Antegrade versus retrograde approach for recanalization of ostial or stumpless coronary chronic total occlusion

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Abstract

Background

Data on the procedural and in-hospital clinical effects of the antegrade-only and retrograde methods for ostial or stumpless CTO PCI are scarce.The purpose of this research was to assess the procedural and in-hospital clinical results of percutaneous coronary intervention (PCI) for ostial or stumpless chronic total occlusion (CTO) using both the antegrade-only and retrograde approaches.

Methods

We performed a retrospective analysis of the procedural and in-hospital clinical effect of 89 consecutive patients who received ostial or stumpless CTO PCI at our institution between April 2015 and October 2022.

Results

The antegrade-olny method had a higher technical success rate(92.0% vs.71.9%,p = 0.041) and procedural success rate(92.0% vs.68.8%,p = 0.022) compared to the retrograde approach (RA) .The RA group had a substantially greater Japanese-CTO (J-CTO) score than the antegrade only approach group (2.45 ± 0.73 vs. 1.64 ± 0.70, p < 0.001). Lesion length of 20 mm or more was notably more prevalent in the RA group than the antegrade-only group (73.4% vs. 28.0%, p < 0.001). The antegrade-only approach group exhibited a higher incidence of microchannels at the proximal stump compared to the RA group (56.0% vs. 10.9%, p < 0.001). In-hospital major adverse cardiac events (MACE) and in-hospital myocardial infarction (MI) were more frequently observed in the RA cases (18.8% vs. 0, p = 0.003; 15.6% vs. 0, p = 0.008). The J-CTO score of less than 2 and the presence of microchannels at the proximal stump were identified as predictors for successful antegrade-only approach PCI for ostial or stumpless CTO (OR: 2.79 [95% CI: 1.92–5.03, P = 0.003]; OR: 2.89 [95% CI: 1.32–6.03, P = 0.001]).

Conclusions

Compared to RA PCI for ostial or stumpless CTO, the antegrade only approach is utilized for less complex CTO lesions and omes with a reduced likelihood of in-hospital MACE and complications.

Introduction

Recanalization of coronary chronic total occlusion (CTO) improves heart function and paitent’s long-term survival[1, 2]. Despite the complexity and high failure risk associated with percutaneous coronary intervention (PCI) for CTO, advancements in devices, experience, and techniques have led to improved success rates[3]. Failure to successfully navigate the guidewire into the true lumen remains the primary reason for unsuccessful CTO PCI[4, 5]. Ostial or stumpless CTOs represent a distinct subset of CTOs that pose ongoing challenges in terms of revascularization[6], as it can be difficult to accurately locate the entrance of the CTO, with the guidewire often slipping into a side branch. To address this, the intravascular ultrasound (IVUS) catheter can be stretched to the CTO lesion's side branch using the initially positioned first wire, and then drawn back until the IVUS visualizes the CTO cap's entrance point[7]. Maintaining the position of the IVUS provides the advantage of real-time vessel imaging, enabling the visualization of the CTO-dedicated guidewire entering the true lumen of the proximal cap[8]. Additionally, the IVUS device and technique can assess the morphology of the proximal stump, aiding the operator in selecting the appropriate wire and significantly improving the success rate of the second wire, ideally entering centrally[9]. Comparatively, IVUS-guided CTO recanalization has demonstrated enhanced clinical outcomes and a potential reduction in MACE when compared to angiography-guided CTO recanalization[10, 11]. While retrograde techniques have contributed to increased overall success rates of CTO-PCI, antegrade-only procedures have demonstrated higher technical and procedural effectiveness costs, as well as reduced in-hospital major negative cardiac event rates as compared to retrograde procedures. The current study compared the features and procedural results of ostial or stumpless CTO-PCI performed using the antegrade-only method versus the retrograde.

Materials and methods

1.Research population

The current paper was retrospectively completed as a single-center research study involving 89 consecutive patients with 89 lesions who underwent PCI for ostial or stumpless CTO at Xiangtan Central Hospital from April 2015 to October 2022 (Fig. 1). All patients included in the study had a single native vessel CTO. The current study was carried out in accordance with the tenets mentioned in the Helsinki Declaration and was approved by the Ethical Board of Xiangtan Central Hospital. Prior to the commencement of the research, our team obtained written informed consent from each patient.

2.Definition

A coronary CTO was characterized as a complete obstruction of a cardiovascular defined with thrombolysis in myocardial infarction (TIMI) 0 antegrade flow, exhibiting a length of manifestations or prior angiography or a history of myocardial infarction (MI) in a specific region supplied by the blocked channel[12], and with an approximate age of ≥ 3 months. The indication for these procedures was angina in combination with verified myocardial viability and/or ischemia within the territory supplied by the target vessel. Technical success denoted the restoration of TIMI 3 blood flow accompanied by a residual stenosis of less than 30%. Procedural success entailed technical success without incurring any MACE during the hospital stay. MACE comprised of death, MI, repeat target vessel revascularisation (TVR), cerebral vascular accident, and instances requiring pericardiocentesis or surgical repair due to tamponade. The in-hospital events were evaluated in order to detect major complications, which included any MACE events that occurred ahead of hospital discharge. A retrograde procedure was every effort to traverse the retrograde way, regardless of success. It was declared secondary when the contractor anticipated an antegrade crossing but had to divert to a retrograde approach (RA) owing to antegrade failure.

3.Procedure description

A soft-tipped guidewire is carefully inserted into the neighboring side branch of the CTO, while a 40-MHz rotational IVUS catheter (Opticross^{tm}, Boston Scientific, America) is advanced into the side branch originating from the proximal stump site. The IVUS pullback procedure alone allows for identification and assessment of the proximal cap of the CTO. A microchannel located at proximal cap of the CTO is defined as a low echogenicity structure situated at the center of proximal cap of the CTO (Fig. 2). The IVUS catheter is positioned at the CTO's entrance, and a dedicated CTO-PCI wire is pushed into the CTO's proximal stump using microcatheters. Additionally, we provide an algorithm for the successful crossing of the CTO (Fig. 3).IVUS imaging is performed following guidewire crossing and pre-dilation using a compliant balloon ranging from 1.5 to 2.0 mm.Ultimately, balloon dilatation and stent implantation are performed following evaluation of the CTO using IVUS.

4.Statistical analysis

Variables were provided as mean ± SD, and as percentages for categorical variables. For categorical variables, the chi-square or Fisher's exact tests were utilized, while for continuous variables, the Student's t-test was used. To identify clinical, procedural, and angiographic parameters related with technical success in antegrade-only CTO PCI, a logistic regression analysis was performed. Our multivariable analysis included parameters that exhibited a significant difference in the univariate logistic analysis. IBM SPSS Statistics 24.0 (America) was employed for every statistical evaluation. Statistical significance was determined by two-sided p-values of 0.05.

Results

1.Patient Characteristics

In the present investigation, 89 patients with 89 ostial or stumpless CTOs were included. Among them, 25 patients underwent an exclusive antegrade-only approach for CTO-PCI, while 64 patients underwent a RA CTO-PCI. The fundamental clinical characteristics are extensively elucidated in Table 1. Upon comparing the antegrade-only approach group and the RA group, it was ascertained that no statistically significant disparities were observed in terms of age, age exceeding 75 years, male gender, and body mass index. The coronary artery disease (CAD) risk variables exhibited a similar pattern between the groups, including hypertension, diabetes mellitus, family history of CAD, and current smoking. The incidence of comorbidities, including a history of MI and stroke, exhibited similarities between the two groups. Furthermore, no noteworthy distinctions were discerned in left ventricular ejection fraction, blood lipid levels, clinical presentation, and the presence of multivessel disease between the two groups.

Table 1
Baseline clinical characteristics

Variables	Antegrade only(n = 25)	Retrograde(n = 64)	Total(n = 89)	p Value
Age(years)	63.36±7.54	65.22 ± 6.60	64.70 ± 6.88	0.254
Age >75years ,n(%)	3(12.0)	6(9.4)	9(10.1)	0.716
Male ,n(%)	17(68.0)	38(59.4)	55(61.8)	0.452
Prior PCI ,n(%)	2(8.0)	10(15.6)	12(13.5)	0.322
History of myocardial infarction ,n(%)	12(48.0)	27(42.2)	39(43.8)	0.619
Hypertension ,n(%)	13(52.0)	39(60.9)	52(58.4)	0.442
Diabetes mellitus ,n(%)	6(24.0)	19(29.7)	25(28.1)	0.592
Triglycerides (mmol/L)	1.46 ± 0.66	1.50 ± 0.90	1.49 ± 0.84	0.825
Total cholesterol (mmol/L)	4.16 ± 0.88	3.91 ± 1.08	3.98 ± 1.03	0.307
HDL-C (mmol/L)	1.13 ± 0.40	1.15 ± 0.36	1.14 ± 0.36	0.861
LDL-C (mmol/L)	2.82 ± 1.05	2.45 ± 0.92	2.56 ± 0.93	0.105
Family history of CAD,n(%)	12(48.0)	28(43.8)	40(44.9)	0.717
Current smokers,n(%)	9(36.0)	14(21.9)	23(25.8)	0.171
Clinical presentation,n(%)				0.891
ACS	7(28.0)	17(26.6)	24(27.0)	
SAP	18(72.0)	47(73.4)	65(73.0)	
LVEF (%)	51.52 ± 6.51	51.08 ± 8.42	51.20 ± 7.90	0.814
LVEF ≦ 40%,n(%)	2(8.0)	9(14.1)	11(12.4)	0.435
BMI	23.41 ± 3.15	22.93 ± 3.41	23.07 ± 3.33	0.545
Stroke,n(%)	2(8.0)	7(10.9)	9(10.1)	0.680
Multivessel disease,n(%)	8(32)	19(29.7)	27(30.3)	0.831

LVEF,left ventricular ejection fraction;BMI,body mass index;CAD,coronary artery disease;SAP,stable angina pectoris;ACS,acute coronary syndrome;LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol;

2.CTO characteristics

The angiographic and interventional procedure features (Table 2). The J-CTO (Japanese-CTO) score was substantially greater in the RA group compared to the antegrade-only approach group(2.45 ± 0.73 vs.1.64 ± 0.70,$p<0.001$). When compared to the antegrade-only approach group, the incidence of J-CTO scores more than 3 was significantly more prevalent in the RA group (51.6% vs. 12.0,$p = 0.001$). Conversely, the incidence of J-CTO scores of 1 was far fewer in the RA group than in the antegrade-only approach group (9.4% vs. 48.0%, $p<0.001$), with no significant difference observed in the incidence of J-CTO scores of 2 (40.0% vs. 40.6%, $p = 0.957$). Among the components of the J-CTO score, the presence of lesion length of 20 or more (≧ 20) was particularly more common in the retrograde group than the antegrade-only group (73.4% vs. 28.0%, $p<0.001$).

Table 2
Angiographic and interventional procedure characteristics

Variables	Antegrade only(n = 25)	Retrograde(n = 64)	Total(n = 89)	p Value
Target CTO vessel,n(%)				0.903
LAD,n(%)	11(44.0)	25(39.1)	36(40.4)	
LCX,n(%)	4(16.0)	12(18.8)	16(18.0)	
RCA,n(%)	10(40.0)	27(42.2)	37(41.6)	
J-CTO score	1.64 ± 0.70	2.45 ± 0.73	2.22 ± 0.81	<0.001
0,n(%)	0	0	0	-
1,n(%)	12(48.0)	6(9.4)	18(20.2)	<0.001
2,n(%)	10(40.0)	26(40.6)	36(40.4)	0.957
≧ 3,n(%)	3(12.0)	33(51.6)	36(40.4)	0.001
stump morphology,n(%)	61(100)	108(100)	169(100)	-
lesion length ≧ 20 mm,n(%)	7(28.0)	47(73.4)	54(60.7)	<0.001
calcification,n(%)	7(28.0)	28(43.8)	35(39.3)	0.172
Segment bending > 45°,n(%)	2(8.0)	15(23.4)	17(19.1)	0.075
re-try lesions,n(%)	0	3(4.7)	3(3.4)	0.155
Technical success,n(%)	23(92.0)	46(71.9)	69(77.5)	0.041
Procedure duration (min)	76.04 ± 22.58	92.06 ± 16.30	87.56 ± 19.54	<0.001
Fluoroscopy time (min)	44.48 ± 17.39	56.97 ± 16.05	53.46 ± 17.28	0.002
Contrast volume (ml)	171.45 ± 95.31	279.2 ± 128.02	223.54 ± 89.43	<0.001

LAD,left anterior descending; LCX,left circumflflex;RCA,right coronary artery;CTO, chronic total occlusion; J-CTO ,Japanese multicenter registry;

3.Procedural Characteristics and IVUS findings

The technical success rates for the 89 CTOs were determined to be 77.5%. The antegrade-only approach exhibited a success rate of 92.0%, whereas the RA showed a success rate of 71.9% (p = 0.041). When compared to the antegrade-only approach group, the procedure length, fluoroscopic time, and contrary volume were considerably longer and greater in the RA group (92.06 ± 16.30 vs. 76.04 ± 22.58,p<0.001;56.97 ± 16.05 vs. 44.48 ± 17.39,p = 0.002;171.45 ± 95.31 vs. 279.2 ±

128.02,p<0.001,respectively) (Table 2). Regarding the antegrade-only approach group exhibited a higher prevalence of microchannels at the proximal stump compared to the RA group (56.0% vs. 10.9%, p<0.001) (Fig. 4). the antegrade-only approach group exhibited a higher prevalence of calcification in CTO lesion compared to the RA group (73.9% vs. 47.8%,p = 0.032). Nevertheless, no noteworthy variations were observed between the two groups in terms of maximum plaque burden post-balloon before stenting, hematoma before stenting, minimum stent area (MSA) within the stent or CTO, the number of stents used, and the total stent length (Table 3).

Table 3
IVUS findings in successfully recanalized CTO lesions

Variables	Antegrade only(n = 23)	Retrograde(n = 46)	Total(n = 69)	p Value
Maximum plaque burden post-balloon before stenting(%)	87.35 ± 5.25	89.26 ± 4.95	88.62 ± 5.09	0.142
Hematoma before stenting,n(%)	3(13.0)	14(30.4)	17(24.6)	0.114
Calcification in CTO lesion,n(%)	11(47.8)	34(73.9)	45(65.2)	0.032
MSA in entire stent(mm^2)	5.87 ± 0.63	5.94 ± 0.58	5.92 ± 0.59	0.639
MSA in CTO segment(mm^2)	6.19 ± 0.69	6.47 ± 0.57	6.38 ± 0.62	0.084
Number of stents implanted in target CTO vessel,n(%)	2.22 ± 0.60	2.46 ± 0.66	2.38 ± 0.64	0.147
Total stent length(mm)	62.17 ± 20.56	69.39 ± 20.89	66.99 ± 20.91	0.178

CTO, chronic total occlusion;IVUS, intravascular ultrasound;MSA,minimum stent area.

4.In-hospital outcomes and major adverse cardiac event

The in-hospital outcomes and major adverse cardiac events between two groups are summarized in Table 4. The antegrade only approach group had substantially greater procedural success rates than the RA group (92.0% vs.68.8%,p = 0.022). Major adverse cardiac event (MACE) in the hospital was more prevalent in the RA group than in the antegrade-only approach group (18.8% vs. 0, p = 0.003). In-hospital MI developed in 10 cases(15.6%,p = 0.008), cerebral vascular accident developed in 1 case(1.6%,p = 0.415),and tamponade in 1 case (1.6%,p = 0.415) in RA group. There were 3 coronary perforation (p = 0.155) occurred in RA group.

Table 4
In-hospital outcomes and major adverse cardiac events.

Variables	Antegrade only(n = 25)	Retrograde(n = 64)	Total(n = 89)	p Value
Procedural success,n(%)	23(92.0)	44(68.8)	67(75.3)	0.022
MACE,n(%)	0	12(18.8)	12(13.5)	0.003
Death	0	0	0	
Myocardial infarction	0	10(15.6)	10(11.2)	0.008
Repeat target vessel revascularisation	0	0	0	
Cerebral vascular accident	0	1(1.6)	1(1.1)	0.415
Tamponade	0	1(1.6)	1(1.1)	0.415
Stent thrombosis,n(%)	0	0	0	
In-hospital CABG,n(%)	0	0	0	
Acute renal failure,n(%)	0	0	0	
Perforation,n(%)	0	3(4.7)	3(3.4)	0.155

MACE, major adverse cardiac event; CABG,Coronary artery bypass grafting;

5.Predictors of antegrade only approach success

Table 5 provides insights on the predictive capabilities of certain factors for the success of antegrade-only approach PCI in ostial or stumpless CTOs. It is observed that a J-CTO score of less than 2 was able to predict the success of antegrade-only approach in treating these CTOs (P = 0.031). Similarly, the presence of microchannels at the proximal stump showed a 3.47-fold increased likelihood (95% CI: 1.09–8.31, P = 0.001) of successful antegrade-only approach for PCI in ostial or stumpless CTOs. On the contrary, the presence of calcification within the CTO lesion was found to predict failure of the antegrade-only approach for ostial or stumpless CTO-PCI (P = 0.026). Table 6 presents the parameters included in the multivariable analysis, considering significant differences identified in the univariate logistic analysis. It is noted that a J-CTO score of less than 2 and the presence of microchannels at the proximal stump were identified as predictors for the success of antegrade-only approach in PCI for ostial or stumpless CTOs (P = 0.003, P = 0.001, respectively).

Table 5
Univariate analysis for antegrade-only approach technical success

Variables	OR	95%CI	p Value
Age	0.43	0.06–2.73	0.324
Age >75years	0.97	0.89–1.22	0.459
Male	1.95	0.51–7.92	0.561
Prior PCI	1.48	0.39–5.87	0.601
History of myocardial infarction	2.43	0.64–7.89	0.179
Hypertension	1.56	0.54–5.31	0.489
Diabetes mellitus	1.04	0.31–3.19	0.891
Family history of CAD	0.68	0.26–2.68	0.634
Current smokers	0.79	0.21–3.47	0.578
Clinical presentation	2.09	0.78–9.97	0.154
LVEF (%)	1.09	0.97–1.32	0.891
BMI	1.32	0.72–3.31	0.539
Stroke	1.19	0.21–4.98	0.719
Multivessel disease	0.71	0.17–3.21	0.412
J-CTO score	2.01	0.65–6.43	0.117
J-CTO score<2	3.92	1.12–10.32	0.031
J-CTO score ≧ 3	0.49	0.35–5.32	0.614
lesion length ≧ 20 mm	0.91	0.02–5.99	0.111
calcification	1.35	0.22–2.59	0.173
Segment bending > 45°	0.99	0.81–1.79	0.412
Maximum plaque burden post-balloon before stenting	1.61	0.51–3.21	0.494
Hematoma before stenting	0.77	0.39–2.03	0.399
Calcification in CTO lesion	0.32	0.19–3.03	0.026
Microchannel at proximal stump	3.47	1.09–8.31	0.001

LVEF,left ventricular ejection fraction;BMI,body mass index;CAD,coronary artery disease;CTO, chronic total occlusion;J-CTO ,Japanese multicenter registry;

Table 6
Multivariate predictors for antegrade only approach technical success

Variables	OR	95%CI	p Value
J-CTO score<2	2.79	1.92–5.03	0.003
Calcification in CTO lesion	0.91	0.32–1.83	0.184
Microchannel at proximal stump	2.89	1.32–6.03	0.001

CTO, chronic total occlusion;J-CTO,Japanese multicenter registry;

Discussion

The following are the main findings of the current study on ostial or stumpless CTO-PCI, comparing the antegrade-only technique versus the RA technique: (a) patients undergoing antegrade-only approach CTO-PCI exhibited lower complexity of CTO lesions compared to patients undergoing RA CTO-PCI; (b) antegrade-only strategy CTO-PCI revealed a greater percentage of technical and procedural success, as well as a reduced chance of in-hospital MACE; (c) the determinants for achieving antegrade-only technical success in ostial or stumpless CTO-PCI were identified as J-CTO score < 2 and the presence of microchannel at the proximal stump.

The J-CTO score for antegrade only approach in ostial or stumpless CTO PCI

The antegrade wiring approach represents the prevailing wire crossing technique in contemporary CTO-PCI, constituting the final crossing strategy in over 50% of successful CTO-PCIs [13]. Our current statistical research also demonstrated that the antegrade-only strategy had a greater rate of technical and procedural success than the RA group. However, it is worth noting that the RA group exhibited a higher complexity of CTO lesion morphology when assessed using the J-CTO score (2.45 ± 0.73 vs. 1.64 ± 0.70, $p < 0.001$). This finding indicates that the successful implementation of the antegrade-only approach is correlated with the J-CTO score in ostial or stumpless CTO-PCI. The RA is frequently employed in cases involving higher J-CTO score CTO lesions. For instance, Karmpaliotis et al. (18) investigated 1301 cases that underwent CTO PCI and found that the retrograde group exhibited significantly greater complexity (mean J-CTO score: 3.1 ± 1.0 vs. 2.1 ± 1.2; $P < 0.001$) and lower technical success rates compared to the antegrade-only group (85% vs. 94%; $P < 0.001$). Similarly, Suzuki et al. (3) observed that among 2846 consecutive CTO-PCI procedures, the primary antegrade group had a considerably higher technical success rate than the primary retrograde group (91.0% vs. 87.3%; $p < 0.0001$). The J-CTO scores of the primary retrograde group were much greater than those of the primary antegrade group (1.9 ± 1.1 vs. 2.4 ± 1.1; $p < 0.001$). Notably, a multicentre registry conducted by Eugene et al.[14] also demonstrated a higher technical success rate in the antegrade-only group (95.9% vs.91.2% ,$p = 0.03$) and lower J-CTO score(2.5 ± 1.2 vs. 3.4 ± 1.0,$p < 0.001$). Megaly et al.[15]conducted an analysis of

12 observational studies involving 10240 patients and found that CTO lesions treated with the antegrade-only approach had a lower J-CTO score (1.9 vs.2.8, $p < 0.001$) and were associated with a higher success rate (87.4% vs. 80.9%, $p < 0.001$).The OPEN-CTO registry[16], demonstrated that retrograde procedures were performed on CTOs with higher morphological complexity and J-CTO scores (2.7 vs. 1.9, $p < 0.001$), resulting in an overall lower technical success rate compared to antegrade-only procedures (82.4% vs. 94.2%, $p < 0.001$). To rate the challenge of CTO-PCIs, an estimation rule centered around J-CTO scores has been devised [17]. Furthermore, a hybrid algorithm for CTO-PCIs has indicated that cases involving complex morphological CTOs tend to favor the RA[18].

Microchannel at proximal stump for antegrade only approach in ostial or stumpless CTO PCI

In our analysis, the prevalence of microchannel at the proximal stump was higher in the antegrade-only approach compared to the RA. Additionally, our study revealed that the presence of microchannels at the proximal stump serves as a positive predictor for the successful performance of ostial or stumpless percutaneous CTO-PCI. A commonly held viewpoint suggests that following the occurrence of coronary occlusion, thrombosis progresses in an upward direction towards the bifurcation of the side branch[19, 20]. Based on autopsy analysis, the CTO body predominantly consists of organized thrombus with microchannels, characterized by small lumens within the CTO lesion, averaging 200μm in size, and connecting the proximal and distal caps[21]. According to the antegrade loose tissue tracking concept, the wire traverses the CTO lesions by following the path of the microchannels and loose tissue[22]. Based on this theory, the presence of microchannels within CTO lesions may significantly influence the success of wire crossing in CTO-PCI. The utilization of IVUS-guided wiring techniques may prove beneficial in identifying the precise entry point of occlusion in stumpless CTO cases, while also confirming the wire puncture into the microchannel at the proximal cap.

In-hospital MACE

Several observational studies and RCT [23–25] have found that effective CTO PCI is related with higher standards of life, decreased need for CABG, improved left ventricular function, and reversal remodeling of the left ventricle when compared to unsuccessful revascularization. The retrograde method is now critical in achieving high success rates, especially in complicated lesions where the antegrade approach is either technically impossible or unsuccessful[13]. When compared to the antegrade-only technique in CTO-PCI, the retrograde strategy has been tied to greater rates of in-hospital MACE, target vessel revascularization, and target vessel failure [15, 26, 27]. Our analysis also demonstrated higher rates of in-hospital MI in the RA group compared to the antegrade-only approach, suggesting that the increased occurrence of periprocedural MI may be associated with the complexity of RA CTO PCI. Furthermore, our research revealed that in-hospital MACE was more common in the RA group compared to the antegrade-only approach group. Consistent with the findings of the OPEN-CTO registry, the RA group exhibited higher rates of in-hospital MACE compared to the antegrade-only approach group (10.8% vs 3.3%, $p < 0.001$) [16]. A comprehensive meta-analysis found that retrograde patients had a greater likelihood of periprocedural MI, the requirement for urgent pericardiocentesis, and contrast-induced nephropathy as compared to antegrade-only cases[15]. Patients in the retrograde group often present with more complex CTOs, and failed revascularization may contribute to worse in-hospital outcomes. The PROGRESS-CTO complication scores, which aid in calculating the level of periprocedural complication danger in patients going through CTO PCI, are based on eight criteria (age, gender, calcification status, stump, left ventricular ejection fraction, prior CABG, atrial fibrillation, crossing strategy). These results show that the retrograde technique and blunt stump are both related with an increased risk of in-hospital MACE[28].

Limitation

First, this was a single center experience retrospective observational study with a limited patient number .Second, some possible selection bias may have existed in patient selection. Third, only in-hospital outcomes were evaluated in this study. Fourth,The microchannel in the present study have not been validated by pathological examination.More researches on substantial lesions are required to analyze the coherence between the IVUS discoveries and pathology.The longer-term impact should be evaluated in ongoing study.New forward-looking technologies and devices are hope to improve the success rate of ostial or stumpless CTO-PCI.

Conclusion

In contrast to the RA in PCI for ostial or stumpless CTO, the antegrade-only approach is employed in less intricate CTO lesions and is linked to a reduced risk of in-hospital MACE and complications. Notably, a J-CTO score of less than 2 and the presence of a microchannel at the proximal stump have been identified as predictors for the successful implementation of the antegrade-only approach in PCI for ostial or stumpless CTO. More research is needed to evaluate the immediate and long-term results of ostial or stumpless CTO-PCI.

Declarations

Ethics approval and consent to participate

The current study was carried out in accordance with the tenets mentioned in the Helsinki Declaration and was approved by the Ethical Board of Xiangtan Central Hospital. Prior to the commencement of the research, our team obtained written informed consent from each patient.

Consent for publication

Not applicable. No individual patient data will be reported.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

XW: Conceptualization (equal);writing – original draft (lead); formal analysis (lead); and writing – review and editing (lead). **MXW:** Data Curation (lead); writing, review, and editing (equal). **HBH:**Formal Analysis (equal); writing, review, and editing (equal). **ZL:**Investigation (lead). **QZZ:**Data Curation (equal);writing, review, and editing (equal). **ZL:**Data Curation (equal). **JC:** Writing, reviewing, and editing (equal). **HH:**Conceptualization (lead);writing, review, and editing (lead).

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Figures

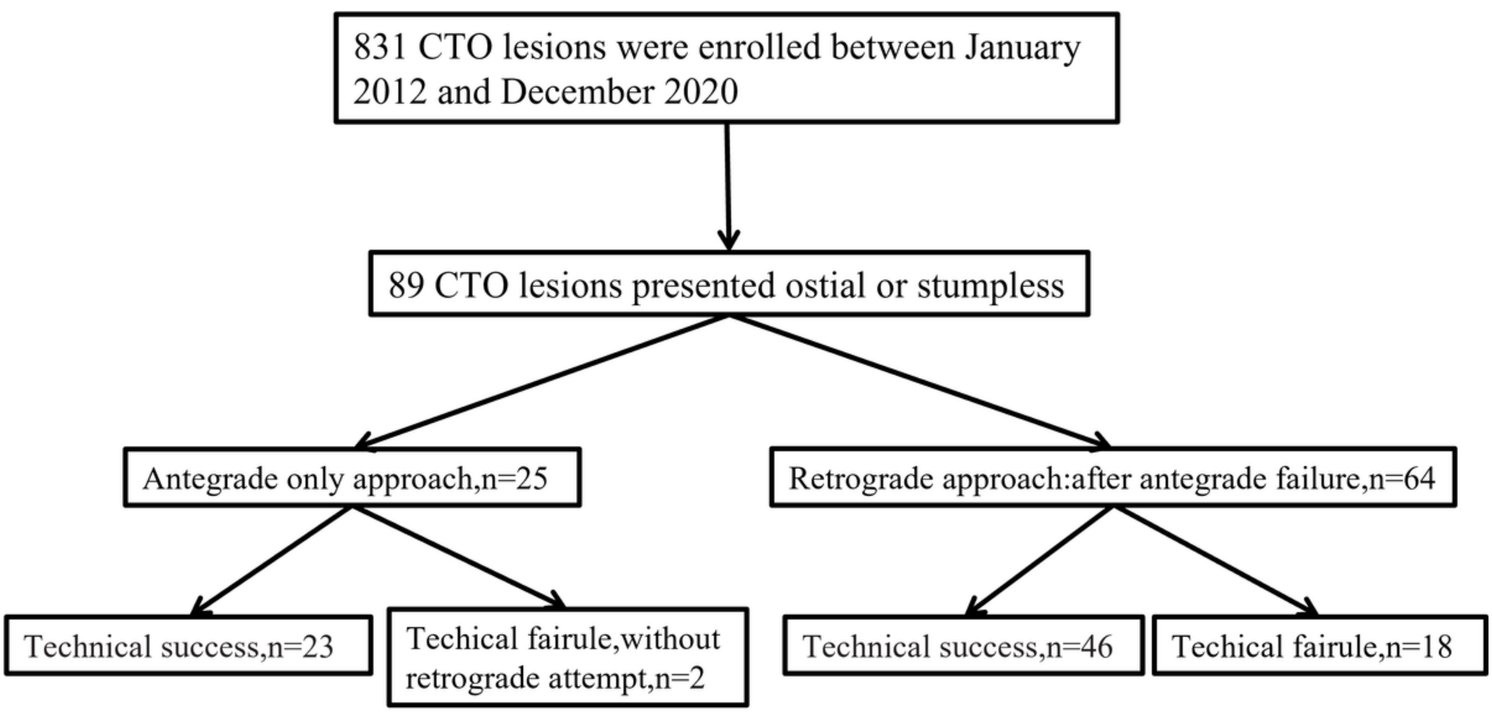

Figure 1

The study flow chart

CTO, chronic total occlusion;

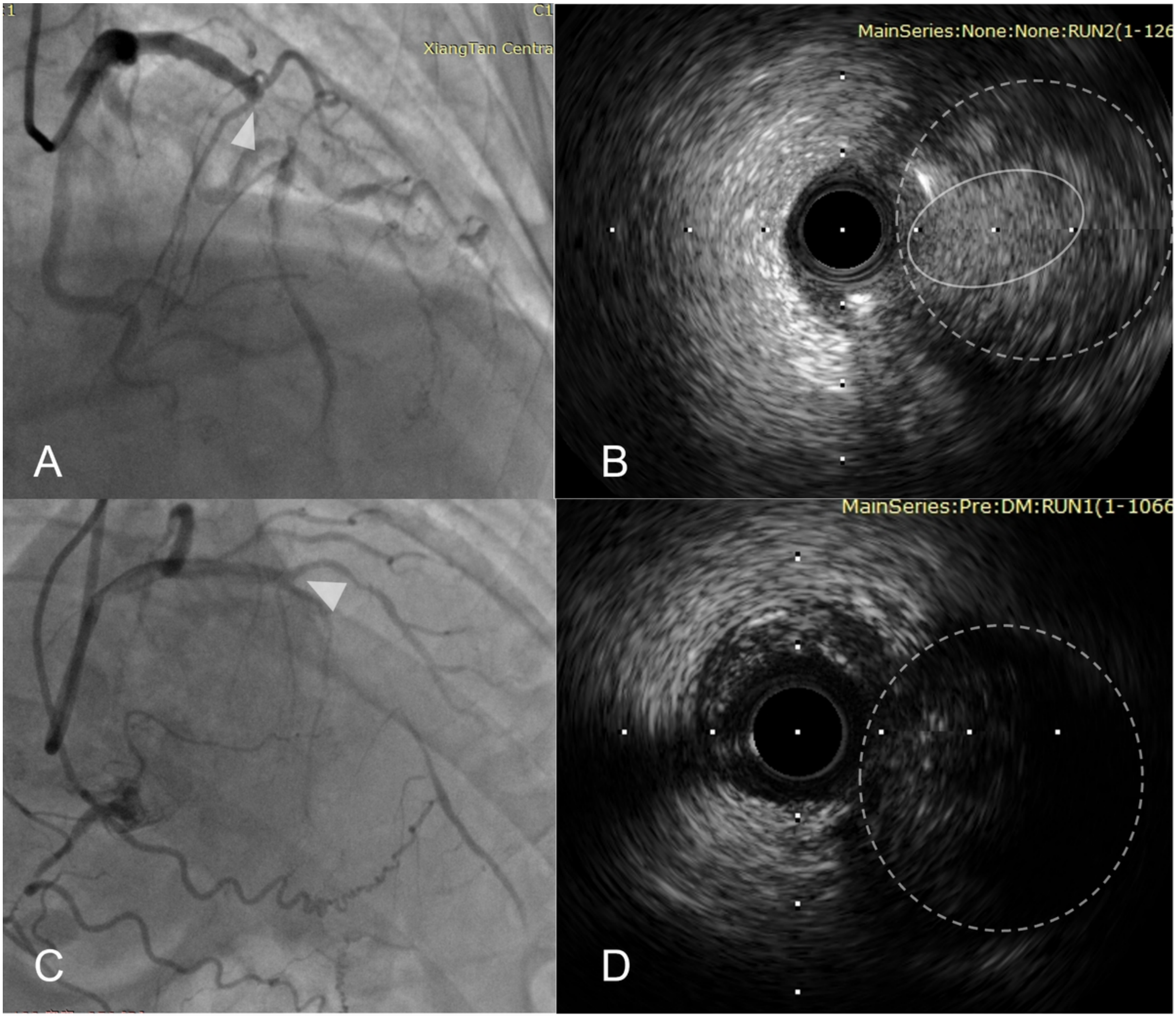

Figure 2

Intravascular ultrasound image of microchannel at proximal stump:

A :A left anterior descending artery was totally occluded. A 40-MHz IVUS catheter (Opticross^{tm}, Boston Scientific, America) pullback from the sidebranch identifies the ostium of the CTO(white arrow).

B:microchannel (a low echogenicity structure,dotted circle)at the proximal stump(solid circle).

C and D:A left anterior descending totally occluded artery(white arrow) and without microchannel at the proximal stump(solid circle).

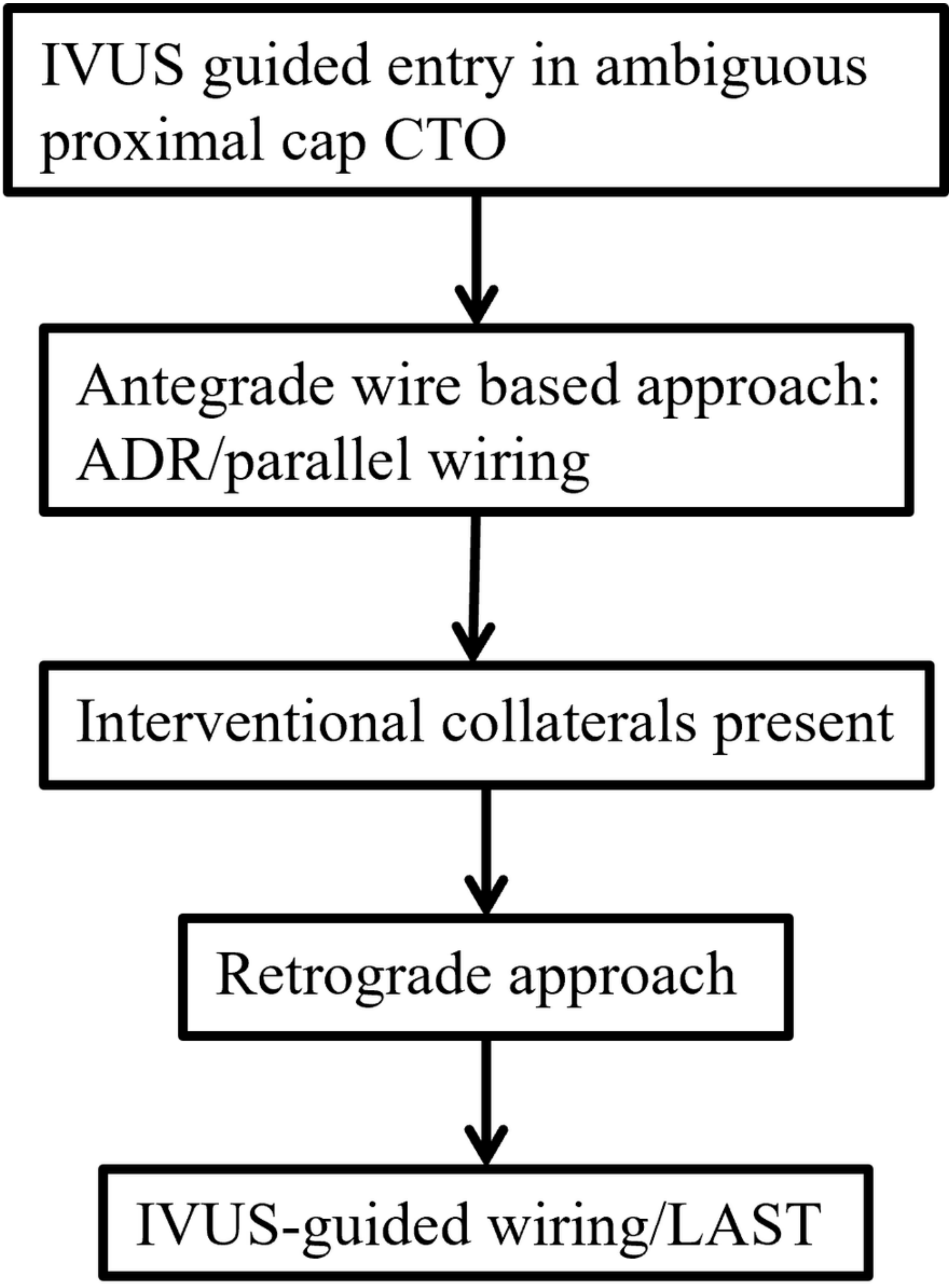

Figure 3

Algorithm for chronic total occlusion crossing

IVUS, intravascular ultrasound;CTO, chronic total occlusion; ADR,antegrade dissection/reentry;LAST,limited antegrade subintimal tracking.

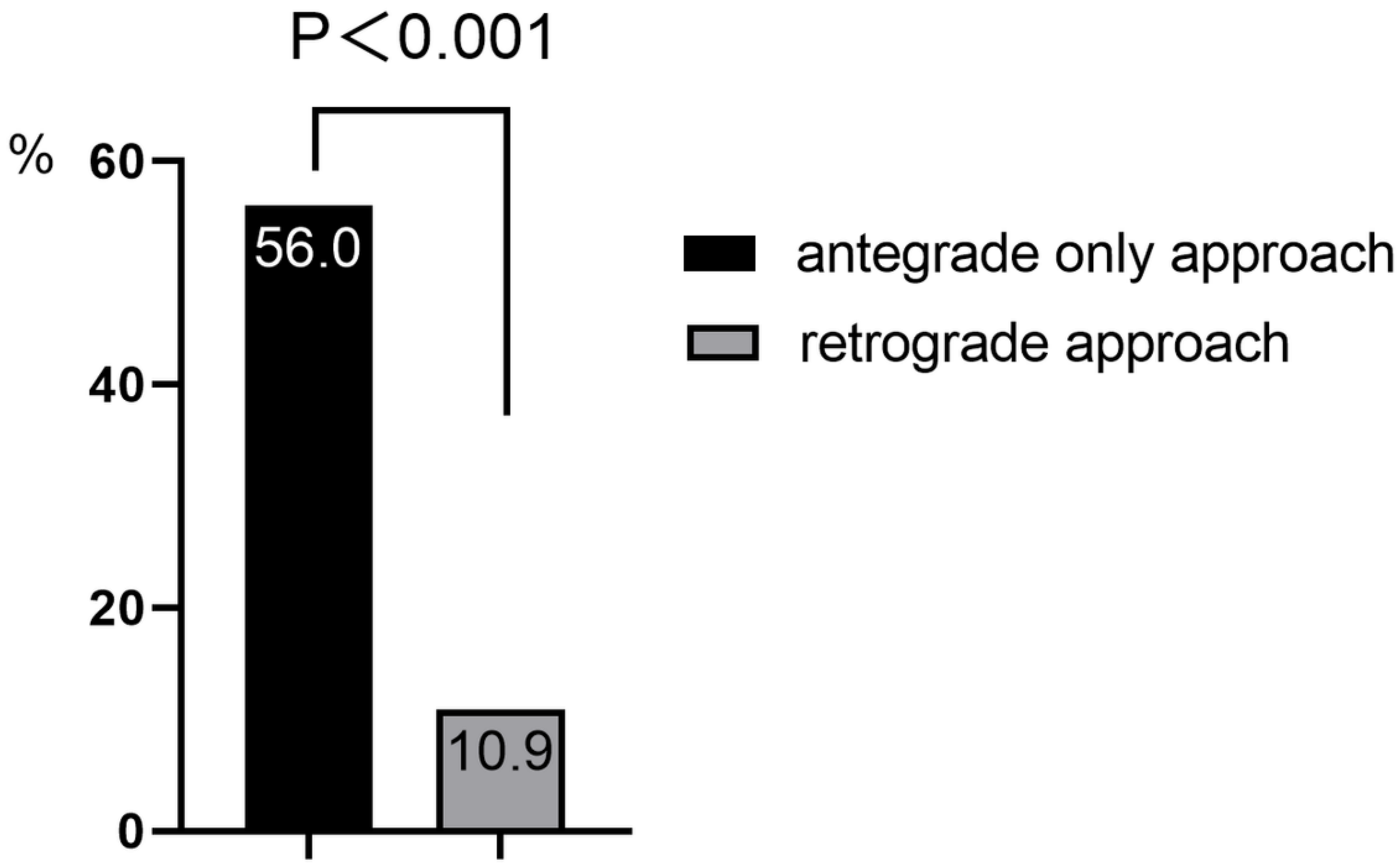

Figure 4

Antegrade only approach group had more microchannel at proximal stump than retrograde approach group,56.0%(n=14) vs. 10.9%(n=7),p 0.001.