Comparison between Antegrade Approach and Retrograde Approach in Percutaneous Coronary Intervention for Chronic Total Occlusion

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Abstract

Background: Successful chronic total occlusion (CTO) Percutaneous Coronary Intervention (PCI) demonstrates significant clinical benefits, but comparative outcomes between antegrade and retrograde approaches are still lacking in Egypt.

Results: We enrolled 152 patients in the period from December 2018 to May 2021. They were referred for CTO-PCI procedures at the National Heart Institute's catheterization laboratory. The studied population was categorized into two groups: The first group: patients with an antegrade approach. The second group: patients with a retrograde approach. The highest percentage of CTO vessels affected was RCA (43.4%). The mean duration of CTO was 12 months with a J CTO score of 3. Approximately more than three-fifth (90.1%) of the studied population had technical success. The technical success was higher in the retrograde group (96.1%) compared to 84.0% of that in the antegrade group (P= 0.012). Technical success was (92.6% & 98.0%) in epicardial and septal collaterals, respectively, with no statistically significant difference. Mean of total procedure time (min.) was 140 ±55 while mean of total contrast volume (ml) used was 301 ±107 while median of Total radiation dose (mGy) was 11925. **Conclusions:** In our institution, the retrograde approach is safer and more effective than antegrade CTO-PCI but involves longer procedure duration, greater radiation exposure, and more contrast material usage. Septal collateral channels were more secure than epicardial collateral channels for the retrograde approach.

Keywords: Antegrade Approach, Retrograde Approach, Percutaneous Coronary Intervention, Chronic Total Occlusion.

Background

A coronary chronic total occlusion (CTO) is the total occlusion of a coronary artery with non-collateral thrombolysis in myocardial infarction (TIMI) 0 flow for at least a three-month duration **[1].** If no previous angiography has been performed to establish CTO presence, determining the duration of occlusion may be challenging. In these conditions, the occlusion duration is determined based on the onset of symptoms and/or a history of myocardial infarction in the target vessel territory [2]**.**

Around 35% of patients who undergo coronary angiography develop CTO [3]. CTO percutaneous coronary intervention (PCI) is a technically difficult technique that accounts for roughly 5.0% of all PCI procedures [2]. It has been demonstrated that successful CTO PCI decreases the need for coronary artery bypass grafting (CABG), enhances left ventricular ejection fraction, relieves angina, and improves long-term survival[3]. Modern CTO-PCI has a high technical success rate greater than 90.0%, with minimal risk of procedural complications because of recent advancements in interventional devices, operator experience, and procedural techniques[4].

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In recent years, the retrograde approach was established and implemented globally, owing to advanced guidewires and microcatheters that enable aggressive collateral channel tracking. Many experts, however, continue to utilize the antegrade technique as their primary first strategy, reserving the retrograde strategy for reattempts (5). The present study aims to compare efficacy and safety of the antegrade and retrograde approaches for CTO-PCI in the contemporary era.

Methods

The current prospective observational comparative study enrolled 152 patients referred for CTO-PCI at the catheterization laboratory in the National heart institute from December 2018 to May 2021. Two groups were established in the studied population: the first group included patients with an antegrade approach and the second one included those with a retrograde approach.

Coronary CTO was defined as an angiographic finding of 100.0% occlusion in a coronary artery with non-collateral thrombolysis in myocardial infarction (TIMI) 0 flow of at least 3-month duration(1). Based on the onset of symptoms and/or a history of myocardial infarction in the target vessel territory, the occlusion duration is estimated (6).

Before hospital discharge, procedural complications involved death from any cause, recurrent angina requiring urgent repeat target vessel revascularization with PCI or coronary bypass surgery, puncture site bleeding requiring transfusion of surgical management or major bleeding, Q-wave myocardial infarction, and cardiac tamponade that requires pericardiocentesis or surgery. In-hospital major adverse cardiac events (MACE) were defined as in-hospital death, in-hospital or peri-procedural MI (non-Q wave), or urgent revascularization during the same admission.

A review of clinical and laboratory data of all groups selected was done, including:

Part I, baseline demographic characteristic as age and gender; **Part II**, patients' history as family history of premature coronary artery disease (CAD), past history of ischemic heart disease (IHD), percutaneous coronary intervention (PCI), etc. **Part III**, angiographic characteristic as qualifying diagnosis, vascular access (radial artery), number of vessels affected (one, two, or three), CTO vessel affected, CTO duration, month, J-CTO score, and prior failed attempt; **Part IV**, procedural characteristics as total contrast volume (ml), type of approach used, total fluoroscopy time (min.), total procedure time (min.), total radiation dose (mGy), IVUS data ;**Part V**, clinical outcomes as plain old balloon angioplasty, technical success, post-procedural complications, types of post-procedural complications, and In-hospital major adverse cardiac events (MACE).

Methodology of Interventional strategies

Coronary angiography was done diagnostically through the radial route. The intervention steps and the medications utilized are consistent with those previously described in the literature (7). The initial strategy was typically determined by the coronary anatomy of each patient (proximal cap ambiguity, lesion length, distal target vessel quality, and the existence of suitable collateral channels, etc.), which was assessed by simultaneous bilateral injection.

Usually, the antegrade method was utilized when the anatomy was favorable with a low J-CTO score. However, the retrograde approach was chosen as the initial approach if the patient's coronary architecture was unfavorable, as indicated by a high J-CTO score, particularly in re-attempt cases, and an appropriate collateral channel(8) .

Three subgroups of anatomic collateral channels were identified: epicardial, septal and

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atrioventricular groove collateral channels. If numerous interventional collateral routes are found, the following criteria were used for the selection: reduced tortuosity, a greater distance between the confluence and the distal cap, and fewer angulations to the donor/recipient arteries. We created personalized strategies based on the aspects mentioned above as well as our clinical judgment.

Statistical analysis

SPSS vs.25 (IBM, Armonk, New York, United States) was used for data management and statistical analysis. To summarize numerical data, Means and standard deviations, or medians and ranges were utilized. Categorical data were summarized using percentages and numbers. To compare the two groups for normally distributed and non-normally distributed numerical data, the independent t-test and the Mann Whitney U test were used, respectively. Comparing the categorical data was done using the Chi-square test or, if appropriate, Fisher's exact test. All P values were two-sided. P values less than 0.05 were considered significant.

Results

The data collected for the present study was organized, summarized, tabulated, and presented in the following sequence:

1. Baseline Demographic and Angiographic Characteristics of the Study Population.
2. Procedural Characteristics and Clinical Outcomes of the Studied Population**.**
3. Comparison between Different Collaterals in the Retrograde Approach

The distribution of the studied population according to their baseline demographic characteristics was illustrated in **table I.** According to sex, nearly three fourth (84.2%) of the population were males. On assessing problems encountered during admission, the most common disease was hypertension **(**84.2%**)** followed by dyslipidemia (73.7%), history of ischemic heart disease (67.8%), diabetes mellitus (55.9%), and history of percutaneous coronary intervention (50.0%), smoking (46.7%), Family history of premature CAD (9.2%) and past history of CABG (4.6%).

Regarding to the angiographic characteristics of the studied population in antegrade and retrograde group**, table II** shows that more than half (64.0%) of the studied population in the retrograde group was diagnosed with NSTE-ACS compared to only (26.0%) in the retrograde group with highly statistically significant differences (<0.001). Meanwhile, 64.9 % in the retrograde group had RCA affected compared to only 21.3% in the ante grade group with highly statistically significant differences (<0.001). Also, 48.1% of the studied population in the retrograde group had prior failed attempts compared to 1.3% in the ante grade group with highly statistically significant differences (<0.001).

The data in **table III** shows that the studied population in the retrograde group were more vulnerable to high mean in total procedure time (165 min) compared to 114min to that in in the retrograde group with highly statistically difference (<0.001). Total fluoroscopy time (min.) was higher (68min) in the retrograde group compared to 48 min in the antegrade group with highly statistically significant difference (<0.001). Total contrast volume used in the retrograde group was higher (323 ml) compared to only (278 ml) in the antegrade group with statistically significant difference (0.01). A Total radiation dose (mGy) of the procedure was more (14160) in the retrograde compared to (10120) in the antegrade group with statistically significant difference (P <0.001). Average stent(s) length (mm) was longer (89) in the retrograde compared to (76) in the antegrade group with statistically significant difference (P= 0.032). Also **table III** shows that technical success was higher in the retrograde Group (96.1%) compared to the antegrade group (84.0%). The difference observed was statistically significant (P= 0.012). It was observed that post procedural Complications were more in the antegrade group (8.0%) than in the retrograde group (6.5%) with no statistically significant difference (P= 0.72).

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No statistically significant differences related to baseline demographic characteristics in the retrograde approach between epicardial and septal collaterals were demonstrated **table IV.**

Concerning angiographic characteristic comparison between epicardial and septal collaterals in the retrograde approach, **table V** shows that 72.4% of the studied population in epicardial collaterals diagnosed with stable IHD compared to 72.0% of that in septal collaterals. Meanwhile, more than half of the studied population in epicardial and septal collaterals had three vessels affected (59.3% and 54.0%), respectively. Prior failed attempts were higher in septal collaterals (56.0%) compared to only 33.3% in epicardial collaterals with no statistically significant difference (p>0.001).

The mean of total procedure time (min.) in the epicardial collaterals group (161 ±36) was near equals to that in the septal collaterals group (167 ±49) in **table VI.** Also, technical success was (92.6% &98.0%) in epicardial and septal collaterals respectively without statistically significant difference. The same table also revealed that approximately one-fifth of the epicardial collaterals group (14.8%) were exposed to post-procedural complications compared to only 2.0% of that in the septal collaterals group with a slightly statistically significant difference (0.048).

The studied population in the retrograde group in **figure I** show that they more female, having hypertension, past history of IHD, and past history of PCI (18.2%, 87.0%, 71.4%, and 50.6%) compared to (13.3%, 81.3%, 64.0%, and 49.3%) in the antegrade group respectively. The differences observed weren't statistically significant. However, 93.5% of the studied population in the retrograde group documented dyslipidemia compared to only 53.3% of that in the antegrade group with a highly statistically significant difference (<0.001). More than half of the studied populations in the retrograde group were smokers (57.1%) compared to only (36.0%) of those in the antegrade group with a statistically significant difference (0.009). As regards to the retrograde group, the family history of premature CAD was higher (14.3%) compared to the antegrade group (4.0%), with a statistically significant difference (0.028).

The studied population in the retrograde group demonstrated in **figure II.** They were more vulnerable to high mean total fluoroscopy time (min.), total procedure time (min.), and total contrast volume (ml) used (165, 68, and 323) compared to only 114, 48 and 278, respectively in the antegrade group with statistically significant difference (<0.001, <0.001 and 0.01 respectively).

Concerning the technical success and post-procedural complications, **figure III** shows that it was higher in the retrograde Group (96.1%) compared to only three fourth (84.0%) of that in the antegrade group. The difference observed was statistically significant (0.012). Compared to the retrograde group (6.5%), it was observed that post-procedural complications were more in the antegrade group (8.0%) without a statistically significant difference.

Mean of reference vessel diameter in **Figure IV** is 2.51 in antegrade group compared to 2.89 in the retrograde group with statistically significant differences (0.011). Also Mean of MSA is 5.17 in antegrade group compared to 6.01 in the retrograde group with highly statistically significant differences (0.007). Median of lesion length in **figure V** shows that the retrograde group (86) was higher than antegrade group (73) but without statistically significant difference (0.052).

Discussion

The overall technical success rate was high in our study with low complication rate. Also 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. Regarding baseline demographic characteristics of the studied populations in our study, it was found that nearly most

(84.2%) of the population were males. This agrees with study that showed 90.7% of the studied populations were male [(9)]. Also, 93.5% of the studied population in the retrograde group documented dyslipidemia compared to only 53.3% of that in the antegrade group (P<0.001). More than half of the studied populations in the retrograde group were smokers (57.1%) compared to only (36.0%) of those in the antegrade group (P=0.009). As regards the retrograde group, the family history of premature CAD was higher (14.3%) compared with the antegrade group (4.0%), with a statistically significant difference (0.028). These results agreed with the study who demonstrated that more patients in the retrograde group had a past history of premature CAD and PCI [[(10)]. Also, another studies found that most of the retrograde group patients had dyslipidemia and past history of PCI conducted by [(11&12).]

Our findings revealed that, in the retrograde group, stable IHD was the most frequent presentation (71.4%), RCA was the most affected (64.9%) and prior failed CTO PCI trial (48.1%) with a statistically significant difference (<0.001). These results correspond to results that found stable IHD was the most common presentation, more prior failed CTO PCI trial and the RCA is the most affected vessel with greater CTO complexity (higher J-CTO score) in the retrograde group with statistically significant difference (<0.001) [(9,10&12)].

Our findings of retrograde procedural time corresponding with many studies which indicate that retrograde success did not occur as a result of persistence in the retrograde approach or prolonged retrograde channel surfing. The present study operators were experienced, which might account for the greater retrograde success rates [(10, 11, 12&13)]. The current total contrast volume, total fluoroscopy time, total procedure time, and total radiation dose were greatly consumed in the retrograde group in comparison to the antegrade group with statistically significant differences (<0.001). This was in agreement with a lot of registries [(9, 10& 11)]. Another study showed that significantly higher total procedure time and total contrast volume in the retrograde group [(12)]. On the other hand, current longer stent length was used in retrograde procedures with statically significant [(10, 11& 12)].

In the current study, the retrograde group success rates were highly significant (96.1%) compared to the antegrade one (84.0%), which was comparable with the reported success rates of the antegrade and retrograde of] study in Japan (91.0% and 87.3%, respectively) [(12)], the registry in the USA (91.0 % and 85.5%, respectively) [(11)] , study in Taiwan(97.4% and 96.4%)[(9)] and the registry in Asia-Pacific (95.9% and 91.2%, respectively). The technical success in the retrograde approach in our study was higher than antegrade. It is recommended to be confirmed in a retrospective randomize trial [(10)].

Previously published registries indicated that retrograde approach usage could result in positive technical success rates for CTO PCI such as the USA [(11& 12)]. Additionally, the present study revealed that enhanced retrograde abilities could increase retrograde technical success rates, as reported in the Taiwan study [(9)] and Asia-Pacific registry by [(10)]. Only 7.2% of the present study population was exposed to post-procedural complications, which presented with 11 perforations (54.5% of them had developed tamponade). The antegrade procedures (6 patients with perforations and five patients with tamponades) had higher complications than the retrograde procedures (5 patients with perforations and one patient with tamponade) with no statistically significant differences. In comparison with previous registries, developed complication (tamponade) higher (4 patients) in retrograde group than antegrade group tamponade (2 patients) with no statistically significant differences [(9)]. Another study showed complications as perforation higher in the retrograde group (7 patients) than antegrade group (2 patients) with no statistically significant differences [(10)].

The present study demonstrated more complications in the antegrade group, which may be due to several trials of puncture proximal tough CTO cap, subintimal dissection with stiff wires, and on the other hand, experienced retrograde operators in the channel surfing and soft distal CTO cap. Perforation risk can be avoided by paying close attention to equipment during the attempts of CTO crossings. Before microcatheters and other devices are advanced, the guidewire's position within the vessel's 'architecture' should be verified. Coronary perforation can cause cardiac tamponade, myocardial infarction, rapid hemodynamic collapse, and death [14]. There in-hospital MACE, there was not any documented cases in the present study among the retrograde group or antegrade group may be due to the small sample size. Comparison with previous registries one who had one peri-procedural MI patient in each group [9] while other study had four MI patients only in the antegrade group while there were (13 MI, one death, and one hemorrhagic stroke) in the retrograde group[10].

In the current study, septal and epicardial collateral channels were used in 50 and 27 respectively of the retrograde procedures. While the AV groove collateral channel didn't use because of operators selection (not our routine selection), his experience and the literature had less research comparing epicardial, septal, and AV groove collateral channels in terms of effectiveness and safety. In the previous studies, septal collateral channels were frequently recommended as the primary choice, mostly for safety reasons [15]. No statistically significant differences were observed in baseline demographic characteristics such as age, gender, smoking, DM, HTN, dyslipidemia, obesity, PH of premature CAD, PH of IHD, PH of PCI, and PH of CABG in the retrograde approach between epicardial and septal collaterals. These findings were run hand in hand with documented in Taiwan [9].

Concerning angiographic characteristic comparison between epicardial and septal collaterals in the retrograde approach, 70.4% of the studied population in epicardial collaterals were diagnosed with stable IHD compared to 72.0% of that in septal collaterals. Meanwhile, more than half of the studied population in epicardial and septal collaterals had three vessels affected (59.3% and 54.0%), respectively. Prior failed attempts was higher in the septal collaterals group (56.0%) compared to only 33.3% in the epicardial collaterals group with no statistically significant difference partially correspond to results found in Taiwan as they documented that prior failed attempts was higher in septal collaterals group (51patients), epicardial collaterals group (33 patients) and AV groove collaterals (17 patients) with no statistically significant difference [9].

J-CTO score and CTO duration were the same in the septal collaterals as the epicardial collaterals group (3 and 12 respectively), similar to the study conducted in Taiwan [9] without a statistically significant difference. The present study showed total procedure time (min.) in the epicardial collaterals group (161 ±36) was near equals to that in the septal collaterals group (167 ±49). Also, technical success was high (92.6% &98.0%) in epicardial and septal collaterals, respectively, without statistically significant differences. Similar to that found in Taiwan, both groups did not show statistically significant differences as regards total contrast volume (ml), total fluoroscopy time (min.), and total radiation dose (mGy) in Taiwan [9].

Our study showed approximately one-fifth of the epicardial collaterals group (14.8%) were exposed to post-procedural complications compared to only 20.0% of that in the septal collaterals group, with a slightly statistically significant difference with a P-value (0.048). Three-fourths of these complications were perforation (4(100.0%)). One of them developed tamponade compared to (1(100.0%)) in the septal collaterals group. In comparing with the study conducted in Taiwan [9] they found AV groove collaterals had 8.3% tamponade, and epicardial collaterals groups had 3.2% tamponade and 1.6% major bleeding were exposed to post-procedural complications compared to only 1.2 % death of that in septal col. So septal collateral channels were safer than epicardial collateral channels. The two collaterals had a high rate of success, low procedural complication, and there wasn't any in-hospital MACE documented.

Perforation is a threatening complication of retrograde CTO PCI, particularly when epicardial collaterals are used, as it can result in rapid tamponade and hemodynamic collapse. Wire perforation does not typically result in tamponade unless a balloon or microcatheter is advanced over the exit point [16]. Tamponade was found to be a 0.5% risk in a recent systematic review of CTO complications [17].Perforation management equipment (coils, covered stents) is critical for any laboratory performing CTO PCI, and operators should be aware of its use [16]. According to IVUS data, Mean ±SD of reference vessel diameter is 2.51 ±1.12 in antegrade group compared to 2.89 ±0.61 in the retrograde group with statistically significant differences (0.011). Also Mean ±SD of MSA is 5.17 ±2.35 in antegrade group compared to6.01 ±1.33 in the retrograde group with highly statistically significant differences (0.007).we need a randomized trial with large size to confirm this result

Study Limitations

- 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.
- Our study focused on acute procedural outcomes without evaluation of long-term prognosis after CTO PCI. The cost-effectiveness of these 2 approaches was not analyzed in the current study as well.

Conclusions

In our institution, the retrograde approach represents 50.65% of cases of CTO PCI. The overall technical success rate was high with a low complication rate, and 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. For the retrograde approach, septal collateral was safer than epicardial collateral channels. Both collaterals had a high rate of success, low procedural complication, and no in-hospital MACE rates.

List of abbreviations

Percutaneous Coronary Intervention (PCI), Chronic total occlusion (CTO), coronary artery bypass grafting (CABG), major adverse cardiac events (MACE), ischemic heart disease (IHD).

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Results

Table I: Distribution of the Studied Population According to their Baseline Demographic Characteristics (n=152):

Baseline demographic Characteristic			
Age (Years)	**Mean ±SD**	62 ±11	
		No	**%**
Gender	**Males**	128	84.2
	Females	24	15.8
Smoking	**Yes**	71	46.7
DM	**Yes**	85	55.9
HTN	**Yes**	128	84.2
Documented dyslipidemia	**Yes**	112	73.7
Obesity	**Yes**	33	21.7
FH of premature CAD	**Yes**	14	9.2
PH of IHD	**Yes**	103	67.8
PH of PCI	**Yes**	76	50.0
PH of CABG	**Yes**	7	4.6

DM: Diabetes Mellitus. **HTN:** Hypertension. **FH:** Family History. **CAD:** Coronary Artery Disease.
PH: Past History**.** **IHD:** Ischemic Heart Disease. **PCI:** Percutaneous Coronary Intervention.
CABG: Coronary Artery by Passes Graft.

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Table II: Comparison between Antegrade and Retrograde Group According to their Angiographic Characteristic (n=152):

Angiographic Characteristic		Antegrade (n = 75)	Retrograde (n = 77)	P value
		No (%)	No (%)	
Qualifying diagnosis	STEMI	0(0.0)	2(2.6)	<0.001
	NSTE-ACS	48(64.0)	20(26.0)	
	Stable IHD	27(36.0)	55(71.4)	
CTO vessel	LAD	38(50.7)	21(27.3)	<0.001
	LCX	21(28.0)	6(7.8)	
	RCA	16(21.3)	50(64.9)	
Prior failed attempts	Yes	1(1.3)	37(48.1)	<0.001

STEMI: ST segment Elevation Myocardial Infraction. **NSTE-ACS:** Non ST Segment Elevation Acute Coronary Syndrome. **IHD:** Ischemic Heart Disease. **LAD:** Left Anterior Descending Artery.
LCX: Left Circumflex Artery. **CTO:** Chronic Total Occlusion**.** **RCA:** Right Coronary Artery.

Table III. Comparison between Antegrade and Retrograde Group According to their Procedural Characteristics and Clinical Outcomes (n=152):

Procedural Characteristics and Clinical Outcomes		Antegrade (n = 75)		Retrograde (n = 77)		P value
		Mean ±SD		Mean ±SD		
Total procedure time (min.)		114 ±52		165 ± 45		<0.001
Total fluoroscopy time (min.)		48 ± 23		68 ± 22		<0.001
Total contrast volume (ml)		278 ± 136		323 ± 61		0.01
		Median (range)		Median (range)		P value
Total radiation dose (mGy)		10170 (1520 - 497224)		14160 (6238 - 27676)		<0.001
Total number of stents used		2 (0 - 4)		3 (0 - 4)		0.178
Average stent(s) length (mm)		76 (0 - 144)		89 (0 - 134)		0.032
		No	%	No	%	P value
POBA	Yes	4	5.3	1	1.3	0.206
Technical success	Yes	63	84.0	74	96.1	0.012
Post procedural complications	Yes	6	8.0	5	6.5	0.72
Type	Tamponade	5	83.3	1	20.0	0.08
	Perforation	6	100.0	5	100.0	

POBA: Plan old balloon angioplasty. Total is not exclusive.

Table IV: Comparison between Epicardial and Septal Collaterals In relation to Baseline Demographic Characteristic in the Retrograde Approach (n = 77)

Baseline demographic Characteristic		Epicardial collaterals (n = 27)		Septal collaterals (n = 50)		P value
Age (Years)	Mean ±SD	61 ±12		60 ±10		0.689
		No	%	No	%	
Gender	Males	22	81.5	41	82.0	0.955
	Females	5	18.5	9	18.0	
Smoking	Yes	15	55.6	29	58.0	0.836
DM	Yes	14	51.9	26	52.0	0.99
HTN	Yes	23	85.2	44	88.0	0.726
Documented dyslipidemia	Yes	25	92.6	47	94.0	0.811
Obesity	Yes	7	25.9	9	18.0	0.413
FH of premature CAD	Yes	3	11.2	8	16.0	0.559

PH of IHD	**Yes**	18	66.7	37	74.0	0.497
PH of PCI	**Yes**	10	37.0	29	58.0	0.079
PH of CABG	**Yes**	2	7.4	1	2.0	0.242

DM: Diabetes Mellitus. **HTN:** Hypertension. **FH:** Family History**.** **CAD:** Coronary Artery Disease**.** **PH:** Past History. **IHD:** Ischemic Heart Disease. **PCI:** Percutaneous Coronary Intervention. **CABG:** Coronary Artery by Passes Graft.

Table V: Comparison between Epicardial and Septal Collaterals In relation to Angiographic Characteristic in the Retrograde Approach (n = 77):

Angiographic Characteristic		**Epicardial collaterals (n = 27)**		**Septal collaterals (n = 50)**		**P value**
		No	**%**	**No**	**%**	
Qualifying diagnosis	**STEMI**	1	3.7	1	2.0	1.0
	NSTE-ACS	7	25.9	13	26.0	
	Stable IHD	19	70.4	36	72.0	
No of vessels affected	**One**	4	14.8	4	8.0	0.443
	Two	7	25.9	19	48.0	
	Three	16	59.3	27	54.0	
CTO vessel	**LAD**	8	29.6	13	26.0	0.644
	LCX	3	11.1	3	6.0	
	RCA	16	59.3	34	68.0	
Prior failed attempts	**Yes**	9	33.3	28	56.0	0.057
Duration of CTO (months)	**Median (range)**	12 (8 - 360)		12 (3 - 240)		0.97
J-CTO score	**Median (range)**	3 (1- 3)		3 (1 - 3)		0.511

CTO: Chronic Total Occlusion.

Table VI: Comparison between Epicardial and Septal Collaterals In relation to Procedural Characteristic in the Retrograde Approach (n = 77):

		Epicardial (n = 27)		**Septal (n = 50)**		**P value**
		Mean ±SD		**Mean ±SD**		
Total fluoroscopy time (min.)		65 ±16		69 ±24		0.357
Total procedure time (min.)		161 ±36		167 ±49		0.492
Total contrast volume (ml)		330 ±50		319 ±66		0.459
Total radiation dose (mGy)		14596 ±3686		15402 ±5432		0.444
		Median (range)		**Median (range)**		**P value**
Total number of stents used		2 (0 - 3)		3 (0 - 4)		0.203
Number of BMS		0 (0 - 2)		0 (0 - 3)		0.56
Number of DES		2 (0 - 3)		3 (0 - 4)		0.382
Average stent(s) length (mm)		76 (0 - 134)		90 (0 - 124)		0.046
		No	**%**	**No**	**%**	**P value**
POBA	**Yes**	0	0.0	1	2.0	1.0
Technical succes	**Yes**	25	92.6	49	98.0	0.280
Post procedural complications	**Yes**	4	14.8	1	20.0	0.048
Type	**Tamponade**	1	20.0	0	0.0	1.0
	Perforation	4	100.0	1	100.0	

Categorical data were compared using Fisher's exact test. Independent t-test or Mann Whitney U tests were used for numerical data. * P < 0.05 (significant). Total is not exclusive.

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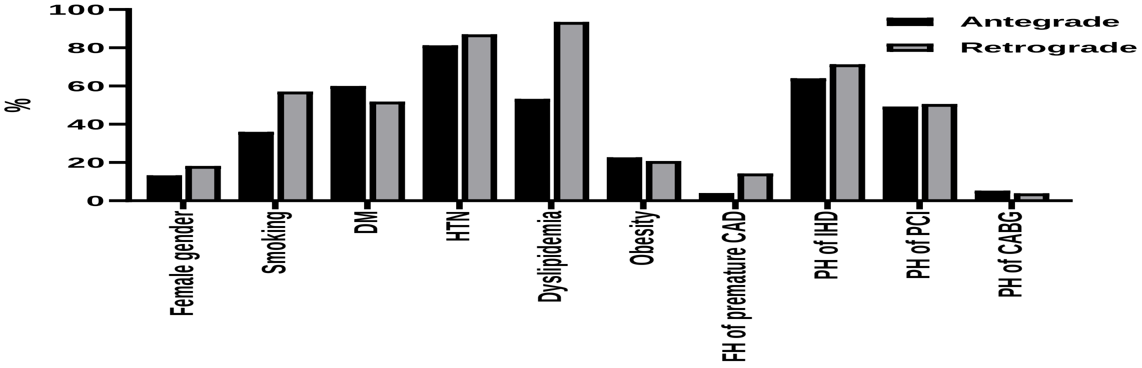

Figure I: Comparison between Antegrade and Retrograde Group According to their Baseline Demographic Characteristics (n=152).

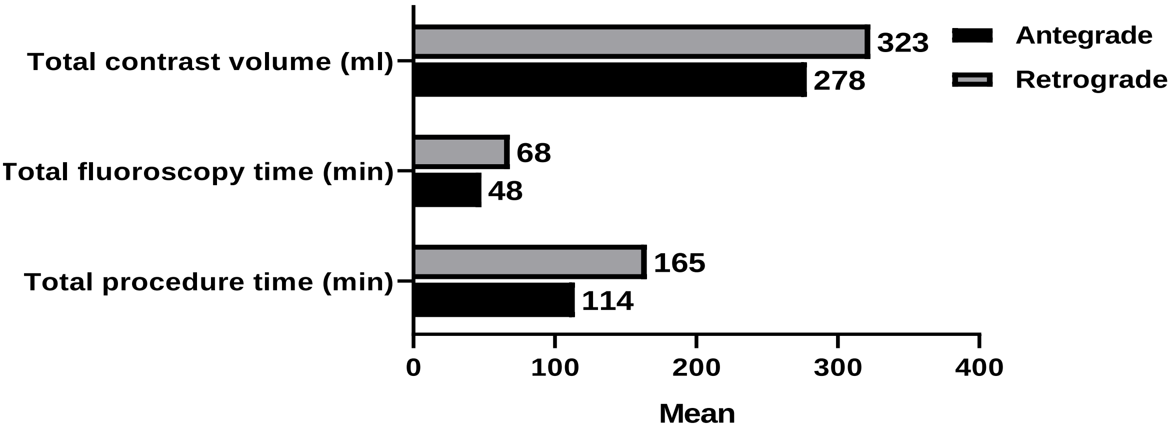

Figure II: Mean Distribution of Procedural Characteristics between Antegrade and Retrograde Group (n=152).

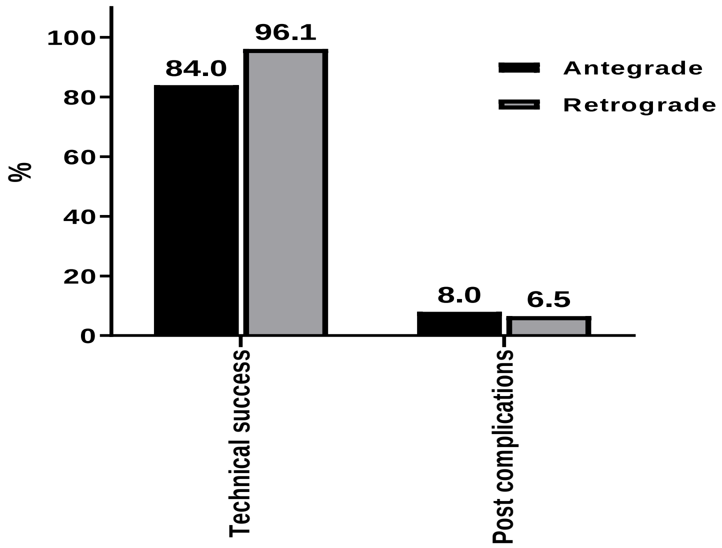

Figure III: Comparison between Antegrade and Retrograde Group According to Technical Success and Postprocedural Complications (n=152).

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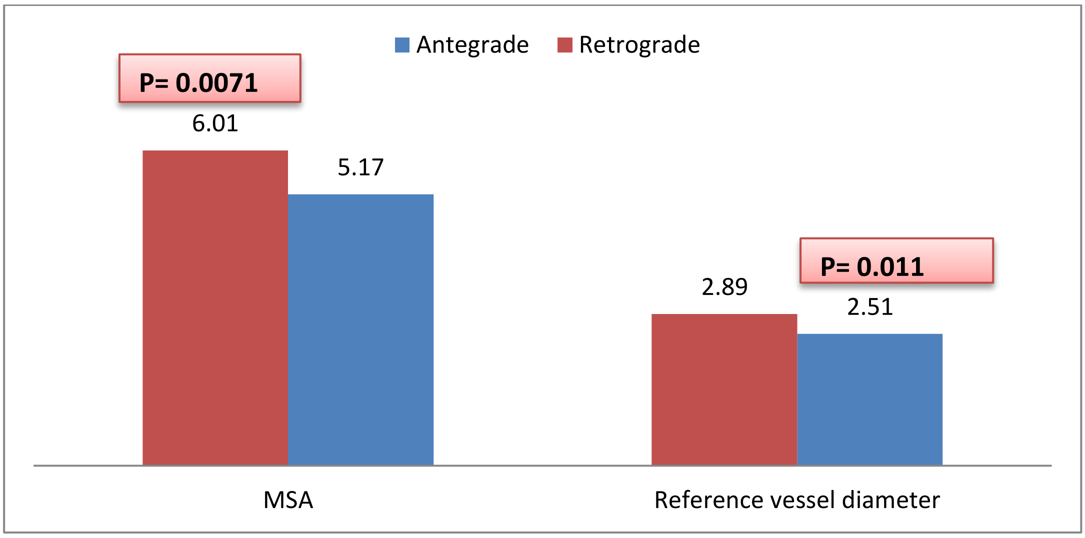

Figure IV: Mean Distribution of Reference vessel diameter and MSA between Antegrade and Retrograde Group (n=152).

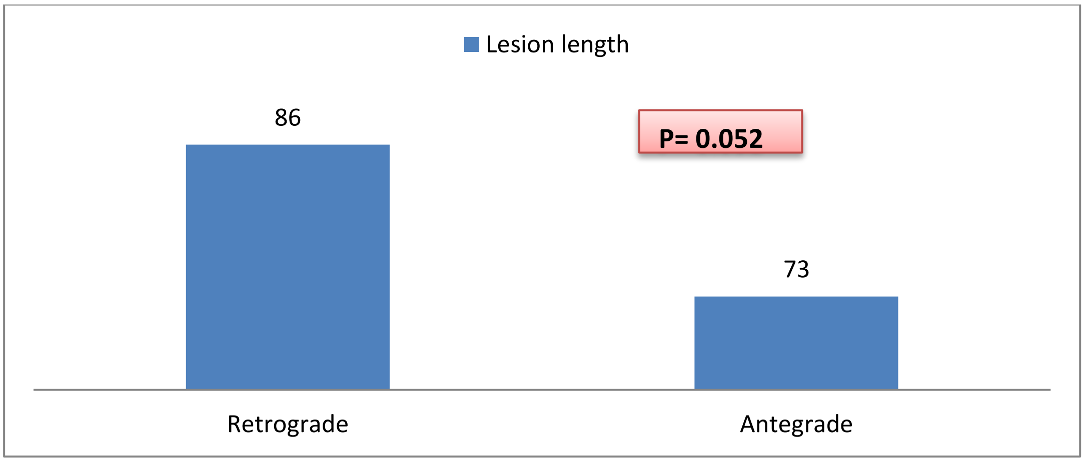

Figure V: Median Distribution of Lesion length between Antegrade and Retrograde Group (n=152).