Long term follow up after successful recanalization of coronary artery chronic total occlusion using antegrade versus retrograde approach by single photon emission computed tomography.

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Abstract

Background: Coronary chronic total occlusions (CTOs) represent the most technically challenging lesion subset that interventional cardiologists face. CTOs are identified in up to one third of patients referred for coronary angiography and remain seriously undertreated with percutaneous techniques. The complexity of these procedures and the suboptimal success rates over a long period of time, along with the perception that CTOs are lesions with limited scope for recanalization, account for the underutilization of CTO Percutaneous Coronary Intervention (PCI).

Keywords: CTO, Coronary intervention, Registy data, Retrograde approach, SPECT.

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Introduction

As the degree of coronary artery disease progresses, there may be near-complete obstruction of the lumen of the coronary artery, severely restricting the flow of oxygen-carrying blood to the myocardium. Individuals with this degree of coronary artery disease typically have suffered from one or more myocardial infarctions (heart attacks), and may have signs and symptoms of chronic coronary ischemia, including symptoms of angina at rest [1].

A distinction should be made between myocardial ischemia and myocardial infarction. Ischemia means that the amount of blood supplied to the tissue is inadequate to supply the needs of the tissue. When large areas of the myocardium become ischemic, there can be impairment in the relaxation and contraction of the myocardium. Infarction means that the tissue has undergone irreversible death due to lack of sufficient oxygen-rich blood [2].

Periprocedural myocardial injury (PMI) is defined as the subset of patients who had evidence of prolonged ischemia as demonstrated by persistent chest pain (>20 minutes), new pathological Q waves seen on the electrocardiogram, or cardiac troponin level elevation using various cutoffs [3].

One of the most technically challenging interventions is PCI of chronic total occlusions (CTOs) which may require use of advanced crossing techniques, resulting in high rates of PMI. Coronary CTOs were defined as coronary lesions with thrombolysis in myocardial infarction (TIMI) grade 0 flow for a duration of at least 3 months [4]. The prognostic implications of PMI in CTO PCI remain unclear [5].

PMI is also more frequent when the retrograde approach is used and is associated with worse subsequent clinical outcomes [6].

99 mTc sestamibi scintigraphy can be used to accurately quantify the extent of myocardial scarring. Furthermore, the relative sestamibi activity in perfusion defects, measured several hours after administration, is a good indicator of myocardial viability determined with microscopy [7].

Aim of the Work

A comparative study between antegrade versus retrograde recanalization of coronary chronic total occlusion, with special concern to ischemic burden assessment by SPECT pre-procedure and six months after.

Patients and Methods

Thirty patients with CTO were treated by an antegrade approach procedure, and another thirty patients with CTO were treated by a retrograde approach.

Each patient in the two groups was examined clinically, doing resting ECG, transthoracic echo, stress ECG before CTO approach.

99 mTc sestamibi scintigraphy was done for each patient before CTO approach to detect the viability of the myocardium and to detect the size of reversible ischemia, and after six months of CTO approach was done for detection the effect of antegrade and retrograde approach for CTO on the viability of the myocardium and reversible ischemia.

Technical Design

Site of study

Cardiology Department, Al-Azhar University Hospitals in collaboration with National Heart Institute.

Sample size

Total patients: 60 patient 30 patient antegrade approach and 30 patient retrograde approach.

Subjects Included in the Study

Inclusion criteria

Patients who have moderate to severe ischemia.

Patients who have had a successful CTO PCI.

Single vessel CTO.

Exclusion criteria

Failed CTO PCI.

Renal Failure.

Heart failure with reduced ejection fraction.

Non-viable CTO territory.

Any DAPT contraindications.

Standard contraindications to coronary angiography.

Tools and Instruments

Electrocardiogram, transthoracic echocardiography, stress ECG, 99 mTc sestamibi scintigraphy for myocardial viability and CTO PCI for all the patients.

Operational Design

Type of Study: Prospective cohort study.

Steps of Performance and Techniques used

Complete history taking.

Electrocardiographic examination.

Conventional Transthoracic Echocardiography.

Stress Electrocardiogram.

99 mTc sestamibi scintigraphy scanning for myocardial viability.

Cardiac biomarkers (Ck-MB) levels were done to all patients before and after the PCI.

CTO PCI was performed to all patients. Antegrade and retrograde approach.

SPECT Myocardial Perfusion Imaging

All patients deemed were encouraged to come off their beta-blockers and calcium-channel-blockers (negative chronotropic) for 48 hours and nitrates for 24 hours prior to the study and were asked to fast for 4 hours.

We do a 2-day protocol and all patients except those who have a depressed systolic function less than 35% and known to be ischemic will start with stress day. The patient is asked to take off his /her clothes, to shave the chest hair in males, and to pull breasts up and outwards in females. The chest is scrubbed using alcohol swap then electrodes are connected to the chest wall. A cannula is inserted.

The patient did either treadmill stress test according Bruce protocol or pharmacological stress using dobutamine agents.

In treadmill stress test the patient will be exercised according to Bruce protocol aiming to reach at least 85% max predicted heart rate according to the patient 's age (220-the patient 's age) plus at least 5 METs to inject the isotope intravenously. In pharmacological stress using dobutamine is infused incrementally starting at a dose of 5 or 10 mcg/kg/ min, which is increased at 3-minute intervals to 20, 30, and 40 mcg/kg/min. Radiotracer is injected at peak heart rate with dobutamine infusion continuing for 1-minute following tracer injection. As with exercise stress, achieving greater than 85% of the predicted heart rate is desirable.

Also, we use the Tc-99 m Sesta MIBI as a tracer. The dose of the isotope is calculated according to the weight of the patient. A light fatty meal given 15-20 min after the injection and SPECT imaging acquired 1 hour following the injection of the radionuclide. Scintigraphy gated images obtained quantitatively by using either a dedicated software (Auto QUANT 6.0; Philips Medical Systems; Cleveland; Ohio).

Sixty-four (thirty-two frames by the dual head camera) projection images were acquired using the stop-and-shoot method. An electrocardiogram R-wave detector provided a gate to acquire eighteen frames per cardiac cycle. Three sets of SPECT slices representing summed, end-diastolic, and end-systolic images formed for computer display.

If the patient has a homogenous perfusion imaging, normal systolic function and no SWMA, the patient will have a stress only day. If the patient has either a perfusion defect, SWMA or an abnormal systolic function, the patient will have another day with rest or rest with nitrate potentiation.

On the 2nd day the patient will come on full medical treatment and fasting for 4 hours. The patient will be injected and will be asked to have a light fatty meal and the SPECT images will be acquired after injection by 1 hour.

Initial image analysis and interpretation: The initial interpretation of the perfusion study should be performed without any clinical information other than the patient's gender, height and weight. Such an approach minimizes the bias in study interpretation. All relevant clinical data should be reviewed after a preliminary impression is formed.

Ventricular dilation: Before segmental analysis of myocardial perfusion, the reader should note whether there is LV enlargement at rest or post- stress or not. Dilation of the LV on both the stress and resting studies usually indicates LV systolic dysfunction, although it may be seen in volume overload states (e.g. severe mitral or aortic regurgitation) with normal ventricular systolic function. An increased stress-to-rest LV cavity ratio, also referred to as transient cavity dilatation (TCD) or transient ischemic dilation (TID), has been described as a marker for high-risk coronary disease. It is actually apparent, and not true, dilatation of the ventricle with stress, and is most likely caused by diffuse subendocardial ischemia and can be seen in other conditions, such as microvascular disease, that cause diffuse subendocardial ischemia even in the absence of epicardial coronary disease. TID is typically described qualitatively but may also be quantified. Normal limits by quantitation will depend on perfusion imaging protocol, the image processing parameters, and the software algorithm used.

Lung uptake: the presence of increased lung uptake after thallium perfusion imaging has been described as an indicator of poor prognosis and should therefore be evaluated in all patients when using this perfusion agent.

Right ventricular uptake: may be qualitatively assessed on the raw projection data and on the reconstructed data. There are no established quantitative criteria for RV uptake.

Non-cardiac findings: Both thallium-and technetium-based agents can be concentrated in tumors, and uptake outside the myocardium may reflect unexpected pathology.

Perfusion defect location: Identified by the use of visual analysis of the reconstructed slices. The perfusion defects should be characterized by their location as they relate to specific myocardial walls that is, apical, anterior, inferior, and lateral. The term posterior should be avoided because it has been variably assigned to either the lateral wall (circumflex distribution) or to the basal inferior wall (right coronary distribution), and is thus ambiguous. Standardization of segment nomenclature is highly recommended.

Defect extent may be qualitatively described as small, medium, or large (Figure 1).

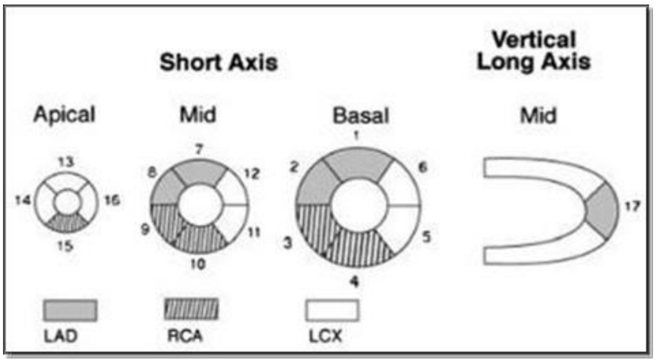

Figure 1. *Territories of coronary arteries.* ***Abbreviations:*** *LAD: Left Anterior Descending Artery; RCA: Right Coronary Artery; LCX: Left Circumflex Artery.*

In semi-quantitative terms, small represents less than 5%, medium represents 5%-9%, and large represents greater than or equal to 10% of the LV. Alternatively, defect extent may also be estimated as a fraction such as the ‘‘basal one half’’ or ‘‘apical one-third’’ of a particular wall or as extending from the base to the apex. Defects whose severity and extent do not change between stress and rest images are categorized as ‘‘fixed’’ or ‘‘nonreversible.’’ When perfusion defects are more severe and/or extensive on stress compared to resting images, a qualitative description of the degree of reversibility is required.

Semi-quantitative in addition to the qualitative evaluation of perfusion defects, it is recommended that the physician also apply a semi-quantitative segmental scoring system. This approach standardizes the visual interpretation of scans, reduces the likelihood of overlooking significant defects, and provides an important semi-quantitative index that is applicable to diagnostic and prognostic assessments (Figure 2).

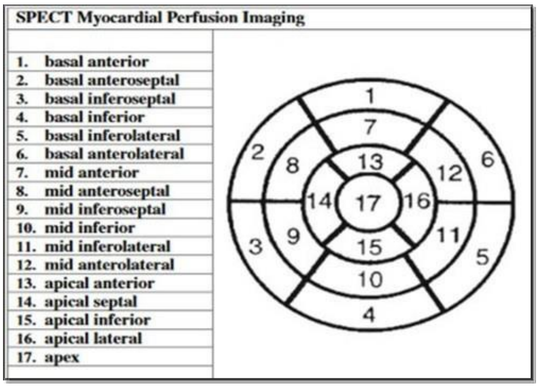

Figure 2. *Myocardial segmentation on Bull's eye.*

The QA Committee of the American Society of Nuclear Cardiology has considered several models for segmentation of the perfusion images and has previously recommended either a 17- or 20-seg-ment model for semi-quantitative visual analysis. In order to facilitate consistency of nomenclature with other imaging modalities, the 17-segment model is preferred and the 20-segment model should no longer be used.

The use of a five-point scoring system provides a reproducible semi- quantitative assessment of defect severity and extent. A consistent approach to defect severity and extent are clinically important because both variables contain independent prognostic information. Points are assigned to each segment according to the perceived count density of the segment. In addition to individual scores, it has been recommended that summed scores be calculated.

The summed stress scores equal the sum of the stress scores of all the segments and the summed rest score equals the sum of the resting scores (or redistribution scores) of all the segments. The summed difference score equals the difference between the summed stress and the summed resting (redistribution) scores and is a measure of perfusion defect reversibility reflecting inducible ischemia. In particular, the summed stress score has been shown to have significant prognostic power, although the resting perfusion data provide incremental prognostic information as well.

Before scoring, it is necessary for the interpreting physician to be familiar with the normal regional variation in count distribution of myocardial perfusion SPECT in men and women (Figure 3).

Category	Score
Normal perfusion	0
Mild reduction in counts—not definitely abnormal	1
Moderate reduction in counts—definitely abnormal	2
Severe reduction in counts	3
Absent uptake	4

Figure 3. *5-point scoring system in semi-quantitative analysis.*

Quantitative analysis: it is useful to supplement visual interpretation. Most techniques of quantitative analysis are based on radial plots of short- axis slices, and analyze the apex separately. These plots are then normalized to allow comparison to a normal gender-specific database. Defect severity can be defined based on the patient's regional myocardial tracer activity compared to the mean regional activity of a normal database. Quantitation of the stress perfusion is compared to the resting perfusion to assess the extent and severity of ischemia. It is customary to use separate normal data bases specific to the patient's gender as well as the perfusion agent used. This quantitative analysis is typically displayed as a ''bulls- eye'' or polar plot.

Regional wall motion should be interpreted with a gray scale display. When computer edge analysis software is available, the physician may choose to analyze wall motion by use of the assigned endocardial and epicardial contours, but reference should also be made to the wall motion without computer-derived edges. Regional wall thickening may be analyzed in gray scale or in a suitable color scheme, although color displays may make it easier to appreciate changes in count intensity.

Gated SPECT: regional wall motion and thickening: Regional wall motion should be analyzed by the use of standard nomenclature: normal, hypokinesis, akinesis, and dyskinesis. Hypokinesis maybe further qualified as mild, moderate, or severe. A semi-quantitative is normal, 1 is mild hypokinesis, 2 is moderate hypokinesis, 3 is severe hypokinesis, 4 is akinesis, and 5 is dyskinesis. This is comparable to the 5-point scoring system used in both contrast and radionuclide ventriculography.

As in any assessment of regional ventricular function, one must be cognizant of expected normal and abnormal variations such as the reduced wall excursion at the base compared with the apex, the greater excursion of the basal lateral wall compared with the basal septum, and paradoxical septal motion, which may result from left bundle, post pericardiotomy or RV pacing. Normal myocardial wall thickness is below the spatial resolution of currently available SPECT systems. Because of the ''partial volume effect,'' regional wall thickening can be estimated by the count increase from end diastole to end systole.

It is more difficult to visually assess the severity of abnormality of myocardial wall thickening than it is to visually estimate abnormalities of wall motion. However, the evaluation of thickening with gated perfusion SPECT lends itself to quantitation because it is characterized by count changes. Wall motion and wall thickening are generally concordant. In addition to noting LV wall motion, wall thickening, and EF, the function of the RV should also be noted.

Quantitative normal databases are available for assessment of regional wall thickening. Left ventricular ejection fraction and volume.

LVEF and LV and RV chamber sizes should routinely be evaluated qualitatively, EF may be categorized as normal, mildly, moderately, or severely reduced. Volume may be categorized as normal, mildly, moderately or severely reduced. Alternatively, LVEF and end-diastolic and end-systolic volumes may be calculated with geometric models applied to the reconstructed data set.

Results

In this study, group A: 30 patients with CTO were treated by an antegrade approach procedure, and group R: 30 patients with CTO were treated by a retrograde approach (Table 1).

***Table 1.** Patients' characteristics in both studied groups.*

		Group A (n=30)	Group R (n=30)	P-value
Age(years)	Mean ± SD	52.6 ± 5.84	53.4 ± 7.36	230
	Range	42-64	40-65	230
Sex	Male	21(70%)	18(60%)	230
	Female	9 (30%)	12(40%)	230
Hypertension	HTN	17(56.7%)	20(66.7%)	230
	No HTN	13(43.3%)	10(33.3%)	230
Diabetes mellitus	DM	19(63.3%)	16(53.3%)	230
	No DM	11(36.7%)	14(46.7%)	230
Smoking	Smoker	24(80%)	22(73.3%)	230
	Not	6(20%)	8(26.7%)	230
Previous MI	Previous MI	5 (16.7%)	7(23.3%)	230
	No	25(83.3%)	23(76.7%)	230
Previous PCI	Previous PCI	7(23.3%)	5(16.7%)	230
	No	23(76.7%)	25(83.3%)	230
Chest pain	C/O chest pain	30(100%)	30(100%)	230
	No	0(0%)	0 (0%)	230

Patients' characteristics (age, sex, hypertension, diabetes mellitus, smoking, previous MI, previous PCI and chest pain) were insignificantly different between both groups (Figure 4).

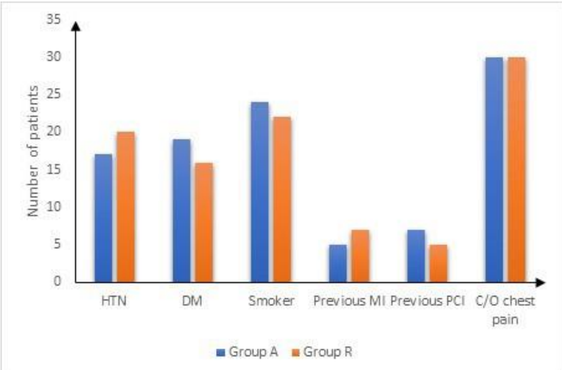

***Figure 4.** Past history of both groups.*

Duration of PCI procedure and contrast volume of PCI procedure were significantly decreased in group A than group R (P<0.001) (Table 2).

***Table 2.** PCI procedure in both studied groups.*

		Group A (n=30)	Group R (n=30	P-value
Duration of PCI procedure (min)	Mean ± SD	86.2 ± 20.29	162 ± 25.78	
	Range	60-120	120-205	<0.001*
Target vessel	LAD	13(43.3%)	17(56.7%)	0.302
	LCX	8(26.7%)	10(33.3%)	0.571
	RCA	9(30%)	3(10%)	0.104
Number of s tent implanted	1	(30%)	10(33.3%)	0.555
	2	15(50%)	17(56.7%)	
	3	6(20%)	3(10%)	

Contrast volume of PCI procedure (ml)	Mean ± SD	335.3 ± 70.8	429.7 ± 68.3	<0.001*
	Range	250-450	300-550	
Note: *significant as P-value<0.05				

Target vessel and number of stents implanted were insignificantly different between both groups (Figure 5).

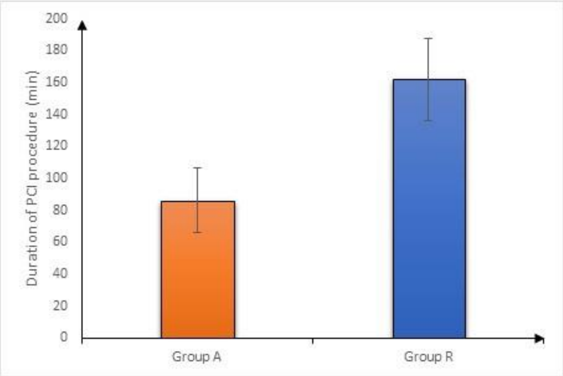

Figure 5. *Duration of PCI procedure of both groups.*

Stress perfusion defect before PCI was insignificantly different between both groups (Table 3).

Table 3. *Stress perfusion defect in both studied groups.*

		Before PCI	After PCI	Decrease
Group A (n=30)	Mean	20.83	4.7	16.13
	± SD	3.77	2.6	1.17
Group R (n=30)	Mean	19.33	6.67	12.67
	± SD	4.53	1.6	2.92
P value		0.169	0.001*	0.007*

Stress perfusion defect after PCI was significantly decreased in group A than group R (P=0.001), stress perfusion defect decrease was significantly increased in group A than group R (P=0.007) (Figure 6).

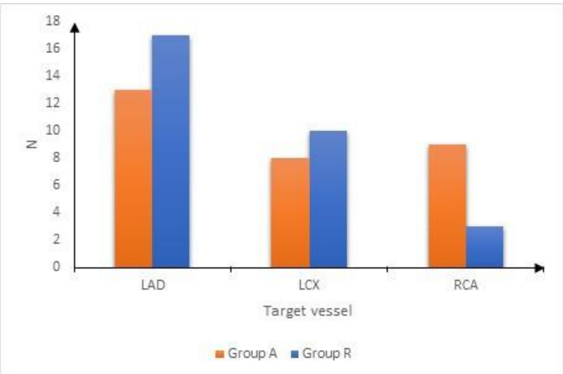

Figure 6. *Target vessel of both groups.*

Rest perfusion defect before PCI, after PCI and decrease were insignificantly different between both groups (Table 4 and Figure 4).

Table 4. *Rest perfusion defect in both studied groups.*

		Before PCI	**After PCI**	**Decrease**
Group A (n=30)	Mean	6.77	1.47	5.3
	± SD	2.3	1.01	1.29
Group R (n=30)	Mean	6.6	1.9	4.7
	± SD	1.63	1.27	0.36
P-value		0.747	0.148	0.323

Stress rest perfusion difference before PCI was insignificantly different between both groups (Table 5). Stress rest perfusion difference after PCI was significantly decreased in group A than group R (P=0.022), stress rest perfusion difference decrease was significantly increased in group A than group R (P=0.030) (Figures 7-12).

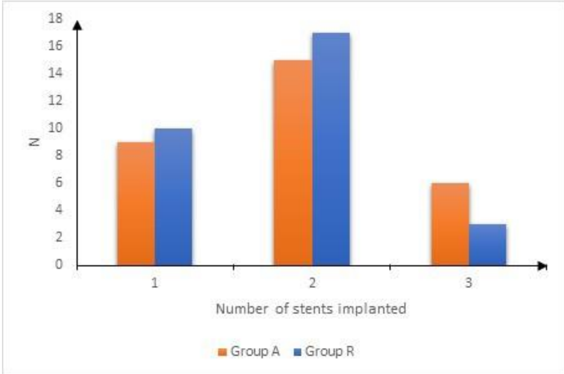

Figure 7. *Number of stents implanted of both groups.*

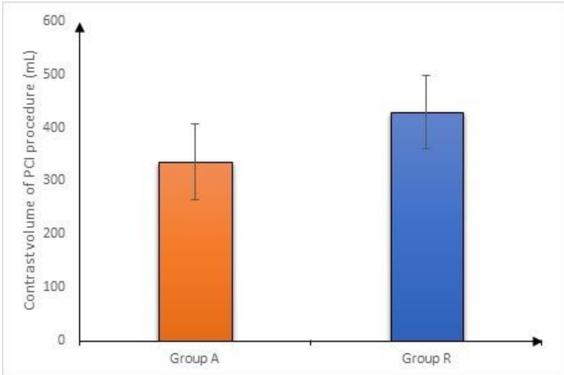

Figure 8. *Contrast volume of PCI procedure of both groups.*

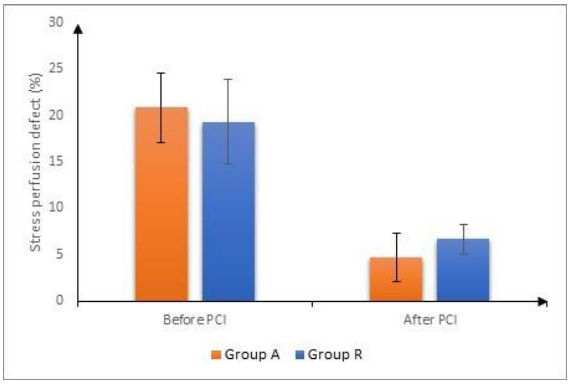

Figure 9. *Stress perfusion defect of both groups.*

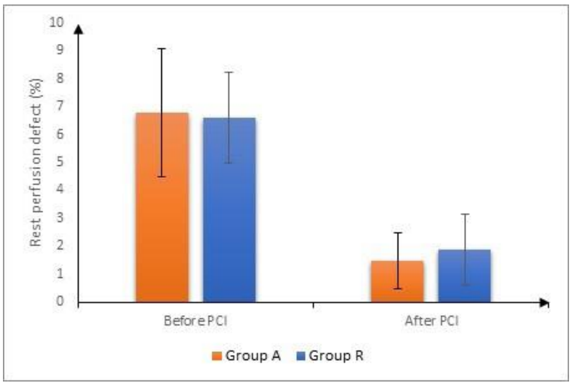

Figure 10. *Rest perfusion defect of both groups.*

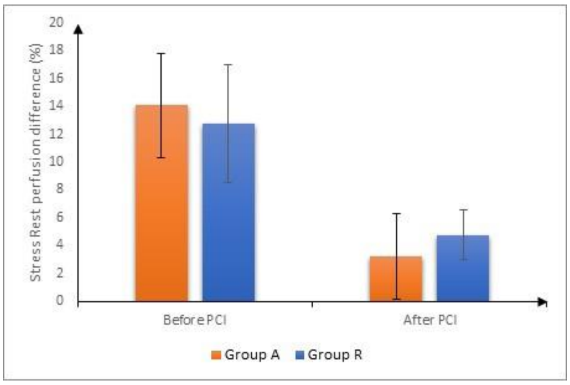

Figure 11. *Stress rest perfusion difference of both groups.*

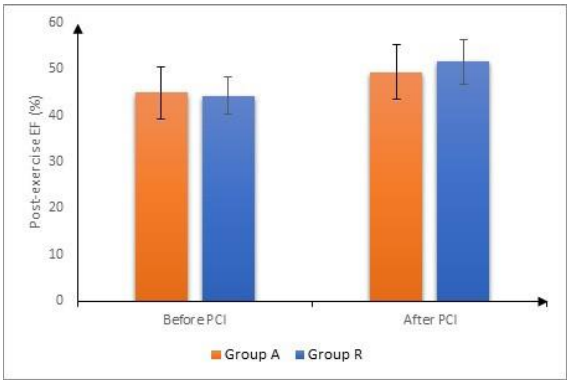

Figure 12. *Post-exercise EF of both groups.*

Table 5. *Stress rest perfusion difference in both studied groups.*

		Before PCI	After PCI	Decrease
Group A (n=30)	Mean	14.07	3.23	10.83
	± SD	3.74	3.08	0.66
Group R (n=30)	Mean	12.73	4.77	7.97
	± SD	4.23	1.77	2.45
P-value		0.201	0.022*	0.030*
Note: *significant as P value <0.05				

Post-exercise EF before PCI, after PCI and decrease were insignificantly different between both groups (Table 6).

Table 6. *Post-exercise EF in both studied groups.*

		Before PCI	After PCI	Decrease
0.201	Mean	44.87	49.33	-4.47
	± SD	5.61	5.9	-0.29
0.201	Mean	44.27	51.5	-7.23
	± SD	4.08	4.85	-0.77
P-value		0.638	0.126	0.065

Discussion

Chronic total occlusions (CTOs) of coronary arteries are common and can be seen in 15%–30% of patients with coronary artery disease [8].

Percutaneous coronary intervention (PCI) of chronic total occlusion (CTO) remains one of the most challenging procedures in interventional cardiology. The main barriers to CTO PCI are: procedural complexity and uncertainties regarding its clinical benefit. CTO PCI is technically challenging and requires skill sets that are very different from non-CTO PCI. It is considered the “final frontier” of coronary intervention. Recently, there has been a growing interest in CTO revascularization as evidenced by developments of novel techniques and devices with improved success rates [9].

In case of anterograde failure to cross the CTO lesion, the retrograde approach may improve the success rate of such procedures.

Using a retrograde approach, as originally described by the Toyohashi Heart Center group in 2006, has dramatically improved success rates of chronic total occlusion (CTO) percutaneous coronary intervention (PCI) [10,11].

However, there remains skepticism and controversy regarding the true clinical benefits of successful CTO revascularization. Single photon emission computed tomography (SPECT) can also be used in the assessment of both ischemia and viable myocardium. Two main tracers can be used: thallium-201 or technetium-99 m. Prior clinical studies suggested that myocardial perfusion imaging with either thallium-201 or technetium-99 m sestamibi can provide clinically important information pertaining to the status of myocardial viability when systolic dysfunction exists in the setting of severe coronary artery disease or after an acute myocardial infarction. This ability to identify ischemic or viable myocardium can help with identification of suitable patients to undergo CTO PCI. [12].

We conducted this study to compared between antegrade versus retrograde recanalization of coronary chronic total occlusion, with special concern to ischemic burden assessment by SPECT pre-procedure and six months after.

In this study, group A: 30 patients with CTO were treated by an antegrade approach procedure, and group R: 30 patients with CTO were treated by a retrograde approach.

In the current study, duration and contrast volume of PCI procedure was significantly lower in group A than group R (P <0.001). While target vessel and number of stents implanted were insignificantly different between both groups.

In harmony with current study, Lee et al. included patients that underwent 321 consecutive attempts. The antegrade approach was used in 152 patients, and retrograde in 169 patients. Their results showed that, the procedure and fluoroscopy times were significantly longer, with more radiation exposure and contrast medium consumption, in the retrograde group. But in disagree with our results, the target CTO lesions were located in right coronary artery (RCA) in 48.6% of the patients, left anterior descending artery (LAD) in 34.9%, and left circumflex artery (LCX) in 15.6%. With significant difference between groups [13,14].

Similarly, the different antegrade and retrograde techniques according to Pillai et al. showed no statistically significant association was seen between the occluded vessel targeted for intervention and the procedural success (p=0.13 by chi-square test) [15].

Moreover, in study by Harding et al. the current radiation and contrast dose, and fluoroscopy time were all comparable [16].

In contrast with current study, baseline characteristics and comparison between those who underwent retrograde versus antegrade procedures are listed by Wu et al. they found number of stents implanted in CTO vessel was 2.1 in Antegrade versus 2.5 in retrograde with significant difference, p<0.001. on the other hands, their results was similar to our finding regarding procedure time (minutes) which significantly prolonged in retrograde than antegrade. Also, Right coronary artery CTO was more commonly approached with retrograde (58% vs. 38.2%) and in-stent restenosis cases were more commonly performed through an antegrade approach only (12.6% vs. 5.7%) with significant difference [17].

In addition, Karmpaliotis et al. reported that, the retrograde approach contributed to 28.7% of all technical success at a cost of more contrast (300 [220-404] versus 245 [180–320] mL; P<0.001), longer procedure time (183 [128-234] versus 100 [68-135] min; P<0.001), compared with antegrade-only cases, respectively [18].

In current study, stress perfusion defect after PCI was significantly decreased in group A than group R (P=0.001), stress perfusion defect decrease was significantly increased in group A than group R (P=0.007). Rest perfusion defect before PCI, and decrease were insignificantly different between both groups. Stress rest perfusion difference after PCI and stress rest perfusion decrease was significantly decreased in group A than group R (P=0.022 and 0.030 respectively). Post-exercise EF and rest EF before PCI, after PCI and decrease were insignificantly different between both groups.

According to our knowledge, there was limited number of studies compared between both modalities in PCI. On the other hands, efficacy and operative outcome of either retrograde and antegrades technique of PCI was evaluated previously. In study by Tuma et al. schemic stress-induced myocardial segments assessed by percutaneous retrograde coronary sinus perfusion (PRCSP) received. They found that, the median baseline area of ischemic myocardium by SPECT of 38.2% was reduced to 26.5% at one year and 23.5% at two years (p=0.001). The median rest left ventricular ejection fraction by SPECT at baseline was 31.2% and improved to 35.5% at 2 year follow up (p=0.019) [19].

Moreover, percutaneous retrograde coronary sinus perfusion (PRCSP) is a well-established technique for delivery of cardioplegia solution in cardiovascular surgery and for protection against myocardial ischemia in patients undergoing high risk percutaneous coronary intervention (PCI) in many studies [19,20].

And regarding to antegrade approaches, study by Pujadas et al. using cardiac magnetic resonance (CMR) had shown inducible perfusion defects in 26 (79%) before PCI, while they were observed in 10 (30%) post-PCI CMR study (p<0.001). The number of segments showing inducible perfusion defect (3.4 ± 2 pre vs. 2.9 ± 4.5 post-PCI, p=0.002) was significantly reduced in this group [21].

Our results was supported by many trails showed that, direct comparisons between gated single photon emission computed tomography (SPECT) and magnetic resonance imaging (MRI) have shown excellent correlations for the evaluation of both global and regional left ventricular function [22,23].

Moreover, in those without prior history of myocardial infarction, stress-induced reversible perfusion defects are observed on single-photon positron emission CT (SPECT) imaging, as shown in a series by

He et al and Enein et al with single vessel CTO. To detect reversible perfusion defects in CTO, adenosine SPECT imaging has been found to be more sensitive than exercise-induced stress imaging [24].

This was in line with Pillai et al. single-center non-randomized descriptive follow-up study on CTO PCI. Techniques employed were antegrade guide wire escalation approach, antegrade parallel wire, and dissection/re-entry. The conventional approach was antegrade in this series. An increase in left ventricular ejection fraction (LVEF) was noted following successful CTO PCI after complete revascularization in both groups equally [15,25].

This study was in disagree with Schumacher et al. compared outcomes in 193 patients who underwent chronic total occlusion (CTO) percutaneous coronary intervention (PCI) using different techniques: antegrade wire escalation, retrograde wire escalation, antegrade dissection and reentry (ADR), and retrograde dissection and reentry. They found increase in hyperemic MBF (P=0.40) and coronary flow reserve (1P=0.84) and decrease in defect size (P=0.77) were comparable between the 4 approaches. Although sometimes necessary to cross a complex CTO lesion, subintimal knuckle wiring and subintimal tracking and reentry resulted in less hyperemic MBF improvement compared with other subintimal crossing and reentry techniques [26-29].

Another opinion was reported by Riley and Yeh, as antegrade dissection and reentry (ADR) was initially adapted from the subintimal tracking and reentry (STAR) technique. This involved pushing a looped or knuckled guidewire within the CTO segment until it reentered the distal true lumen. This approach typically results in an uncontrolled reentry into the distal true lumen of the vessel, can result in poor runoff, and has been associated with high rates of target vessel failure when used as a primary revascularization strategy. One adaptation of subintimal tracking and reentry is limited antegrade subintimal tracking. This approach involves placement of a guidewire in a subintimal position. The subintimal space is then fenestrated into the true lumen with a stiff wire, followed by wiring the true lumen with a medium-weight polymer jacketed wire. However, similar to subintimal tracking and reentry, reentry with limited antegrade subintimal tracking has associated with relatively poor long-term outcomes. Evolving from these strategies, dedicated equipment for ADR has been developed to make subintimal reentry more reliable and has resulted in much more favorable, durable long-term results. Use of retrograde recanalization techniques are now standard techniques that associated with significant improvements by expert operators [27-29].

Summary

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.

With recent advances in interventional devices, procedural techniques, and operator experience, the technical success rate of modern CTO PCI is consistently above 90%, with low procedural complication rate. The retrograde approach has been developed and utilized worldwide in recent years, thanks to the development of modern guide-wires and micro-catheters allowing aggressive collateral channel tracking. However, many experts still use the antegrade approach as the default initial strategy, and reserve the retrograde approach only for reattempts.

During the past decade, there has been a renewed interest in treating coronary chronic total occlusions (CTOs) percutaneously after the development of both controlled anterograde dissection reentry (ADR) and retrograde recanalization techniques, which are often utilized in the treatment of more complex CTOs.1 Antegrade dissection reentry (ADR) refers to an attempt to cross a CTO lesion that leads to wire or equipment passage in the subintimal space followed by reentry to the distal true lumen.

The use of a retrograde approach and algorithm-driven CTO (chronic total occlusion) percutaneous coronary intervention (PCI) has become widespread, and many registries have reported good results.

We conducted this study to compared between antegrade versus retrograde recanalization of coronary chronic total occlusion, with special concern to ischemic burden assessment by SPECT pre-procedure and six months after.

In this study, group A: 30 patients with CTO were treated by an antegrade approach procedure, and group R:30 patients with CTO were treated by a retrograde approach.

Our results showed that;Patients' characteristics (age, sex, hypertension, diabetes mellitus, smoking, previous MI, previous PCI and chest pain) were insignificantly different between both groups.

The duration and contrast volume of PCI procedure was significantly lower in group A than group R (P<0.001). While target vessel and number of stents implanted were insignificantly different between both groups.

The stress perfusion defect after PCI was significantly decreased in group A than group R (P=0.001), stress perfusion defect decrease was significantly increased in group A than group R (P=0.007). Rest perfusion defect before PCI, and decrease were insignificantly different between both groups. Stress rest perfusion difference after PCI and stress rest perfusion decrease was significantly decreased in group A than group R (P=0.022&0.030 respectively). Post-exercise EF and rest EF before PCI, after PCI and decrease were insignificantly different between both groups.

Conclusion

PCI CTO treatments are very demanding in terms of staff skills and equipment used. Retrograde approach had a higher duration and contrast volume of PCI procedure compared to antegrade approach but without differences in target vessel and number of stents implanted.

Retrograde approach had a higher stress perfusion defect and stress rest perfusion difference after PCI compared to antegrade approach but without difference in rest perfusion defect. Post-exercise EF and rest EF before PCI, after PCI and decrease were insignificantly different between both retrograde and antegrade approaches.

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