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Outcomes With Retrograde Versus Antegrade Approach in Chronic Total Occlusion Revascularization

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ABSTRACT

The retrograde approach is considered a paradigm shift development in CTO PCI and has become an integral part of the contemporary CTO PCI armamentarium. It increases the success rates but also carries a risk of complications and should, therefore, be used cautiously by experienced operators and centers. The aim of the current study was to compare efficacy and safety of the antegrade and retrograde approaches to determine the best type of approach for CTO-PCI. The study included 60 patients as a comprehensive sample, diagnosed with chronic total occlusion proven by at least with one radiological method either CT coronary angiography scan or Coronary angiography. Complete history taking, physical Examination, 12 lead ECG and conventional transthoracic echocardiography were performed to all patients. Patients were then divided into two groups one with antegrade approach and the other group with retrograde approach, both groups were followed up to detect Primary endpoints during hospital admission were in-hospital mortality, myocardial infarction (MI), need for urgent revascularization, need for urgent pericardiocentesis, contrast-induced nephropathy, procedural success, procedural time, fluoroscopy time, and contrast volume. Secondary endpoints which start after hospital discharge and last for 6 months included long-term outcomes: all-cause mortality, MI, target lesion revascularization (TLR), and target vessel revascularization (TVR). There was no statistically significant difference between both groups regarding ECG findings. Concerning the 2D Transthoracic Echo measures of the studied groups, there was no statistically significant difference between both groups regarding 2D transthoracic Echo measures including EF and WMSI. The predominant occluded vessel of antegrade approach group was LAD artery (50%), meanwhile, that of retrograde approach group was RCA (63.3%). There was a statistically significant difference in the type of CTO vessel between both groups. The success rate was significantly higher in patients subjected to retrograde approach than those subjected to antegrade approach (90% vs. 66.7%, p=0.028). However, the retrograde approach took significantly longer procedure time, fluoroscopy time and more contrast volume than the antegrade approach. Regarding the primary outcome during hospital stay, there was no statistically significant difference between both groups regarding the incidence of mortality, MI, CIN, need for urgent revascularization and pericardiocentesis. During follow up of the patients for 6 months after discharge, no statistically significant difference was detected between both groups as regard the secondary endpoints. The incidence of all-cause mortality was 13.3% for the antegrade approach group and 10% for the retrograde approach, incidence of MI was 13.3% for antegrade approach and 10% for retrograde approach. Furthermore, the incidence of TLR was 23.3 for the antegrade approach and 16.7% for the retro grade approach and finally the incidence of TVR was 10% for the antegrade approach and 13.3% for the retrograde approach. So we can safely conclude that the retrograde approach can be frequently used as the primary CTO-PCI strategy, especially for more complex CTO lesions and reattempts procedures. However careful follow up is highly recommended during and after the retrograde approach for PCI to CTO vessels.

Keywords: Retrograde Approach; Antegrade Approach; Chronic Total Occlusion Revascularization

Introduction

Percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) lesions are still one of the most challenging subsets **(1).** Although its success rate has gradually improved in recent years as new techniques and devices for CTO-PCI have been developed **(2).**

Chronic total occlusions were defined as a lesion with thrombolysis in myocardial infarction (TIMI) grade 0 flow for at least 3 months duration, clinically estimated based on onset of angina symptoms, history of myocardial infarction, or documentation on invasive or computer tomography angiography **(3).**

The introduction of retrograde CTO crossing techniques was instrumental in increasing CTO PCI success rates from <70% to nearly 90% Some, but not all, studies have reported that the retrograde approach is associated with longer procedural time, increased use of contrast and fluoroscopy, and higher incidence of periprocedural and possibly long-term adverse cardiac events **(4).**

Nevertheless, considering that about two-thirds of patients with CTO have multi-vessel disease (MVD), the procedure is not always as successful as it is desired **(5).** In patients with 3-vessel disease who presented with non-ST-elevation myocardial infarction, CTO of a non-infarct-related artery was independently associated with 12-month mortality **(6).**

Complex coronary artery disease has negative impacts on procedural success rates and clinical outcomes in patients undergoing CTO-PCI **(6).** Moreover, ischemia of donor artery for CTO territory during PCI leads to broad ischemia of the myocardium. On the other hand, patients with MVD show a more pronounced survival benefit of CTO recanalization despite their increased baseline risk and the observed lower procedural success rates **(7)**.

Therefore, this study aimed to evaluate the efficacy and safety of retrograde versus antegrade approach in revascularization of chronic total occlusion.

Patients and Methods

This observational cohort study was carried out in Cardiology Department, Zagazig University Hospitals and Police Hospitals from January 2023 to January 2024. During the study period (12 months), 60 cases who met the inclusion and exclusion criteria were included as a comprehensive sample.

Inclusion criteria:

Patient with age between 18 to 80 years old. Patients with chronic total occlusions which defined as a lesion with thrombolysis in myocardial infarction (TIMI) grade 0 flow for at least 3 months duration **(3).**

Exclusion criteria:

Patients with impaired renal and liver function, acute coronary syndrome, decompansated heart failure, refractory arrhythmia, indicated for open heart surgery, patient Refusal, severe anemi, coagulopathy

Ethical Consideration:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Written informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Steps of performance and techniques used:

All patients diagnosed with chronic total occlusion proved by at least with one radiological method either CT coronary angiography scan or Coronary angiography were undergone to:

1- **Complete history taking.**
2- **Physical Examination.**
3- **Electrocardiographic examination:** For detection of new ischemic changes (ST segment changes, hyperacute T wave, T wave inversions), previous ischemia (pathological Q waves) or arrhythmias.
4- **CT coronary angiography or Coronary angiography:** Obtained on hospital admission. Chronic total occlusions defined as a lesion with thrombolysis in myocardial infarction (TIMI) grade 0 flow for at least 3 months duration **(3).**
5- **Transthoracic Echo:** Echo is obtained on hospital admission using 2D and M-Mode measures to detect regional wall motion abnormality (by eyeballing based on the 16–Segments model of the LV. Through this model, the culprit coronary artery could be identified), wall motion score index (obtained by diving the regional wall motion score by the number of segments. A score of 1 was assigned to normokinesia, 2 for hypokinesia, 3 for akinesia and 4 for dyskinesia) and Left ventricular function evaluation by (2D and M-Mode measures) **(8).**
6- Patients were be divided into two groups one with antegrade approach and the other group with retrograde approach, both groups were followed up to detect Primary endpoints during hospital admission. A retrograde procedure was defined as one where an attempt was made to cross the retrograde channel regardless of

whether it was successful or not. It was defined as a primary retrograde procedure if the operator planned to perform retrograde, regardless of whether antegrade preparation was performed before or after the retrograde channel attempt. It was defined as secondary when the operator planned on an antegrade crossing but switched to retrograde after antegrade failure **(3).**

7- Primary endpoints included in-hospital mortality, myocardial infarction (MI), need for urgent revascularization, need for urgent pericardiocentesis, contrast-induced nephropathy, procedural success, procedural time, fluoroscopy time, and contrast volume. Technical success was defined as a successful CTO PCI with <30% residual diameter stenosis and restoration of TIMI grade III flow. Procedural success was technical success without in-hospital major adverse cardiovascular events (MACE), including: death, myocardial infarction, repeat target vessel revascularization, cerebral vascular accident, and tamponade requiring pericardiocentesis or surgical repair **(9).**

8- Secondary endpoints which start after hospital discharge and last for 6 months included long-term outcomes: all-cause mortality, MI, target lesion revascularization (TLR), and target vessel revascularization (TVR) **(10).**

Statistical analysis:

Data collected and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage , quantitative continues group represent by mean ± SD. Differences between quantitative independent multiple by ANOVA. P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

This study included 60 patients with chronic total occlusions defined as a lesion with thrombolysis in myocardial infarction (TIMI) grade 0 flow for at least 3 months duration, divided into two groups (30 patients subjected to PCI by antegrade approach and 30 subjected to PCI by retrograde approach). In antegrade approach group, 83.3% of patients were males and 16.7% were females with a mean age of 62.03 ± 7.66 years (range between 46 and 85 years). Regarding risk factors, 63.3% of patients were diabetic, 43.3% had dyslipidemia, 60% were hypertensive, 53.3% were smokers and 23.3% had family history. In retrograde approach group, 80% of patients were males and 20% were females with a mean age of 60.03 ± 4.21 years (range between 50 and 66 years). As regards risk factors, 56.7% of patients were diabetic, 63.3% had dyslipidemia, 60% were hypertensive, 50% were smokers and 23.3% had family history **(Table 1).**

As regards vitals of antegrade approach group, heart rate ranged from 64 to 85 bpm with a mean of 74.13 ± 6.36 bpm, systolic blood pressure ranged from 100 to

150 mmHg with a mean of 128 ± 16.69 mmHg and diastolic blood pressure ranged from 60 to 90 mmHg with a mean of 72.33 ± 10.06 mmHg. In retrograde approach group, heart rate ranged from 64 to 85 bpm with a mean of 75.07 ± 6.38 bpm, systolic blood pressure ranged from 100 to 150 mmHg with a mean of 124 ± 17.73 mmHg and diastolic blood pressure ranged from 60 to 90 mmHg with a mean of 73.33 ± 10.93 mmHg. There was no statistically significant difference between both groups in terms of vital signs including heart rate and blood pressure **(Table 2).**

In antegrade approach group, the most frequently detected ECG findings were T inversion (23.3%), ST depression (20%) followed by aVR pattern and RBBB (each in 13.3%) then 1st degree heart block, LBBB and sinus bradycardia (each in 6.7%) and Q wave, sinus tachycardia and nonspecific changes (each in 3.3%). Regarding ECG findings in retrograde approach group, RBBB and ST depression were each detected in 16.7% of patients, T inversion was detected in 13.3%, aVR pattern and sinus bradycardia were each detected in 10% while 1st degree heart block, Q wave, LBBB, sinus tachycardia and nonspecific changes were each detected in 6.7%. There was no statistically significant difference between both groups regarding ECG findings **(Table 3).**

According to coronary angiography, the predominant occluded vessel in antegrade approach group was LAD artery (in 50% of patients) followed by LCX (30%), RCA (16.7%) and RCA-LAD (3.3%). In retrograde approach group, the predominant occluded vessel was RCA (in 63.3% of patients) followed by LAD (26.7%) and LCX (10%). There was a statistically significant difference between both groups regarding the type of CTO vessel (P=0.001) **(Table 4).**

2D Trans thoracic Echo measures of antegrade approach group, EF ranged from 38 to 63 % with a mean of 49.07 ± 8.51 % and WMSI ranged from 1 to 2.5 with a mean of 1.73 ± 0.47. In retrograde approach group, EF ranged from 38 to 64 % with a mean of 52.67 ± 8.08 % and WMSI ranged from 1 to 2.5 with a mean of 1.58 ± 0.44. There was no statistically significant difference between both groups regarding 2D Trans thoracic Echo measures including EF and WMSI **(Table 5).**

Regarding primary outcome during hospital stay in antegrade approach group, the incidence of mortality was 6.7% and that of MI and CIN was 10% and 6.7% respectively. Moreover, 6.7% of patients needed urgent revascularization and only 3.3% needed pericardiocentesis. Success rate in this group was 66.7%. Procedure time ranged from 98 to 121 minutes with a mean of 106.6 ± 6.46 minutes, fluoroscopy time ranged from 35 to 48 minutes with a mean of 41.47 ± 3.49 minutes and contrast volume ranged from 252 to 281 ml with a mean of 266.7±8.23ml. In retrograde approach group, the incidence of mortality was 6.7% and that of MI and CIN was 6.7%, each. Moreover, only 3.3% of patients needed urgent revascularization and 3.3% needed pericardiocentesis. Success rate in this group was 90%. Procedure time ranged from 132 to 199 minutes with a mean of 170.73 ± 17.67 minutes, fluoroscopy time ranged from 65 to 94 minutes with a mean of 77 ± 8.23 minutes and contrast volume ranged from 289 to 357 ml with a mean of 328.5 ± 20.06 ml. The comparison between both groups revealed that success rate was significantly higher in patients subjected to retrograde approach than those subjected to antegrade approach (P=0.028). Moreover, procedure and fluoroscopy durations were significantly longer with more contrast volume in retrograde approach than the antegrade (P<0.001). On the other hand, there was no statistically significant difference between both groups regarding the incidence of in-hospital mortality, MI, CIN and the need for urgent revascularization and Pericardiocentesis **(Table 6).**

As regards secondary endpoint after discharge in antegrade approach group, the incidence of all-cause mortality, MI, TLR and TVR was 13.3%, 13.3%, 23.3% and 10% respectively. In retrograde approach group, the incidence of all-cause mortality, MI, TLR and TVR was 10%, 10%, 16.7% and 13.3% respectively. No statistically significant difference was detected between both groups regarding the incidence of all-cause mortality, MI, TLR and TVR after discharge **(Table 7).**

Table (1): Baseline characteristics of the studied groups

		Antegrade approach (n=30)	Retrograde approach (n=30)	p value
Age (years)	Mean ± SD	62.03 ± 7.66	60.03 ± 4.21	0.215
	Range	46 - 85	50 - 66	
Sex	Male	25 (83.3%)	24 (80%)	0.739
	Female	5 (16.7%)	6 (20%)	
Risk factors	DM	19 (63.3%)	17 (56.7%)	0.598
	Dyslipidemia	13 (43.3%)	19 (63.3%)	0.121
	HTN	18 (60%)	18 (60%)	>0.999
	Smoking	16 (53.3%)	15 (50%)	0.796
	Family history	7 (23.3%)	7 (23.3%)	>0.999

Data are presented as frequency (%) unless otherwise mentioned, ; DM: Diabetes mellitus, HTN: Hypertension.

Table (2): Vital signs of the studied groups

		Antegrade approach (n=30)	Retrograde approach (n=30)	P value
Heart rate (bpm)	Mean ± SD	74.13 ± 6.36	75.07 ± 6.38	0.572
	Range	64 – 85	64 – 85	

Systolic blood pressure (mmHg)	**Mean ± SD**	**128 ± 16.69**	**124 ± 17.73**	**0.372**
	Range	**100 – 150**	**100 - 150**	
Diastolic blood pressure (mmHg)	**Mean ± SD**	**72.33±10.06**	**73.33 ± 10.93**	**0.714**
	Range	**60 – 90**	**60 - 90**	

Table (3): ECG findings of the studied groups

	Antegrade approach (n=30)	Retrograde approach (n=30)	p value
1st degree heart block	**2 (6.7%)**	**2 (6.7%)**	**0.995**
aVR pattern	**4 (13.3%)**	**3 (10%)**	
Q wave	**1 (3.3%)**	**2 (6.7%)**	
RBBB	**4 (13.3%)**	**5 (16.7%)**	
LBBB	**2 (6.7%)**	**2 (6.7%)**	
Sinus tachycardia	**1 (3.3%)**	**2 (6.7%)**	
Sinus bradycardia	**2 (6.7%)**	**3 (10%)**	
ST depression	**6 (20%)**	**5 (16.7%)**	
T inversion	**7 (23.3%)**	**4 (13.3%)**	
Nonspecific changes	**1 (3.3%)**	**2 (6.7%)**	

Data are presented as frequency (%), aVR: Augmented vector right, RBBB: Right Bundle Branch Block, LBBB: Left Bundle Branch Block

Table (4): Coronary angiography results of the studied groups

	Antegrade approach (n=30)	Retrograde approach (n=30)	value
CTO vessel			
LAD	15 (50%)	8 (26.7%)	**.001***
LCX	9 (30%)	3 (10%)	
RCA	5 (16.7%)	19 (63.3%)	
RCA-LAD	1 (3.3%)	0 (0%)	

*Data are presented as frequency (%), *: Statistically significant as p value<0.05, CTO: Chronic total occlusion, LAD: Left anterior descending, LCX: Left Circumflex, RCA: Right coronary artery*

Table (5): In-hospital 2D Transthoracic Echo measures of the studied groups

		Antegrade approach (n=30)	Retrograde approach (n=30)	value
	Mean ± SD	**49.07 ± 8.51**	**52.67 ± 8.08**	

F (%)	Range	38 - 63	38 – 64	.098
MSI	Mean ± SD	1.73 ± 0.47	1.58 ± 0.44	.205
	Range	1 – 2.5	1 – 2.5	

ef: ejection fraction, wmsi: wall motion score index

Table (6): In-hospital primary end point of the studied groups

		Antegrade approach (n=30)	Retrograde approach (n=30)	value
Mortality		2 (6.7%)	2 (6.7%)	0.999
MI		3 (10%)	2 (6.7%)	0.999
Urgent revascularization		2 (6.7%)	1 (3.3%)	0.999
Pericardiocentesis		1 (3.3%)	1 (3.3%)	0.999
CIN		2 (6.7%)	2 (6.7%)	0.999
Success		20 (66.7%)	27 (90%)	**.028***
Procedure time (min)	**Mean ± SD**	106.6 ± 6.46	170.73 ± 17.67	**0.001***
	Range	98 - 121	132 – 199	
Fluoroscopy time (min)	**Mean ± SD**	41.47 ± 3.49	77 ± 8.23	**0.001***
	Range	35 - 48	65 – 94	
Contrast volume (ml)	**Mean ± SD**	266.7 ± 8.23	328.5 ± 20.06	**0.001***
	Range	252 - 281	289 - 357	

*Data are presented as frequency (%) unless otherwise mentioned, *: Statistically significant as p value<0.05, MI: Myocardial infarction, CIN: Contrast-induced nephropathy*

Table (7): Secondary end point of the studied groups after discharge and last for 6 months

	Antegrade approach (n=30)	Retrograde approach (n=30)	p value
All-cause mortality	4 (13.3%)	3 (10%)	>0.999

MI	4 (13.3%)	3 (10%)	>0.999
TLR	7 (23.3%)	5 (16.7%)	0.519
TVR	3 (10%)	4 (13.3%)	>0.999

Data are presented as frequency (%), MI: Myocardial infarction, TLR: target lesion revascularization, TVR: Target vessel revascularization

Discussion:

Chronic total occlusion (CTO) is one hundred percent (100.0 %) occlusion in coronary artery with non-collateral TIMI 0 flow of at least three months duration. Successful CTO-PCI demonstrates significant clinical benefits with a higher frequency of technical success and low procedural complication rates **(11)**.

The retrograde approach, when used by experienced operators, can produce higher retrograde success in complex CTO lesions. Many previous studies demonstrated the efficacy of the retrograde approach but concerns regarding procedural safety limited its wide adoption **(12)**.

The aim of the current study was to compare efficacy and safety of the antegrade and retrograde approaches to determine the best type of approach for CTO-PCI.

The study included 60 patients as a comprehensive sample, diagnosed with chronic total occlusion proven by at least with one radiological method either CT coronary angiography scan or Coronary angiography.

Complete history taking, physical Examination, 12 lead ECG and conventional transthoracic echocardiography were performed to all patients. Patients were then divided into two groups one with antegrade approach and the other group with retrograde approach, both groups were followed up to detect Primary endpoints during hospital admission were in-hospital mortality, myocardial infarction (MI), need for urgent revascularization, need for urgent pericardiocentesis, contrast-induced nephropathy, procedural success, procedural time, fluoroscopy time, and contrast volume. Secondary endpoints which start after hospital discharge and last for 6 months included long-term outcomes: all-cause mortality, MI, target lesion revascularization (TLR), and target vessel revascularization (TVR).

Regarding baseline demographic characteristics of the studied populations, there was no statistically significant difference between the studied groups regarding age, sex distribution and risk factors including DM, dyslipidemia, HTN, smoking and family history. Regarding the ECG findings of the studied groups, the most frequently detected ECG findings in antegrade approach group were T inversion (23.3%) and ST depression (20%) while in retrograde approach group were ST depression and RBBB (each 16.7%) followed by T wave inversion (13.3%). There was no statistically significant difference between both groups regarding ECG findings. Concerning the 2D Transthoracic Echo measures of the studied groups, there was no statistically significant difference between both groups regarding 2D Transthoracic Echo measures including EF and WMSI.

in contrast with our results, **Lee et al. (10)** found that 93.5% of the studied population in the retrograde group had documented dyslipidemia compared to only 53.3% of that in the antegrade group with highly statistically significant difference (<0.001). More than half of the studied populations in the retrograde group were smoker (57.1%) compared to only (36.0%) of that in antegrade group with statistically significant difference (0.009). Family history of premature CAD in the retrograde group was higher (14.3%) than that in the antegrade group (4.0%) with statistically significant difference (P= 0.028).

Moreover, **Wu et al. (12)** found that more patients in retrograde group had past history of dyslipidemia, premature CAD and PCI.

As regard the coronary angiography findings in our study, the predominant occluded vessel of antegrade approach group was LAD artery (in nearly 50% of patients) followed by LCX (30%), meanwhile, that of retrograde approach group was RCA (in 63.3% of patients) followed by LAD (26.7%). There was a statistically significant difference in the type of CTO vessel between both groups (p=0.001).

In agreement with our results, **Lee et al. (10)** assessed both the antegrade and retrograde approaches for CTO-PCI patients and found that the RCA was the most affected vessel with greater CTO complexity (higher J-CTO score) in the retrograde group with statistically significant difference (<0.001) compared to the antegrade group.

Also, **Suzuki et al. (13)** studied 2846 CTO patients and found that RCA was significantly the most affected vessel in the retrograde group (65%) followed by LAD (25%) and finally LCX (8%).

Regarding the primary outcome during hospital stay, there was no statistically significant difference between both groups regarding the incidence of mortality (6.7% of each group), MI (10% of antegrade approach group vs. 6.7% of the retrograde approach one), CIN (6.7% of each group), the need for urgent revascularization (6.7% vs. 3.3% respectively) and pericardiocentesis (3.3% of each group).

In agreement with that results, **Lee et al. (10)** compared antegrade and retrograde approaches for CTO patients. No significant difference was observed regarding mortality, pre procedural MI, need for urgent revascularization, pericardiocentesis and MACE between the antegrade and retro grade groups.

Also, **Wu et al. (12)** assessed antegrade and retro grade approaches for CTO patients and found no significant differences regarding periprocedural complications, coronary perforation and pericardiocentesis between antegrade and retro grade approaches.

However, in contrast with our results, **Suzuki et al (13)** found that periprocedural complications especially coronary perforation with/without tamponade were higher in the retrograde group (0.9%) than antegrade group (0.2%) with statistically significant differences.

On the other hand, the success rate was significantly higher in patients subjected to retrograde approach than those subjected to antegrade approach (90% vs. 66.7%, p=0.028). However, the retrograde approach took significantly longer procedure time (170.73 min. vs. 106.6 min respectively, p<0.001), fluoroscopy time (77 min vs. 41.47 min respectively, p<0.001) and more contrast volume (328.5 ml vs. 266.7 ml respectively, p<0.001) than the antegrade approach.

That was in agreement with **Karmpaliotis et al. (14)** registry in USA who assessed 462 CTO patients during the period from 2006 to 2011 and showed that the retrograde approach gave more favorable technical success rates in CTO-PCI but with significantly higher total procedure time and total contrast volume.

Also, **Eugene et al. (15)** assessed 485 patients with 497 CTOs who underwent CTO PCI performed by eight high-volume CTO operators, and showed that although the initial technical success rates were 96% with the antegrade approach and about 91% with the retrograde approach, patients were further analyzed in terms of those who had a retrograde approach and those who went through the whole PCI procedure without any retrograde attempt. The pure retrograde success rate was about 80% and the pure antegrade success rate was nearly 75%. However procedural time, fluoroscopy time, wire crossing time and radiation dose were similarly higher in the retrograde group.

Furthermore, **Lee et al. (10)** studied 321 CTO Patients between 2012 and 2013, the antegrade approach was used in 152 patients, and retrograde approach was used in 169 patients. They found that the procedure and fluoroscopy times were significantly longer, with more radiation exposure and contrast medium consumption among the retrograde group.

However that was disconcordant with **Suzuki et al. (13)** who assessed 2,846 consecutive CTO-PCI cases undertaken in Japan over the study period from January 2014 to December 2015 and compared clinical outcomes between the different PCI approaches, following the intention-to-treat principle. They found that the technical success rate of the primary antegrade approach was significantly better than that of the primary retrograde approach (p < 0.0001), but the technical success rate decreased to 78.0% with the rescue retrograde approach. The reason of technical failure was mostly failed guide wire crossing in both groups. The procedural time, fluoroscopy time and contrast volume were similarly higher among the retro grade group.

During follow up of the patients for 6 months after discharge, no statistically significant difference was detected between both groups as regard the secondary endpoints. The incidence of all-cause mortality was 13.3% for the antegrade approach group and 10% for the retrograde approach, incidence of MI was 13.3% for antegrade approach and 10% for retrograde approach. Furthermore, the incidence of TLR was 23.3 for the antegrade approach and 16.7% for the retro grade approach and finally the incidence of TVR was 10% for the antegrade approach and 13.3% for the retrograde approach.

In agreement with our results, **Suzuki et al. (13)** showed that rates of MI, death urgent revascularization and stroke were 0.8%, 0.2%, 0.2% and 0.2% respectively in the antegrade group and 2.0%, 0.4%, 0.1% and 0.3% respectively in the retrograde group with no statistically significant difference.

However, **Wu et al. (12)** reported higher incidence of secondary endpoints including MI, need for urgent revascularization, stroke and all-cause mortality among retrograde group patients. They reported only four MI patients in the antegrade group while there were 13 patients with MI, 1 patient death and 1 patient with hemorrhagic stroke in the retrograde group.

So, the retrograde approach, when used by experienced operators who have been trained by a master of retrograde, can produce higher retrograde success in complex CTO lesions. Careful follow up by experienced operator can improve procedural efficiency, reduce contrast and radiation dosage, and reduce the time spent in failure mode. These tools remain vital to the development of future CTO PCI.

This study was not a randomized controlled one and the sample size was small. Lack of standardized PCI procedures; no definite criteria for strategy selection, except for operators' experience, skills, and clinical judgments. Thus, it lacks approaches that would have more clinical implication for less experienced specialists. The percentage of patients with previous CABG in this study was low, so the results of procedures may be different in other populations with a higher percentage of patients with prior CABG. Follow up was done for 6 months only post PCI, so prolonged follow up periods are needed. Also, the cost-effectiveness of these 2 approaches was not analyzed in the current study.

CONCLUSION:

The overall technical success rate was high with low complication rate. The retrograde approach in CTO-PCI was safe and more effective than the antegrade approach at the expense of more procedure time, radiation exposure and contrast medium consumption.

So we can safely conclude that the retrograde approach can be frequently used as the primary CTO-PCI strategy, especially for more complex CTO lesions and reattempts procedures. However careful follow up is highly recommended during and after the retrograde approach for PCI to CTO vessels.

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