66.7)
Hypercholesterolemia	10 (55.6)
Congenital heart failure	4 (22.2)
Peripheral Arterial Occlusive Disease	0 (0.0)
Cerebrovascular accident	3 (16.7)
End Stage Renal Disease	0 (0.0)
Laboratory Parameters	
Low density lipoprotein	102.4 ± 28.6
High density lipoprotein	39.7 ± 12.6
Triglycerides	197.2 ± 96.0
Creatinine	1.09 ± 0.5
Hemoglobin (g/dL)	12.9 ± 1.6

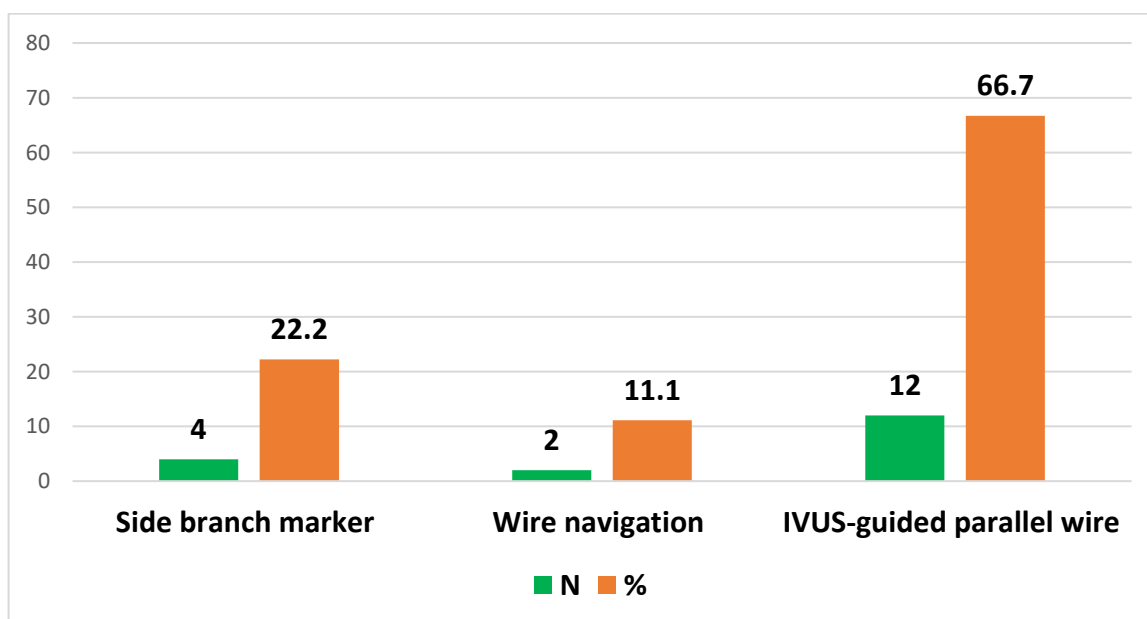


Figure-1 types of IVUS-guided wiring technique

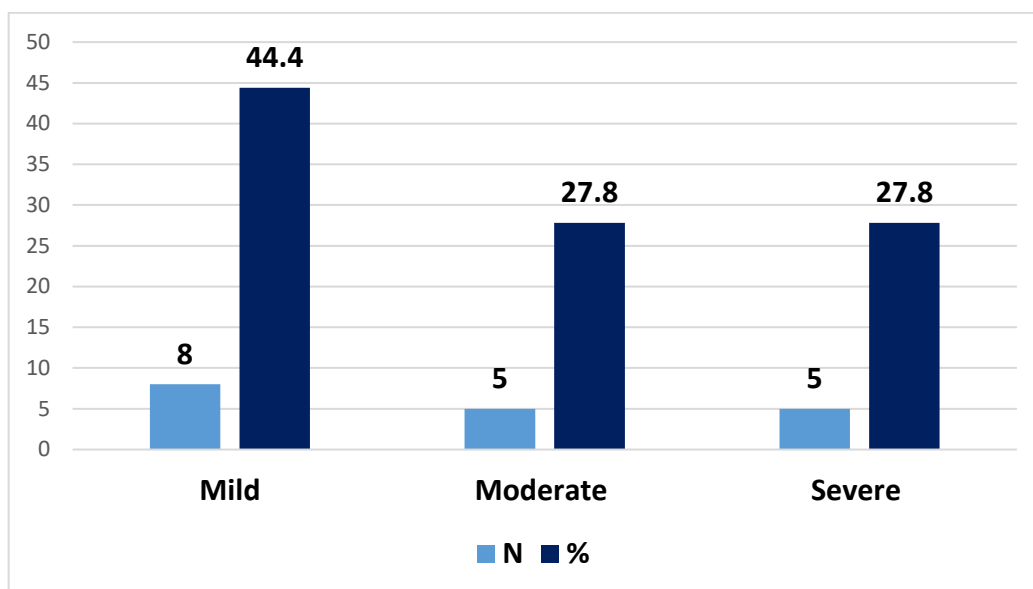


Figure-2 Calcified lesions (mild, moderate, and severe)

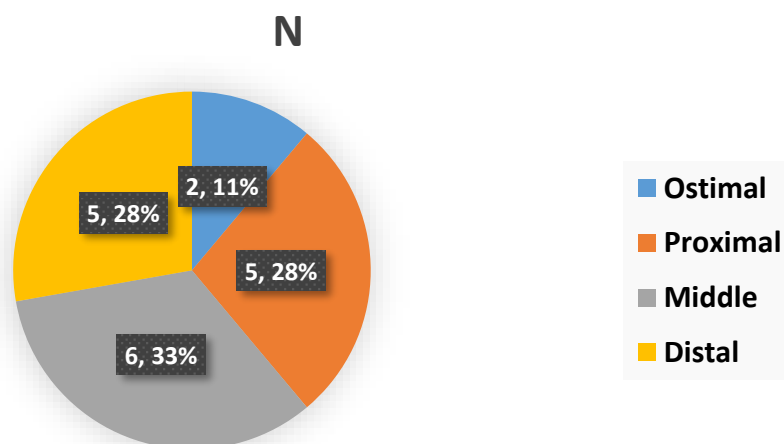


Figure-3 CTOs lesion sites

Table-II angiographic characteristics of the lesions and specific details of the percutaneous coronary intervention (PCI)

Characteristics	N (%)
Recanalization status	
Successful	16 (88.9)
Failed	2 (11.1)
Bridging collaterals	
Yes	10 (55.6)
No	8 (43.4)
CTO Stump	
Tapering	2 (22.2)
Blunt	16 (77.8)
CTO Length (mean ± SD, mm)	62.8 ± 24.3
Stent profile	
Drug-eluting	17 (94.4)
Bare-metal	1 (5.6)
TIMI flows	
0	1 (11.1)
1	1 (11.1)
2	0 (0)
3	16 (77.8)

DISCUSSION

The present study mainly focused on the assessed the clinical viability and effectiveness of employing IVUS guidance for the wiring re-entry technique in managing these complex CTOs lesions. This holds true even when the use of an intravascular ultrasound (IVUS) catheter is required prior to guidewire crossing. The method outlined in this study, although considered the last resort in our catheter laboratory, enhances the probability of achieving technical success in PCI for CTOs that are initially challenging to cross. Employing various tips and strategies, it is possible to achieve a high success rate, minimize major complications, and potentially attain a favorable outcome [12, 13]. While retrograde and hybrid approaches have significantly improved the success rates of recanalizing chronic total occlusions (CTOs) [14-16]. In challenging CTO cases, the antegrade guidewire often enters the subintimal space, even when employing the parallel wire technique. Moreover, extensive manipulation of the guidewire typically results in expansion of subintimal space, leading to the reduction in perfusion to the distal myocardium, often culminating in procedure failure [17, 18].

IVUS serves the purpose of verifying the guidewire's location and distinguishing between the false and true lumen. Notably, the separation of the true lumen related intimal plaque from the subintimal space tends to be more resistant to the penetration of a stiff guidewire. Consequently, if the guidewire enters the subintimal space, it is more probable for it to advance within the distal subintimal space rather than achieving successful re-entry into the true lumen [19, 20].

Stumpless chronic total occlusion (CTO) lesions that include a side branch originating from the occluded segment have been associated with a reduced success rate in percutaneous coronary intervention (PCI) [21]. Harding et al. previously described a technique known as the "side-branch method," involving the withdrawal of the intravascular ultrasound (IVUS) catheter from the CTOs lesions entry point location associated with side branch. They subsequently endeavored to introduce an additional rigid guidewire at the occlusive sites while monitoring it in real-time with IVUS imaging [22]. In our cases, we consistently apply this approach when a side branch emerges from the CTO lesions. Nonetheless, it's crucial to acknowledge that manipulating a second stiff guidewire can occasionally pose challenges, including potential interference causing damage to the IVUS catheter during the procedure.

We also took care to manipulate the guidewire carefully and ensure it remained within the vessel before pre-dilation. Subintimal pre-dilation was performed exclusively with a small balloon catheter. Furthermore, it's important to note that long dissections were frequently encountered after IVUS-guided wire re-entry PCI [23-26]. There have been only a few studies that compared IVUS-guided and angiography-guided CTOs, and these studies have typically involved an inadequate sample size [27, 28].

In summary, IVUS plays a crucial role in enhancing the safety and effectiveness of PCI procedures for CTO lesions by providing detailed anatomical information, guiding wire and stent placement, and improving long-term outcomes. Its use can contribute to higher procedural success rates and reduced complication rates in this challenging subset of patients. Furthermore, it's worth noting that the additional insights provided by IVUS may have influenced the adoption of more personalized techniques, although capturing this aspect technically presents challenges in traditional clinical studies [29].

In an effort to consolidate all available data, a meta-analysis, which revealed that routine IVUS use in CTO-PCI does not lead to improvements in clinical outcomes such as major adverse cardiovascular events (MACE), all-cause mortality, myocardial infarction (MI), or cardiovascular mortality. Indeed, it has been observed that the use of intravascular ultrasound (IVUS) can significantly reduce the incidence of stent thrombosis. IVUS provides valuable information during percutaneous coronary intervention (PCI) procedures, helping to optimize stent placement and ensure proper stent expansion and apposition to the vessel wall. This enhanced precision in stent deployment can contribute to improved long-term outcomes, including a lower risk of stent thrombosis, which is a serious complication associated with incomplete stent apposition or

malapposition, under-expansion, and other stent-related issues. By reducing the incidence of stent thrombosis and ultimately benefiting patient outcomes [30].

CONCLUSION

The present study found that the use of the IVUS-guided wire re-entry technique can facilitate the effective reopening of these CTO lesions while minimizing the occurrence of significant complications. Furthermore, this approach could potentially be related to favorable long-term clinical outcomes.

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