

Study of Coronary Bifurcation Lesions and Procedural Outcome at Manmohan Cardiothoracic Vascular And Transplant Center, Kathmandu, Nepal

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Abstract

Background and Aims: Coronary bifurcation lesions are associated with high atherosclerotic plaque burden due to turbulent blood flow and high shear stress. There are various strategies for bifurcation stenting however, they are often prone to major cardiac events during percutaneous coronary intervention. The aim of this study was to assess the clinical profile and procedural outcome of patients with coronary bifurcation lesions.

Methods: This retrospective study was carried out at Manmohan Cardiothoracic Vascular and Transplant center, Kathmandu, Nepal. Two hundred and eight patients were enrolled in this study who had coronary bifurcation lesions seen on invasive coronary angiography from August 2017 to October 2021. The procedural complications were assessed.

Results: The mean age of patients with coronary bifurcation lesions was 61.48±11.19 years. Out of total 208 patients, 77% were males. True bifurcation lesion was seen in 65.4% of patients. Left anterior descending artery with diagonal was the most common bifurcation lesion (67.3%). The provisional stenting was done in 80.8% of patients and rest underwent 2-stent strategy. The complications mainly observed during the provisional stenting were plaque shift and side branch dissection.

Conclusion: The provisional stenting is the most preferred and suitable technique for most bifurcation lesions if technically feasible.

Keywords: Bifurcation lesions, Provisional stenting, Two stent strategy

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Introduction

A bifurcation lesion is a lesion occurring at or adjacent to a significant division of a major epicardial coronary artery. Atheromatous plaque causing > 50% narrowing of both branches at the bifurcation level is the definition of “true” coronary bifurcation lesions.¹ The atherosclerosis occurs predominantly in low shear-stress regions at lateral walls of bifurcation opposite to the carina.^{2,3}

The bifurcation lesions accounts for approximately 15-20% of patients undergoing percutaneous coronary interventions.⁴ Coronary bifurcation stenting is technically challenging in terms of procedural success and long term cardiac events such as high risk of stent thrombosis and restenosis even in the era of drug-eluting stent (DES).^{5,6} Various techniques have been developed to optimize treatment of such lesions using provisional or two stent-technique, though a large amount of uncertainty prevails while selecting the most appropriate strategy.⁷ However, provisional approach (one-stent technique) has been preferred in most studies compared to elective two-stent technique in terms of clinical outcome which make it the standard strategy of coronary bifurcation stenting.^{8,9}

In this study, we aim to observe the coronary bifurcation lesions and the various techniques we used to treat these lesions with the procedural outcome.

Methods

A retrospective observational study was carried out in the department of cardiology of Manmohan cardiothoracic Vascular and Transplant center (MCVTC), Kathmandu. This study was started after the ethical clearance from the Institutional Review Board of the Institute of Medicine.

The patients who had coronary bifurcation lesions and underwent percutaneous coronary intervention either elective or following acute coronary syndrome from August 2017 to October 2021 were enrolled in this study. Medina classification was done of the bifurcation lesions which is a 3-digit binary code which defines a bifurcation lesion by the presence (>50% stenosis) or absence (<50% stenosis) of disease at the proximal and distal part of main vessel and the side branch. The bifurcation lesion involving the left main were excluded as the management strategy may differ.

In provisional stenting, the stenting of main branch (MB) only without intervention in the side branch (SB) was done if a good TIMI flow was seen in the SB. When the TIMI flow was too low due to dissection or significant plaque shift to SB, a two-stent strategy was considered. In culotte stenting, implantation of stent across the most angulated branch i.e. the side branch was done and then a second stent was placed from the proximal MB towards the distal MB through the struts of the first stent resulting in a double layer of struts



in the proximal MB. In crush stenting, two stents were advanced simultaneously into both MB and SB. The SB stent was first deployed and the proximal segment of it into the MB was crushed against the wall of main vessel during deployment of MB stent resulting in a three layers of struts in the proximal MB. In T stenting, MB stent was deployed first, followed by SB stent deployment just at the ostium of the side branch when the bifurcation angle was about 70-90 degrees. Whereas in T and protrusion technique, a 1-2mm of side branch stent was protruded into the main branch. In the reverse TAP technique, the SB stent was deployed first followed by MB stent. After MB stent deployment, the wire was recrossed into the side branch for final kissing balloon inflation.

Procedural success was defined as a residual intraluminal narrowing of <20% obtained by coronary angiography without major cardiac procedural complications. The procedures were performed either by femoral or radial approach and drug eluting stents were used. All the patients were followed-up clinically while admitted in hospital. Baseline characteristics were noted. Continuous variables were expressed as mean± SD and dichotomous variables were expressed in numbers and percentages. All analyses were conducted using SPSS 21 software.

Results

A total of 208 patients with coronary bifurcation lesions were enrolled during the study period. The mean age of the patients was 61.48±11.19 years with range of 42 years to 81 years of age. The maximum number of patients were in the age group of 70-79 years. [Fig. 1] Out of total 208 patients, 160 (77%) were males and 48 (23%) were females. The baseline characteristics of the patients are given in [Table no.1].

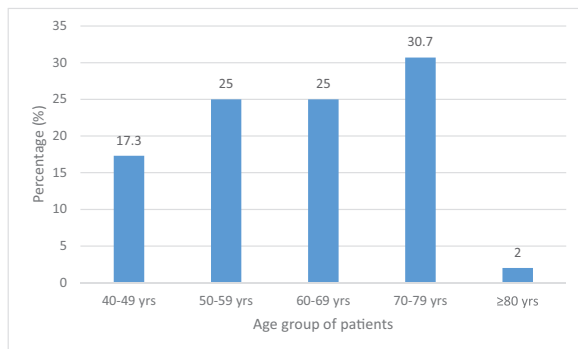


Fig. 1: Coronary Bifurcation lesions according to age group

Table No.1: Baseline characteristics of patients with coronary bifurcation lesions

Patient characteristics	Number(%)
Age (years)	Mean: 61.48 SD: ±11.19
Male	160(77%)
History of smoking	104(50%)
Hypertension	156(75%)
Diabetes Mellitus	76(36.54%)
Dyslipidemia	84(40.38%)
Chronic kidney disease	24(11.54%)
COVID-19 infection	4(1.92%)

The patients commonly presented with chronic stable angina 52(23%) followed by non-ST elevation myocardial ischemia

42(19.3%), unstable angina 40(17.3%) and heart failure with reduced ejection fraction (HFrEF) 32(15.4%). [Table no. 2]

Table no. 2: Presenting diagnosis of patients

Diagnosis	Number of patients(%)
Chronic Stable angina	52(23%)
NSTEMI	42(19.3%)
Unstable Angina	40(17.3%)
STEMI	23(9.6%)
STEMI late presentation	19(7.7%)
HFrEF	32(15.4%)
Total	208(100%)

The radial artery was accessed for angioplasty in majority of patients (63.46%) and the remaining were accessed through femoral artery route. The sheath size of 6F was used in 144 (69.2%) patients and 7F in 64 (30.8%) patients. The guiding catheter chosen were XB in 104 (50%) patients, JL in 40 (19.2%) patients and CLS in 28 (13.5%) patients for left coronary artery and JR in 36 (17.3%) for right coronary artery. The average amount of the contrast agent used was 232.12 ± 70.16 ml. The amount of contrast used for provisional stenting was 224.76 ± 70.06 ml and for double stent strategy was 263 ± 64.98 ml. The mean fluoro-time for provisional stenting was 22.23±4.61 min and for double stent strategy was 32.94±7.18 min. The mean radiation for provisional stenting was 1719.01± 465.49 mGy and for double stent strategy was 2211.05±590.96 mGy. Among 208 patients, 48(23%) had single vessel disease, 64(30.8%) had double vessel disease and 96(46.2%) had triple vessel disease. [Table no. 3.]

Table no. 3: Access and coronary angiographic findings in patients with bifurcation lesions

Access	
Radial artery	132(63.46%)
Femoral artery	76(36.54%)
Sheath size	6F(144(69.2%)), 7F(64(30.8%))
Coronary angiographic findings	
Single Vessel Disease	48(23%)
Double Vessel Disease	64(30.8%)
Triple Vessel Disease	96(46.2%)
Total	208(100%)

The bifurcation lesion was most commonly seen in left anterior descending artery with diagonal artery 140(67.3%), followed by left circumflex artery with obtuse marginal artery 32(15.4%) and right coronary artery with PDA or Acute marginal. [Table no. 4]

Table no. 4: Bifurcation lesions

Bifurcation lesion	No. of patients(%)
Left Anterior Descending Artery/Diagonal	140(67.3%)
Left circumflex/Obtuse Marginal	32(15.4%)
Right coronary artery/Posterior descending artery	32(15.4%)
Right coronary artery /Acute Marginal	4(1.9%)
Total	208(100%)

True bifurcation lesions were present in 136(65.4%) of cases and non-true bifurcation lesions in 72 (34.6%) of cases according to MEDINA classification.

The most common risk factors for coronary artery disease such as diabetes, hypertension, smoking and dyslipidemia were most related to bifurcation lesions involving Left anterior descending artery/Diagonal and the MEDINA classification they were most associated with is given in the [Table no. 5].

Table no. 5: Association of Diabetes, hypertension, smoking and dyslipidemia with bifurcation lesions

MEDI-NA	Diabetes	Hypertension	Smoking	Dyslipid-emia
1,1,1	40(52.6%)	76(48.7%)	40(38.6%)	28(33.3%)
0,1,1	8(10.5%)	14(9%)	12(11.5%)	16(19.1%)
1,0,1	12(15.8%)	18(11.5%)	12(11.5%)	17(20.2%)
1,1,0	12(15.8%)	18(11.5%)	20(19.2%)	12(14.3%)
0,1,0	4(5.3%)	30(19.3%)	20(19.2%)	11(13.1%)
Total	76(100%)	156(100%)	104(100%)	84(100%)

Of 208 patients, provisional stenting technique was performed in 168(80.8%) patients and two-stent technique was performed in the remaining 40(19.2%), including eight patients who were shifted from one-stent to two-stent technique due to side branch dissection and major plaque shift leading to less than TIMI 3 flow in SB.

The two-stent techniques used were T technique, culotte, reverse TAP technique, minicrush, reverse minicrush and TAP techniques. [Fig. 2] All the two-stent techniques were performed on elective basis. The various performed procedures with the MEDINA classification is given in [Table no. 6].

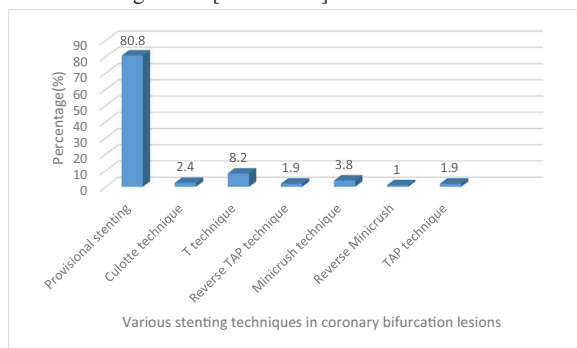


Fig. 2: Various stenting techniques in coronary bifurcation lesions

Table no. 6: Various stenting techniques with the MEDINA classification

MEDINA	Provi-sional	Culotte	T-stent-ing	TAP	Mini-crush	Reverse TAP	Reverse Minicrush	Total
1,1,1	76	2	7	0	8	0	0	93
1,0,1	24	1	4	2	0	0	0	31
0,1,1	8	1	6	2	0	4	2	23
1,0,0	4	0	0	0	0	0	0	4
0,1,0	24	1	0	0	0	0	0	25
1,1,0	32	0	0	0	0	0	0	32
Total	168	5	17	4	8	4	2	208

The provisional stenting was mainly done in Left anterior descending/Diagonal artery (LAD/D) lesion. The two stent strategy were done in LAD/D and Left circumflex/Obtuse Marginal (LCX/OM) lesions. [Table no. 7] In the LAD/D, the most commonly chosen technique among the two-stent strategy was T-stenting (50%) and minicrush technique (20.8%). In the LCX/OM also, T-stenting was

commonly done (31.3%) followed by equal proportion of culotte, TAP and minicrush techniques that was 18.7% each. [Fig.3]

Table no. 7: Bifurcation stenting techniques used in various bifurcation lesions

Bifurcation lesion	No. of patients (%) with provi-sional stenting	No. of patients (%)with two-stent technique	Total No. of patients(%)
LAD/D	120	24	144(69.2%)
LCX/OM	16	16	32(15.4%)
RCA/PDA	28	0	28(13.5%)
RCA/Acute Marginal	4	0	4(1.9%)
Total	168(80.8%)	40(19.2%)	208(100%)

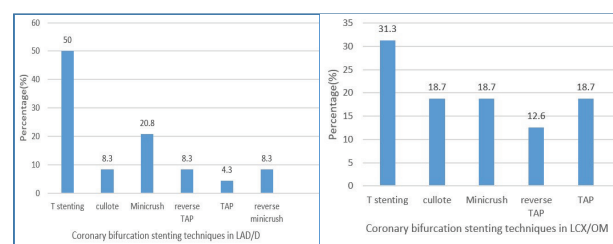


Fig. 3: Various Two-stent techniques in bifurcation lesions of different coronary arteries

The complications observed during the provisional stenting were plaque shift to side branch in 10 cases with no ischemic symptoms and <70% stenosis, 8 patients had TIMI II flow with symptoms due to plaque shift but hemodynamically stable (of whom two patients underwent T stenting, one underwent reverse minicrush and one underwent culotte technique but four had difficulty wiring of the side branch) and six patients had side branch dissection (of whom three underwent T stenting and one underwent reverse minicrush and the other two had difficulty wiring of the side branch). We didn't find immediate complications in two-stent strategy during the procedure. There was no in-hospital mortality or reinfarction seen in this study.

Discussion

This study was done to observe the clinical profile, risk factors, angiographic characteristics and various bifurcation stenting strategies with their immediate complications in patients with coronary bifurcation lesions. The revascularization of bifurcation lesions by percutaneous coronary intervention has been associated with lower success rate and higher restenosis rate than non-bifurcation lesions and is associated with short term and long term complications with different treatment techniques. Whether one stent or two stent strategy should be chosen is still a matter of debate.

The mean age of the patients was 61.48±11.19 years with the range of 42 years to 81 years with maximum in the age group of 70-79 years with male predominance (77%). Kumar et al had similar findings in their study.¹⁰

The most common risk factors seen were hypertension, smoking, diabetes mellitus and dyslipidemia and they were more associated with true bifurcation lesions. The chronic kidney disease was seen in 11.54% of cases and COVID-19 infection in 1.92%. The patients commonly presented with stable angina (23%) followed by non-ST elevation myocardial ischemia (19.3%), unstable angina (17.3%) and heart failure with reduced ejection fraction (15.4%).

The radial artery was accessed for angioplasty in majority of patients (63.46%) and the remaining were accessed through femoral

artery route. Among 208 patients, 23% had single vessel disease, 30.8% had double vessel disease and 46.2% had triple vessel disease.

True bifurcation lesion was seen in 65.4% of the study population. The bifurcation lesion was most commonly seen in left anterior descending artery with diagonal artery i.e. 67.3%, followed by left circumflex artery with obtuse marginal artery i.e. 15.4% and right coronary artery with PDA or Acute marginal artery. Maske et al found that the left anterior descending artery with diagonal artery is the most common vessel to undergo bifurcation stenting apart from left main disease.¹¹

The provisional stenting was performed in majority of patients i.e., 80.8% of patients in our study, which was the preferred procedure in other studies as well.¹¹ The two-stent technique was performed in the remaining patients on elective basis, including eight patients who were shifted from one-stent to two-stent technique due to SB dissection and major plaque shift leading to less than TIMI 3 flow. The current European Bifurcation Club (EBC) guidelines suggests that provisional stenting may be the preferred option for most lesions while two stent strategy may be considered upfront for more complex lesions with a large side branch that supplies a significant myocardial territory.¹² However Jabir et al explains in their study that, in the case of suboptimal SB outcome during provisional stenting, it may be necessary to stent the SB as well converting one stent to two stent strategy.¹³ The two-stent techniques used in our study were culotte, T-technique, reverse TAP, minicrush, reverse minicrush and TAP techniques. The T technique of the bifurcation stenting was the preferred strategy because of its simplicity and proficiency of the operator. Giuseppe et al from his metaanalysis depicts that a clinical benefit of two stent technique was observed over provisional stenting only where side branch lesion length was $\geq 10\text{mm}$ and $>70\%$ stenosed.¹⁴

The two stent strategies was associated with longer fluoroscopy time, radiation exposure and contrast volume than provisional stenting that was similar to the Nordic Bifurcation study.¹⁵ Several randomized clinical trials have recommended provisional technique of stenting as it has been found to be associated with lower all-cause mortality, major adverse cardiac events (MACE) and non-procedure related myocardial infarction on a long term outcome compared to two stent strategy,¹⁵⁻¹⁷ however the risk of target vessel revascularization and stent thrombosis remained same in both strategies.⁸ But the side branch occlusion after main vessel stenting is a major procedure related complication for provisional technique.¹⁸ Thus, the complications seen in our study during provisional stenting were plaque shift to side branch in 10 cases with no ischemic symptoms and $<70\%$ stenosis, 8 patients had TIMI II flow with symptoms due to plaque shift but hemodynamically stable (of whom 2 patients underwent T stenting, 1 underwent reverse minicrush and 1 underwent culotte technique but 4 had difficulty wiring of the side branch) and 6 patients had side branch dissection (of whom 3 underwent T stenting and one underwent reverse minicrush and the other 2 had difficulty wiring of side branch). There were no immediate complications seen in two-stent strategy however there was some difficulty in rewiring of the side branch in few cases but was eventually able to be crossed for the final kissing balloon inflation. This could be because the number of the patients in our study undergoing two-stent strategy was small and carefully selected but findings in larger studies could differ. There was no mortality or re-infarction during hospital admission. A recent metaanalysis shows that the DK-crush technique which is a two-stent technique was associated with fewer MACE and lower rates of repeat target vessel revascularization, however there were no significant differences among other two stent techniques and provisional stenting regarding cardiac death, myocardial infarction and stent thrombosis.¹⁴ Henceforth, with the continuous evolution in the field of intervention regarding bifurcation lesions, the provisional stenting is still considered suitable for most bifurcation lesions.¹⁹

Limitation

This was a retrospective study done on a small number of patients in a single center. This study couldn't include the long term follow up of the patients who underwent provisional stenting strategy or two-stent strategy. Hence the long term study of such patients is recommended to observe long term clinical and angiographic outcome and to further generalize the uses of various techniques of bifurcation stenting.

Conclusion

The provisional stenting was the chosen strategy in our study, nevertheless the bifurcation lesions stenting is still a challenge so as to decide the appropriate stenting strategy with minimization of complications and achieve better quality of life on long term.

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