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Clinical outcomes of ostial stenting versus left main cross-over stenting in patients with isolated ostial left anterior descending artery stenosis presented with acute coronary syndrome

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Abstract
Background: Controversial outcomes are present in the current literature on isolated ostial Left Anterior Descending artery (LAD) disease. The aim of this investigation was to investigate the clinical outcomes of patients who presented with acute coronary syndrome and an ostial LAD significant lesion treated with crossover stenting and the others were treated with precise ostial stenting.
Methods: This observational investigation was conducted on 68 patients, both male and female, with acute coronary syndrome and underwent Percutaneous Coronary Intervention (PCI). The culprit lesion was an isolated ostial LAD lesion. Patients were further subdivided into two groups: Group 1 (Ostial stenting) (n = 41): Precise ostial LAD stenting and Group 2 (Cross-over stenting) (n = 27): LM-LAD cross over stenting.
Results: There was significant difference between the two groups regarding stent length, Major Adverse Cardiovascular Events (MACE), maximum stent post dilatation, kissing balloon inflation (KBI) and type of intervention (P value <0.05). Univariate and multivariate analysis were performed to investigate the possible predictive factors for MACE. In univariate analysis: crossover stenting and performing KBI were associated with lower incidence of MACE, but multivariate analysis showed none of both can independently predict incidence of MACE.
Conclusions: Patient with significant isolated ostial LAD lesion treated with PCI using precise ostial stenting had higher incidence of MACE compared to LM - LAD crossover stenting, so in term of both safety and efficacy, 6-month clinical outcomes of PCI to isolated ostial LAD stated that the crossover stenting might be reasonable and safe option in treating ostial LAD lesions.

Keywords: Ostial stenting, ostial left anterior descending artery stenosis, acute coronary syndrome

Introduction
Globally, atherosclerotic cardiovascular disease ranks first in terms of mortality. Atherosclerosis often entails the development of plaques inside the lumen of coronary arteries that obstruct blood flow [1].
The most critical damage occurs when atherosclerotic plaque becomes unstable and ruptures, a condition known as vulnerable plaque. This rupture induces the formation of thrombi, which can obstruct blood flow and subsequently result in the development of Acute Coronary Syndrome (ACS) [2].
ACS caused by isolated ostial Left Anterior Descending (LAD) lesions is linked to high morbidity and mortality due to the extensive ischemic area. However, clinical evidence regarding the most effective interventional approach remains limited, particularly in cases of ostial LAD-related acute myocardial infarction [3].
The main objective of Percutaneous Coronary Intervention (PCI) for ostial LAD lesions is to reduce the risk of injury to nearby bifurcation segments while obtaining total stent coverage of the plaque at the coronary ostium [4].
Although angiography may underestimate involvement of distal Left Main (LM) as an apparently simple Medina 0,1,0 lesion, determining its extent in such situations might be difficult. An intravascular ultrasonography investigation found that isolated ostial LAD stenosis is substantially less prevalent than anticipated by traditional angiography [5].

There are two important stenting strategies that might be used for this bifurcation lesion: precise ostial stenting and the provisional approach, which is sometimes called crossover stenting from LM to LAD [6].

The most common strategy for treatment of isolated ostial LAD lesions is accurate ostial stent placement, which has the potential to impair the LM bifurcation and increase the chance of geographic miss (missing the real ostium). Stent positioning from the distal LM into the LAD ostium is an alternate stenting strategy [7].

Compared to solely covering the LAD ostium, this approach may provide more comprehensive lesion coverage while potentially avoiding the development of LM disease that could be induced by the ostial stenting procedure [7].

On the other hand, ostial LAD stenoses that need crossover stenting from the LM trunk to the LAD might lead to dangerous stent thrombosis due to stent malapposition at the LMT and left circumflex artery (LCX) flow limitation. There is still much uncertainty about the patterns of restenosis and the incidence of reintervention for restenotic lesions, which includes the surrounding stent-free LM segment after ostial LAD stenting [8].

The major cardiovascular and cerebral events (MACCE) in this particular patient population have not been well studied [10]. Furthermore, the present research on isolated ostial LAD lesions has contradictory results. While many scientists prefer the precise ostial stenting approach, others highlight that the clinical results of cross-over stenting are more favourable [6, 9].

This work aimed to study the difference in clinical outcomes of patients presented with ACS with ostial LAD significant lesion treated with the crossover stenting and those treated with precise ostial stenting.

Patients and Methods

This observational study was performed on 68 patients, both sexes, with ACS treated with PCI in whom the culprit lesion was isolated ostial LAD lesion. The study was done from January 2022 to January 2024 after approval from the Ethical Committee, Faculty of Medicine, Tanta University Hospitals, Tanta, Egypt. The study was conducted in accordance with the declaration of Helsinki. The patient or their family members were asked to sign a formal permission form after receiving all relevant information.

The exclusion criteria were patients with multivessel disease, and those with an angiographically significant distal LM or ostial LCX lesion.

Patients were further subdivided into two groups: Group 1 (Ostial stenting) (n = 41): Precise ostial LAD stenting and Group 2 (Cross-over stenting) (n = 27): LM-LAD cross over stenting.

All patients were subjected to complete history taking [Systemic hypertension, diabetes mellitus as defined by American Diabetes Association, dyslipidaemia, smoking, family history of premature coronary artery, renal impairment, recent surgery or trauma, and cerebrovascular events], full clinical examination [vital signs, general examination and local cardiac examination], resting 12 leads Electrocardiogram (ECG), baseline laboratory tests, reperfusion through percutaneous coronary intervention, echocardiography, follow-up for in-hospital outcomes and clinical follow-up for 6 months.

Patients were allocated to PCI according to catheterization lab availability after confirming diagnosis.

Reperfusion through percutaneous intervention for Infarct related artery

All patients underwent coronary angiography using standard femoral or radial approach using standard catheters.

Culprit ostial LAD lesion was identified, patients with angiographically significant distal LM or ostial LCX stenosis were excluded.

PCI was carried through the femoral artery or radial artery using Seldinger's technique and using 6F or 7F catheters JL3.5, 4.0, XB 3.5. The choice of stent strategy (cross-over stenting or precise ostial stenting) was left to the operator's discretion.

The choice of DES was at the discretion of the physician. Stents which were used in the study were FDA approved eg: Everolimus Eluting Stent (Xience, Promus stents) and Zotarolimus Eluting Stent (Onyx).

The following information was obtained: Stent type, size and length and special procedural steps (such as post dilatation and kissing balloon inflation) were used when indicated according to operator's discretion.

Procedural outcomes were recorded including main vessel and side branch complications and optional procedural steps and post PCI complications (bleeding - contrast induced nephropathy)

Echocardiography

A Philips CX50 cardiac ultrasound phased array system with tissue Doppler imaging employing an S5-1 PureWave transducer operating at 5-1 MHz was used for all investigations.

In-hospital outcome regarding post PCI complications (bleeding -CIN) and MACCE which is defined as occurrence of (mortality - re-infarction - heart failure - revascularization - stroke) [10].

Clinical follow-up: for six months, regarding MACCE (mortality - myocardial infarction - heart failure - revascularization - stroke) [10].

The primary outcome was the incidence of MACCE (mortality - myocardial infarction - heart failure - revascularization - stroke [10] at 6 months. The secondary outcomes were the individual components of the primary endpoint, in-hospital events and PCI related outcomes such as bleeding and contrast induced nephropathy.

Statistical analysis [11]

The pre-installed IBM SPSS software program version 20.0 (IBM Corp., Armonk, New York) was employed to conduct the analysis. Numbers and percentages were utilized to describe the qualitative data. The distribution's normality was confirmed using the Shapiro-Wilk test. Standard deviation, median, range (both minimum and maximum), and interquartile range (IQR) were used to depict quantitative data. To assess the results, we used a 5% significance level. Monte Carlo correction, Fisher's Exact, Mann Whitney, Chi-square, and Student T-tests were among the tests used.

Results

One hundred patients were assessed for eligibility; 30 patients did not meet the criteria; 2 patients refused to participate; 68 patients included and analyzed in this study Figure 1.

Regarding demographic data, Systolic Blood Pressure (SBP), Heart Rate (HR), electrocardiographic and

angiographic data were comparable between the two groups. Wider angles were observed in group I with a statistically significant difference (P = 0.003). Table 1

Regarding: Diabetes Mellitus (DM), Hypertension (HTN), smoking, previous PCI, dyslipidaemia and Chronic Kidney Disease (CKD), there was no statistically significant difference between two groups. Figure 2

In group I, 27 patients were presented with STEMI (65.9%) and 14 patients presented with non-STE ACS (34.1%), while in group II, 20 patients presented with STEMI (74.1%) and 7 patients presented with non-STE ACS (25.9%). Neither group differed significantly from the other. Figure 3

Regarding angiographic success, bleeding, contrast induced nephropathy, procedural success, discharge ejection fraction and control coronary angiography, there was no substantial difference between the two groups and there was considerable difference in stent length between the two groups (p<0.001). Table 2

Heart failure occurred in 10 patients (24.4%) from group I and 3 (11.1%) from group II (P = 0.173); cardiovascular death was reported in two cases, both from group I (4.9%) (P = 1.000); two patients had stroke (4.9%) in group I and 1 (3.7%) in group II (P = 1.000); total in-hospital events were recorded in 11 cases (26.8%) in group I and 3 (11.1%) in group II, with no significant difference; and the mean discharge ejection fraction was comparable with 46.2 ± 7.44% in group I and 45.33 ± 5.45% in group II (P = 0.607, Table 7, P = 0.117) Figure 4

Regarding Target Lesion Revascularization (TLR) and compliance to treatment: There was no significant difference between the two groups.

Regarding the incidence of MACCE: There was a significant difference between the two groups (P value <0.05). Table 3

Study populations were further divided into 2 groups according to MACE incidence over 6 months: MACE occurred in 20 patients (group A) and 48 patients didn't have MACE (group B), different clinical and procedural parameters are compared among both groups; there was no substantial difference between the two groups regarding gender distribution, age, DM, HTN, smoking, dyslipidaemia, SYNTAX score, stent length, thrombus aspiration and main vessel final TIMI flow while there was a significant difference between the two groups regarding maximum stent post dilatation diameter, kissing balloon inflation and type of intervention (p<0.05) Table 4

Potential MACE predictors were explored using univariate and multivariate analysis. In univariate analysis: crossover stenting and performing KBI were associated with lower incidence of MACE, but multivariate analysis showed none of both can independently predict incidence of MACE. Table 5.

Table 1: Demographics, SBP, HR, electrocardiographic and angiographic findings of the studied groups

		Total (n = 68)	Type of interventions		P	
			Ostial stenting (n = 41)	Cross-over stenting (n = 27)		
Age (years)		61.03 ± 10.17	60.07 ± 10.85	62.48 ± 9.04	0.343	
Sex	Male	47(69.1%)	28(68.3%)	19(70.4%)	0.856	
	Female	21(30.9%)	13(31.7%)	8(29.6%)		
					test	P
HR		87.35 ± 15.86	86.90 ± 16.38	88.04 ± 15.33	t = 0.287	0.775
SBP		115.4 ± 17.48	115.9 ± 18.16	114.6 ± 16.69		
Electrocardiographic findings						
Normal ECG		3(4.4%)	2(4.8%)	1(3.7%)	$\chi2$ = 0.515	0.773
ST elevation		47(69.1%)	27(65.9%)	20(74.1%)		
Others		18(26.5%)	12(29.3%)	6(22.2%)		
Angiographic findings						
LM/LAD ratio		1.36 ± 0.05	1.37 ± 0.05	1.35 ± 0.05	t = 1.651	0.103
LAD/LCX angle		75.84 ± 8.33	78.24 ± 7.04	72.19 ± 8.92	t = 3.119*	0.003*
SYNTAX		18.24 ± 6.57	17.74 ± 6.56	18.98 ± 6.63	U = 458.50	0.224
TIMI flow	0	39(57.4%)	22(53.7%)	17(63.0%)	FET = 0.666	0.939
	1	8(11.8%)	5(12.2%)	3(11.1%)		
	2	12(17.6%)	8(19.5%)	4(14.8%)		
	3	9(13.2%)	6(14.6%)	3(11.1%)		

Data are presented as mean ± SD or frequency (%). t: Student t-test, HR: heart rate, SBP: systolic blood pressure, ECG: electrocardiogram, LM: Left main, LAD: left anterior descending artery, LCX: Left Circumflex Artery, SYNTAX: percutaneous coronary intervention with taxus and cardiac surgery, TIMI: thrombolysis in myocardial infarction.

Table 2: Procedural variation in both groups

		Total (n = 68)	Type of interventions		Test of significance	P
			Ostial stenting (n = 41)	Cross-over stenting (n = 27)		
Access	Radial	33(48.5%)	17(41.5%)	16(59.3%)	χ^2 = 2.064	0.151
	Femoral	35(51.5%)	24(58.5%)	11(40.7%)		
Thrombus aspiration		9(13.2%)	6(14.6%)	3(11.1%)	χ^2 = 0.176	0.675
Side branch trouble		11(16.2%)	5(12.2%)	6(22.2%)	χ^2 = 1.207	^{FE}p = 0.324
POT, side, POT		6(8.8%)	3(7.3%)	3(11.1%)	χ^2 = 0.291	^{FE}p = 0.675
Bail out 2 stents		2(2.9%)	0(0.0%)	2(7.4%)	χ^2 = 3.129	^{FE}p = 0.154
Final main vessel flow	I	1(1.5%)	1(2.4%)	0(0.0%)	FET = 0.699	1.000
	II	8(11.8%)	5(12.2%)	3(11.1%)		
	III	59(86.8%)	35(85.4%)	24(88.9%)		

Final Side branch flow	II	1(1.5%)	1(2.4%)	0(0.0%)	χ^2 = 0.668	^{FE}p = 1.000
	III	67(98.5%)	40(97.6%)	27(100.0%)		
Bleeding		5(7.4%)	3(7.3%)	2(7.4%)	χ^2 = 0.000	^{FE}p = 1.000
Contrast induced nephropathy		7(10.3%)	5(12.2%)	2(7.4%)	χ^2 = 0.404	^{FE}p = 0.694
Angiographic success		58(85.3%)	34(82.9%)	24(88.9%)	χ^2 = 0.461	^{FE}p = 0.729
Procedural success		49(72.1%)	28(68.3%)	21(77.8%)	χ^2 = 0.727	0.394
			Post dilatation	**POT diameter**		
Post dilation diameter			2.85 ± 1.65	4.57 ± 0.41		
Stent diameter		3.65 ± 0.27	3.61 ± 0.29	3.70 ± 0.25	t = 1.393	0.168
Stent length		25.85 ± 7.39	25.85 ± 7.39	25.85 ± 7.39	**U = 193.00***	**< 0.001***
Discharge EF		45.85 ± 6.69	46.20 ± 7.44	45.33 ± 5.45	t = 0.517	0.607
Control coronary angiography						
Control angio		6(8.8%)	4(9.8%)	2(7.4%)	χ^2 = 0.112	^{FE}p = 1.000
Lesion in control angio	Medina 1,1,1	1(1.5%)	1(2.4%)	0(0.0%)	FET = 3.352	0.676
	Stent thrombosis	2(2.9%)	2(4.9%)	0(0.0%)		
	Patent	2(2.9%)	1(2.4%)	1(3.7%)		
	Medina 0,0,1	1(1.5%)	0(0.0%)	1(3.7%)		

Data are presented as mean ± SD or frequency (%), *: Statistically significant at p ≤ 0.05. t: Student t-test, U: Mann Whitney test, POT: postural orthostatic tachycardia syndrome, EF: Ejection fraction.

Table 3: Incidence of MACE in both groups

	Total(n = 68)	**Type of interventions**		**Test**	**p**
		Ostial stenting (n = 41)	**Ostial stenting (n = 41)**		
Heart failure	16(23.5%)	12(29.3%)	4(14.8%)	χ^2 = 1.890	0.169
Myocardial infarction	2(2.9%)	2(4.9%)	0(0.0%)	χ^2 = 1.357	^{FE}p = 0.514
Death	5(7.4%)	3(7.3%)	2(7.4%)	χ^2 = 0.000	^{FE}p = 1.000
Stroke	5(7.4%)	3(7.3%)	2(7.4%)	χ^2 = 0.000	^{FE}p = 1.000
TLR	4(5.9%)	3(7.3%)	1(3.7%)	χ^2 = 0.384	^{FE}p = 1.000
Total MACE	20(29.4%)	16(39.0%)	4(14.8%)	χ^2 = 4.596*	0.032*

Data are presented as mean ± SD or frequency %, *: Statistically significant at p ≤ 0.05, x^2: Chi square test, FET: Fisher Exact test, TLR: Activation of Toll like receptors, MACE: major adverse cardiac events.

Table 4: Relation between total MACE and different parameters

		MACE Clinical follow-up		**Test of Sig.**	**P**
		Yes (n = 20)	**No (n = 48)**		
Type of interventions	OS	16(80.0%)	25(52.1%)	**χ^2 = 4.596***	**0.032***
	COS	4(20.0%)	23(47.9%)		
Sex	Male	15(75.0%)	32(66.7%)	χ^2 = 0.459	0.498
	Female	5(25.0%)	16(33.3%)		
Age (years)		61.25 ± 12.78	60.94 ± 9.02	t = 0.100	0.921
DM		8(40.0%)	22(45.8%)	χ^2 = 0.195	0.659
HTN		8(40.0%)	23(47.9%)	χ^2 = 0.357	0.550
Dyslipidemia		7(35.0%)	17(35.4%)	χ^2 = 0.001	0.974
Smoking		11(55.0%)	19(39.6%)	χ^2 = 1.361	0.243
SYNTAX score		18.25 ± 2.41	18.25 ± 4.91	U = 447	0.378
Stent length		26.45 ± 10.45	25.60 ± 5.78	U = 455.0	0.735
Stent post dilatation		3.0 ± 1.84	3.76 ± 1.38	U = 316.0*	0.025*
KBI		1(5.0%)	16(33.3%)	χ^2 = 6.04	0.014*
Thrombus aspiration		4(20.0%)	5(10.4%)	χ^2 = 1.129	0.287
Final TIMI flow	I	1(5.0%)	0(0.0%)	FET = 4.293	0.094
	II	4(20.0%)	4(8.3%)		
	III	15(75.0%)	44(91.7%)		

Data are presented as mean ± SD or frequency %, *: Statistically significant at p ≤ 0.05, t: Student t-test, χ2: Chi square test, OS: Ostial stenting, COS: cross-over stenting, DM: diabetes mellitus, HTN: hypertension, SYNTAX: percutaneous coronary intervention with taxus and cardiac surgery, TIMI: thrombolysis in myocardial infarction.

Table 5: Univariate and multivariate analysis of factors predicting MACE incidence

	Univariate		**Multivariate**	
	P	**OR (LL - UL 95%C. I)**	**P**	**OR (LL - UL 95%C. I)**
Type of interventions (Ostial stenting)	0.038*	3.680(1.072 - 12.632)	0.370	1.880(0.473 - 7.470)
Max stent post dilatation	0.073	0.745(0.539 - 1.028)		
KBI	0.035*	0.105(0.013 - 0.858)	0.109	6.377(0.661 - 61.574)

Data were presented as median and interquartile range (IQR) * significant p value <0.05, KBI: kissing balloon inflation.

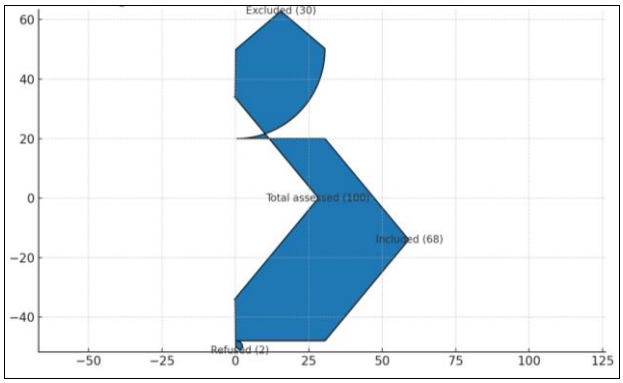

Fig 1: CONSORT flowchart of the enrolled patients

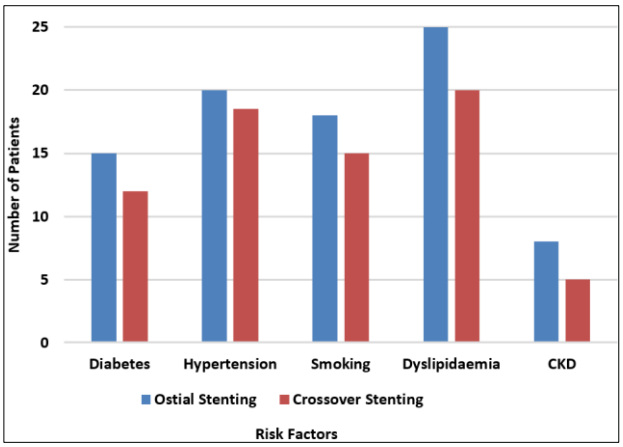

Fig 2: Prevalence of risk factors in both groups

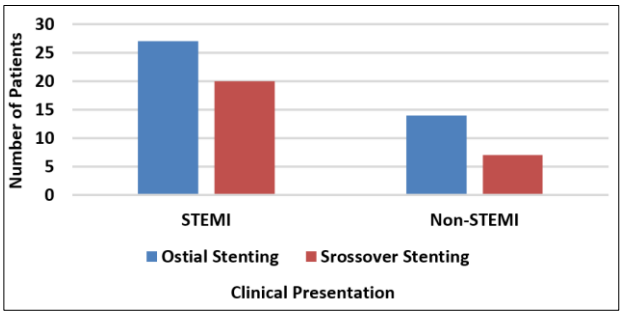

Fig 3: Clinical presentation in both groups

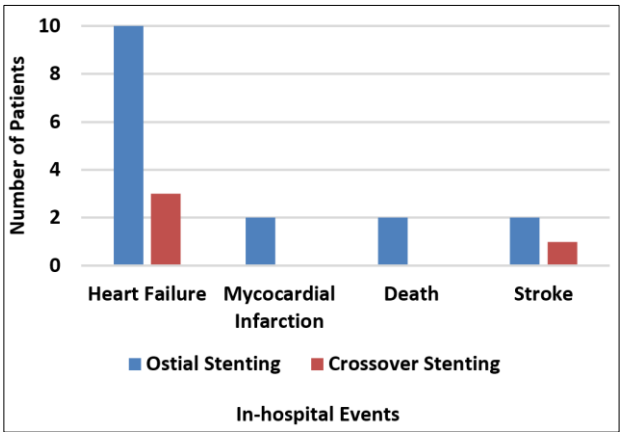

Fig 4: In-hospital events in both groups

Discussion

Acute coronary syndromes originating from isolated ostial LAD lesions have been linked with substantial morbidity and death due to the large ischemic region and till the moment, the optimum intervention technique for ostial LAD lesion in the absence of angiographically significant distal LM plaque (Medina 0,1,0) is a matter of controversy regarding procedural safety and long-term events [3].

Femoral access was used in 51.5% of the study population (58.5% in group I and 40.7% in group II) while Radial artery was used in 48.5% of the study population (41.5% in group I and 59.3% in group II). In the study by Yamamoto *et al.* [8], three access sites were used Femoral (69.6% vs 76.7%), Radial (30.4% vs 20.0%), and brachial artery (0 vs 3.3%) in corresponding groups.

In this study, the mean LAD-LCX angle was significantly wider in Ostial Stenting (OS) group Whereas in the study by Yamamoto and colleagues. [8] the angle was similar with no significant difference.

In this investigation, both groups were comparable as regards SYNTAX score whereas in the study by Rigatelli *et al.* [3], SYNTAX score was higher in crossover group indicating more complex lesions. This discrepancy may be explained by small sample size and the fact that we are studying specific types of lesions with similar angiographic analysis.

This study found that the stents used in the Crossover Stenting (CS) group were much longer than those in the ostial approach; this is because the stents used in the crossover technique only slightly reach into the LM.

Similar results were found in Soylu and colleagues [9] research on 97 patients where stents were significantly longer in CS group (23.9 mm vs 20.3 in OS group, $p<0.008$). also, the study by Rigatelli *et al.* [3] but relatively shorter stents (24.6 vs 14.8 mm, $p<0.0001$). However, both groups were comparable in the studies conducted by Capranzano and colleagues. [12] Yamamoto *et al.* [8].

In this study, there was no significant difference in mean diameter of deployed stents (3.7 mm in CS group vs 3.61 mm in OS group). Similar to the study by Elkhateeb *et al.* [13] (3.2 ± 0.1 in CS vs 3.2 ± 0.39 in OS group). Whereas Güner *et al.* [6] (3.57 vs. 3.11 mm), Yang *et al.* [14] (3.76 vs. 3.17 mm), Soylu *et al.* [9] (3.3 vs. 3.1 mm) reported significantly larger diameters in their studies

In this study, POT was routinely done in all cases of CS group and mean balloon diameter was 4.57 ± 0.41 mm.

Rigatelli and co-authors. [3] noted that out of 36 patients who had crossover stenting followed by POT, only six needed LCX ballooning. With a low chance of needing a second LCX procedure, the POT method may improve the crossover stenting procedure and lead to better long-term results [15].

Both groups were comparable regarding side branch troubles, which was numerically higher but statistically non-significant between both groups (22.2% in CS vs 12.2% in OS group). definition of side branch troubles varies across different studies; but in the study conducted by Soylu and co-authors [9]. They found no statistically significant difference regarding side branch occlusion.

KBI is an optional step in provisional stenting depending on results after stenting, it wasn't routinely done unless indicated. The CS group received approximately 10 times more KBI than the other group (55.6% vs 4.9%). In addition, Yamamoto and co-authors. [8] and Seung and co-authors [16]. Also noted significantly higher KBI with CS compared to OS for ostial LAD stenosis, at 30% vs. 0% and 39.1% vs. 6.7%, respectively. In the study by Capranzano *et*

al. [12]. KBI was used routinely in all cases of the CS group and only in 8.9% of cases in the OS group, P value <0.05).

Perhaps the higher KBI rate in the crossover stenting group is due to concerns about the potential complications of future LCx surgeries caused by floating stent struts in the LCx ostium. Lastly, the reason for the increased KBI rate in the crossover group might have been because the stenosis in the SB ostium was only physically assessed and not physiologically. The therapeutic effect of the KBI is still uncertain, despite the fact that it accelerated SB dissection in some trials and offered more luminal gain in the proximal MV and SB.

Provisional side branch stenting was done in two patients included in crossover (7.4%). There was a numerically higher but statistically non-significant significant difference between both groups. This came in agreement with Soylu *et al*. [9] who studied total of 97 patients; 9.8% in the CS group and 3.7% in OS group had side branch stenting.

The LCx ostium is at risk of plaque or carina shift because of larger stents used and Proximal Optimization (POT) in the CS method. And this explains the numerically higher percentage of side branch troubles and SB stenting in the crossover group.

Procedure time was significantly longer in CS group, (35.81 vs 30.49 minutes, P value 0.026). This came in line with Soylu and colleagues. [9] (34 vs 26.7 minutes, P value = 0.026). Fluoroscopy time is another time factor used in some studies like Rigatelli and colleagues [3] and was significantly longer in OS group, but the research performed by Güner and colleagues [6] both procedure and fluoroscopy times showed non-significant differences between both groups. This discrepancy in results may be due to the difference in operators' experience and different clinical and procedural scenarios in such a complex subset of patients.

The amount of contrast was significantly decreased in the CS group (130.7 ml vs 149 ml, P = 0.007), this came in line with Rigatelli and colleagues [3] in contrast to the investigation performed by Güner and colleagues [6] both groups were comparable regarding this variant. Larger amount of contrast in the precise ostial stenting technique can be explained by multiple injections needed for accurate stent positioning.

BARC definition criteria were used in this study for reporting and classification of bleeding. The two groups did not vary significantly with respect to bleeding. The results were consistent with those of the research by Güner *et al*. [6] they used TIMI bleeding definitions for assessment of bleeding and found no significant difference between both groups.

CIN incidence was statistically non-significant across both groups. Like the study conducted by Güner *et al*. [6].

There was no statistically significant difference between the two groups as regard angiographic and procedural success, in line with the research by Elkhateeb *et al*. [13].

There was no significant difference between both groups as regards in-hospital major adverse cardiac events (heart failure, re-infarction, mortality, and stroke). In the study conducted by Rigatelli and colleagues. [3], it included only patients with unstable angina or non-STEMI. All procedures were successfully performed without any in-hospital deaths or major complications. Another study conducted by Capranzano *et al*. [12] included the entire spectrum of CAD (STEMI, non-STE ACS and stable CAD) they reported in hospital events, there was no need for repeat intervention. However, two in-hospital deaths were observed: one (1.5%) in a patient treated with crossover stenting and another (1.1%) in a patient who underwent focal ostial LAD stenting, both likely due to probable stent thrombosis.

Twenty patients (or 29.4% of the total) had a MACE during the 6-month follow-up period. The crossover group had a much-decreased MACE incidence compared to the ostial stenting group. However, there was no statistical significance detected for MI, TLR, stroke, or cardiovascular mortality. Longer follow-up and larger-scale studies are required since the numerically greater incidence of individual components of MACE is the primary driver of the statistically higher incidence of MACE in the ostial stenting group. Similar to the study conducted by Güner *et al*. [6], MACE occurred in 52 patients (22.7%) patients during a mean follow-up time of 40.56 ± 21.1 months, crossover technique was associated with significantly lower incidence of MACE and lower all-cause mortality rate than ostial stenting in patients with Medina 0,1,0. Also, no statistical significance was found in terms of MI nor stroke. But target lesion revascularization was higher in the ostial stenting group. This difference as regards mortality and TLR can be explained by short duration of follow-up in our study.

Another retrospective study by Yang *et al*. [14] found that over a mean follow-up period of 13 ± 4.1 months, the composite outcome rate was higher in patients with LAD ostial stenosis who underwent ostial stenting compared to those treated with the crossover technique. This difference was primarily driven by a higher incidence of target vessel revascularization

In contrast to other studies which showed that the incidence of MACE was comparable across both groups with no statistically significant difference, Elkhateeb *et al*. [13] found that MACE after 1 year was similar, also after 5 years it was statistically non-significant but numerically higher in the crossover group. In their study, incidence of mortality and TLR also showed non-significant differences after 1 and 5 years.

Limitations of the study included that the sample size was relatively small. The study was in a single center, short follow-up period and lack of routine use of intravascular imaging and invasive functional assessment which is proven to help better assessment of the lesions and optimization of results.

Conclusions

Patient with significant isolated ostial LAD lesion treated with PCI using precise ostial stenting had higher incidence of MACE compared to LMT - LAD crossover stenting, so in term of both safety and efficacy, 6-month clinical outcomes of PCI to isolated ostial LAD stated that the crossover stenting might be reasonable and safe option in treating ostial LAD lesions.

What is already known?

- ACS caused by isolated ostial left anterior descending (LAD) lesions is linked to high morbidity and mortality due to the extensive ischemic area.
- Clinical evidence regarding the most effective interventional approach remains limited, particularly in cases of ostial LAD-related acute myocardial infarction

What is new?

- LM-LAD cross-over stenting is safe and reasonable stenting technique in treating isolated ostial LAD lesion in patients presented with ACS.

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