MSDL Publications
Research is creating new knowledge

Research International Journal of Cardiology and Cardiovascular Medicine

Case Report

Provisional stenting for left main bifurcation disease under IVUS guidance: Case series my Cath lab philosophy

Rohit Mody[1]*, Debabrata Dash[2], Bhavya Mody[3], Anand Reddy Maligireddy[4], Ankit Agrawal[5], Lakshay Rastogi[6]

[1]Department of Cardiology, MAX Super specialty hospital, Bathinda, Punjab, India.
ORCID - https://orcid.org/0000-0001-8977-5803

[2]Department of Cardiology, Aster Hospital, Dubai, Al Quasis, UAE.
ORCID- https://orcid.org/0000-0003-1354-3808

[3]Department of Medicine, Kasturba medical college, Manipal, Karnataka, India.
ORCID- https://orcid.org/0000-0001-8944-9418

[4]Department of Cardiology, Mayo Clinic, 13400 E Shea Blvd, Scottsdale, AZ 85259, USA.
ORCID- https://orcid.org/0000-0003-3608-4923

[5]Department of Cardiology, Cleveland Clinic, 9500 Euclid Avenue Cleveland, Ohio 44195, USA.
ORCID- https://orcid.org/0000-0001-7885-6667

[6]Department of Cardiology, Kasturba Medical College, Manipal, India.
ORCID - https://orcid.org/0000-0002-7746-5389

Received: 07 August, 2022

Accepted: 19 August, 2022

Published: 20 August, 2022

***Corresponding author:** Rohit Mody, Department of Cardiology, MAX Super specialty hospital, Bathinda, Punjab, India. Tel: +91-9888925988;
E mail: drmody_2k@yahoo.com

Keywords: Left Main Bifurcation, Provisional Approach, TAP technique.

Abstract

Instead of various developments in percutaneous coronary intervention (PCI), management of the bifurcation especially left main bifurcation (LM) is difficult and quite challenging. In maximum number of patients who present with the LM bifurcation lesion, the one-stent strategy is the most preferred therapeutic option. However, with the objective to reduce the risk of various peri-procedural complications such as side branch occlusion, physiological and anatomical assessment of the LM lesion should be done by using the intravascular imaging techniques during the procedure. Here, we present the three cases of LM bifurcation which were successfully treated by using the provisional stenting method. All three cases were treated with the guidance of the fractional flow reserve (FFR) and Intravascular Ultrasound (IVUS) and heart team considerations. Measurement of the fractional flow reserve was done to avoid the risk of unnecessary complex interventions. At the three months follow-up, all patients were identified as ischemia free.

Introduction

PCI is used as the potential alternative therapeutic option in the patients presenting with unprotected left main coronary artery (LMCA) stenosis, as evidenced provided by the results of various randomized trials and observational studies [1]. However, PCI is associated with various long-term adverse clinical outcomes and various other technical challenges [2]. Furthermore, very few randomized clinical trials have demonstrated about the strategies for the management of the distal LM lesion which make it difficult to select the optimum stenting strategy for the treatment of the LM bifurcation lesions. Based upon the findings of the various non-LM bifurcation trials [3], in comparison to the two-stent technique, better clinical outcomes and lower risk of various adverse events [4,5] such as death [5], myocardial infarction (MI), revascularization of the target vessel [6] are associated with the one-stent technique. Due to all these factors, for the treatment of the LM bifurcation lesions, the one-stent technique is recommended [7].

However, in clinical practice, the two-stent technique is mostly preferred in comparison to the one-stent technique in the treatment of the bifurcation lesion due to concern of ischemic myocardial volume of the side branch (SB) [3]. Furthermore, LM bifurcation disease is not focal [8], it is a mostly diffuse and inaccurate assessment of the extent of severity of both branches and Ostia is determined by angiography [9]. Considering this, side branch occlusion risk is quite high with the angiography-guided intervention technique. Furthermore, in the selection of suitable stenting method for the complex LM bifurcation lesions, pre-procedural IVUS determination is quite helpful as it provides quite accurate information about the severity of the disease [10]. A low mortality rate is reported with the usage of the IVUS-guided PCI method as it also reduces the risk of side branch occlusion after the main vessel (MV) stenting [11,12].

Furthermore, with the objective to reduce the SB occlusion risk, pre-stenting, calcified plaque presence [13] and relative distribution of the plaque [14] should also take into consideration. The decision to the selection of suitable treatment strategy is further facilitated by the fractional flow reserve determination for the side branch as it provides useful information about the association between angiographic and physiological severity [15].

Currently, two stent techniques used for the treatment of the distal LM bifurcation lesions are the crush and its variants, culotte and kissing balloon technique (KBT). Currently, no guidelines are available about the selection of suitable two-stent technique after considering the LM bifurcation lesion anatomical factors. Various other factors such as the morphology of the LM bifurcation, two branches' diameter and extent of severity of the ostial SB lesion severity should take into consideration before the selection of the suitable technique. A modified version of the T or kissing stent technique is the crush technique in which against the main branch (MB) wall crushing of the SB stent is induced by the main branch stent [16]. Another variant of the classic rush method is named the double-kissing (DK) crush technique which involves the inflation of the kissing balloon between MV stenting and SB crushing and it potentiates the stent apposition [17].

CASE – 1

Case Description

A 54-year-old male patient, having a history of hypertension, type 2 diabetes mellitus, and dyslipidemia, presented angina at rest for 3 days. The patient underwent percutaneous transluminal coronary angioplasty (PTCA) to the left anterior descending artery (LAD) with a sirolimus-eluting stent (DES) 5 years ago. The patient had severe left ventricular (LV) dysfunction and regional wall motion abnormalities (RWMA) in LAD territory with an ejection fraction (EF) of 26%. He was diagnosed with non-ST-elevation myocardial infarction (NSTEMI).

Investigations

The angiographic results indicated distal left main with triple vessel disease (TVD), and LAD proximal showed restenosis with clot (Figure 1a).

Intervention

An intravascular ultrasound was done in order to understand the distal reference, plan the LAD stent size, to recognize the tightest point in the LM. The branching point of LAD was identified along with the left circumflex (LCx) ostial region (Figure 1b) and even the previous stent was under-deployed. The intervention started with crossing the BMW wire and deploying a 2.5 x 38 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition; Abbott Vascular, Santa Clara, California) in the distal LAD at 14 atm followed by deploying a 4 x 33 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) from LM to LAD at 16 atm. Proximal optimization technique (POT) was done with a 5.0 x 8 mm balloon (Mozec™ NC) at 18 atm. After the post dilatation, a long lesion was observed in the LCx to obtuse marginal (OM) (Figure 1c). A 2.5 x 33 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) was deployed from OM followed by a kissing balloon technique with satisfactory results. POT was done to the left main coronary artery resulting in a fully expanded stent in LM and LAD (Figure 1d).

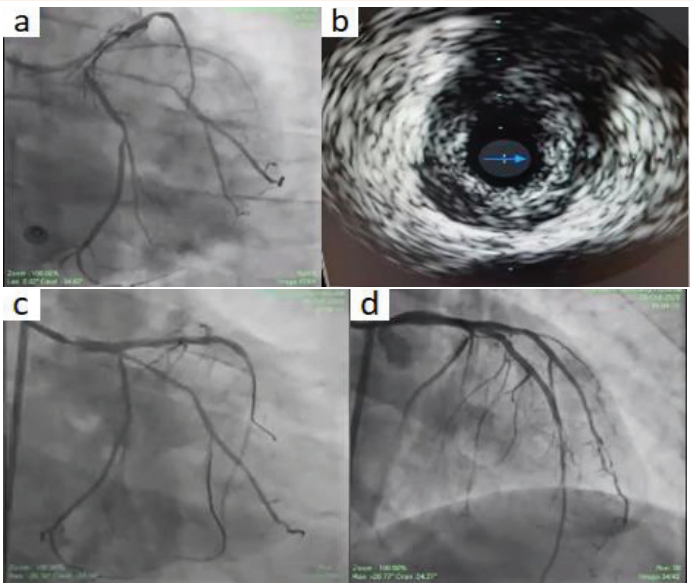

Figure 1: LM stenting done with provisional TAP technique.
Figure 1a: Coronary Angiography (CAG) showing TVD and restenosis with clot in LAD.
Figure 1b: IVUS run pre-PCI showing tightest point in LM.
Figure 1c: Long lesion was observed in LCx to OM after post dilatation.
Figure 1d: Final angiographic result showing well expanded stent in LAD and LM.

CASE – 2

Case Description

A 68-year-old male patient with a history of hypertension, and type 2 diabetes mellitus, presented with angina on exertion class 3 and dyspnoea on exertion class 3. The patient had chronic kidney disease (CKD) with serum creatinine levels of 3.5 ml/L. He had previously undergone PCI to distal LCx and OM1 with patent stents.

Investigations

The angiographic results showed distal LM with diffused LAD lesion, 50% diseased ostial LCx and patent stents in distal LCx and OM1 (Figure 2a).

Intervention

An IVUS was done which showed calcification in the LM ostium prior to the tightest area in LM. However, no plaque modification was done as this area was about 8.8 mm (Figure 2b). The distal LAD was deployed with a 2.5 x 48 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) at 16 atm followed by deploying a 3.0 x 28 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) in mid LAD at 16 atm. Then a 4.0x18mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) was deployed from LMCA to LAD overlapping the distal stent at 16 atm (Figure 2c). The LAD was post dilated with a 3.0 x 13 mm balloon (AccuForce) from distal to proximal. Post PCI, a good minimal lumen area was achieved in the slightly calcified LAD ostium while the tightest LM also showed an expansion despite being calcified, achieving an extension area of about 12.8mm (Figure 2d). The final FFR was done to determine the significance of ostial LCx which was 0.80. Hence, the provisional stenting of the LCx was not done.

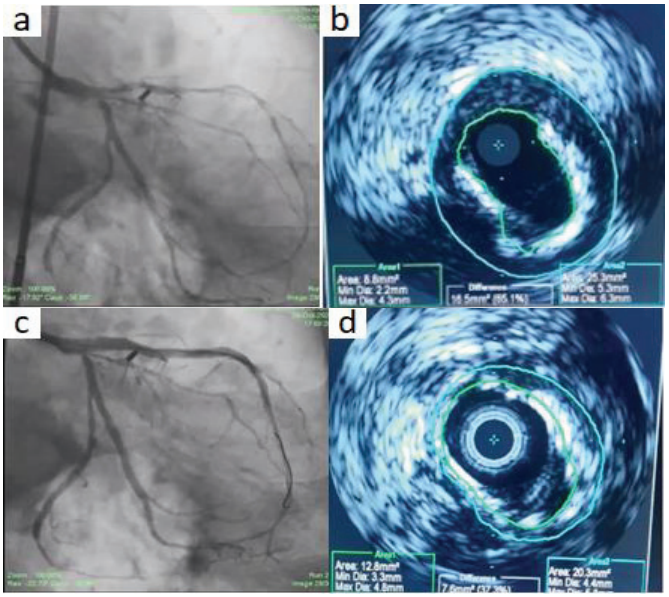

Figure 2: LM bifurcation done with provisional technique- one stent strategy.
Figure 2a: CAG showing distal LM with diffuse LAD, ostial LCx disease (50%) and patent stents in distal LCx and OM1.
Figure 2b: Pre PCI IVUS showed calcification of ostial LM with patent stents in distal LCx and OM1.
Figure 2c: 4.0 x 18 mm stent deployed from LMCA to LAD overlapping distal stent.
Figure 2d: Post PCI improvement in the tightest LM with expansion and extension area of 12.8mm.

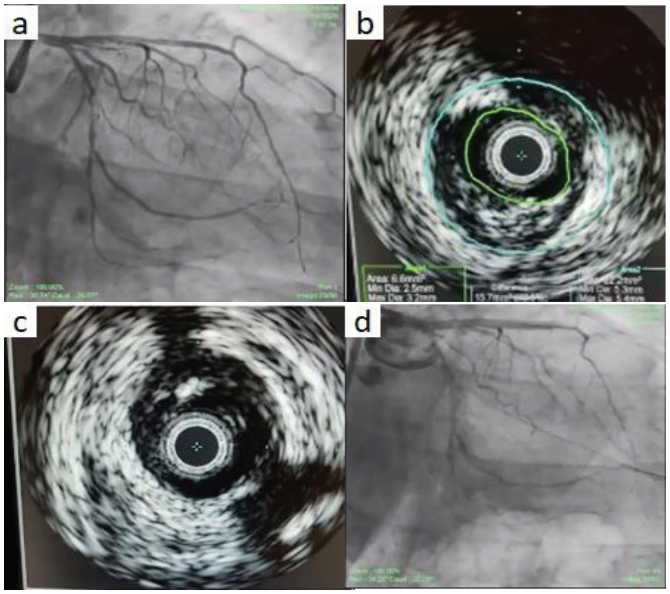

Figure 3: Ostial LM done with sparing of bifurcation.
Figure 3a: CAG showing ostial LM lesion and diffuse disease lesion in LAD with ISR.
Figure 3b: IVUS before stenting showing disease at ostium of LM.
Figure 3c: Post PCI IVUS showed fully expanded LAD stent with good LM stent expansion.
Figure 3d: Distal LCx showed some dissection.

CASE – 3

Case Description

A 71-year-old male with a history of type 2 diabetes mellitus, and dyslipidaemia, presented with angina on exertion class 3 and dyspnoea on exertion class 3. The patient had undergone PCI to the LAD and LCx with a sirolimus-eluting stent 6 years ago.

Investigations

He had severe LV dysfunction with an ejection fraction of 20%. The angiography results showed a lesion in the ostial LM and diffused disease lesion in the LAD with In-stent restenosis (ISR) (Figure 3a). The LCx also showed ISR.

Intervention

An IVUS run done from LAD to LM showed that the ostium of the LM was diseased pre-PCI (Figure 3b). Pre-dilation with a 2.5 x 13 mm balloon (Mozec™ NC) from distal to proximal followed by deploying a 3.0 x 32 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) in the mid LAD at 14 atm. A 3.0 x 12 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) was deployed in proximal LAD at 16 atm. An ostial lesion was still observed post dilatation to the LAD stents. A 4.0 x 8 mm stent (cobalt-chromium everolimus eluting stent, XIENCE Xpedition) was deployed in the ostial LMCA at 12 atm. POT was done with a 5.0 x 8 mm balloon (AccuForce) in ostial LMCA at 18 atm. An IVUS run post PCI showed a fully expanded LAD stent along with a good LM stent expansion and the LM bifurcation appeared disease-free (Figure 3c). The LCx ostium was free of significant disease while the distal LCx had some dissection (Figure 3d) so was kept for the second-stage procedure as the patient developed left ventricular failure (LVF) and was dyspnoeic after the LM procedure.

Discussion

PCI has emerged as a safer alternative to coronary artery bypass grafting (CABG) for LM stenosis in patients with low SYNTAX scores. Despite several advancements, treating LM bifurcation lesions involves potential complications such as acute occlusion of LCx or target lesion revascularization in the long run. In comparison to the double-stenting technique, the temporary one-stent strategy for LM bifurcation has better results making it the most recommended strategy. While for distal LM lesions, the provisional stenting strategy is the most preferred. If required, the type of 2 stent technique is decided on the anatomy of the bifurcation and the preference of the operator. The provisional stenting can opt when there is small LCx, no LCx disease, wide-angle LCx/LAD, in LM to LAD, LAD ostium is free from disease or LCX has significant vessel dominance. The preference for two stent techniques should be given when there is no small LCx with any of the following features significant and long lesion in ostium, complex lesion in ostial LCx, and narrow-angle LAD-LCx.

In some cases, DK crush has emerged as a better technique like in cases with medina '1, 1, 1' classification, where the side branch is huge (at least 2.5mm) and has some lesion on it. The findings of the EBM trial demonstrate non-significant better results with provisional stenting.

Angiography alone can be challenging to determine the amount of obstructive disease of the LMCA. Intravascular ultrasound (IVUS), in contrast to the two-dimensional, shadow visual aspect of coronary angiography, is a precise tomographic technique for measuring both the coronary lumen and arterial wall features [18]. Pre-procedural IVUS evaluation is highly helpful in identifying an acceptable and safe stenting

strategy as it provides more accurate information on the disease status of the distal LM complex, diameter and length of LM including the LCx ostium [19].

It also provides data regarding the type of lesion whether calcific or fibrotic, the need for modification and the technique to be implemented. The use of IVUS has been shown in previous trials to minimise the incidence of SB occlusion after MV stenting in coronary bifurcation lesions. The characterization of the plaque aids in determining the specific location and extension of the calcification, and selection of the most adequate device (rotablator or IVL). It is useful in selecting the strategy either provisional stenting or 2 stent technique, and stent sizing becomes easy. The fractional flow reserve (FFR) has been a prominent method for determining which lesions require revascularization [20]. In the above-presented cases, the modalities like IVUS and FFR played a prominent role in determining the requirements of the lesion and making the long-term results better. The key learning points are discussed in (Table 1).

Table 1: Key learning points.

- In high-risk patients like NSTEMI, provisional approach bifurcation stenting is preferred especially when the side branch is relatively disease-free.
- Recently DK crush has emerged as a preferable strategy for LM bifurcation stenting, but in selective cases, provisional stenting can be a philosophy and can be used successfully in many LM bifurcation cases with long-term results better than DK crush.
- The use of imaging like IVUS makes the long-term results better.

Acknowledgment

I thank Ms. Nikita and Mr. Rohit for assisting me to finalize the research article. Figures are edited by Jiwan Singh.

Author Contributions

The lead author of the article is Dr Rohit Mody. Dr Debabrata Dash, Dr Bhavya Mody, Anand Reddy Maligireddy, Ankit Agrawal and Lakshay Rastogi had equal and substantial contributions in the formation of this article. They were involved in conceptualization, data curation, formal analysis, resources, software, validation, visualization, writing - original draft, Writing, review & editing.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Ethical approval was not required since it is an accepted procedure.

Consent for Publication

Written consent has been obtained to publish the case report from the guardian. The consent copy is available with the authors and ready to be submitted if required.

Disclosure - The remaining authors have nothing to disclose.

Financial Disclosure - There is no financial conflicts of interest to disclose.

Abbreviations

1. CAG = Coronary Angiography
2. CKD = chronic kidney disease
3. DES = Drug Eluting Stent
4. DK = Double Kissing Crush
5. ECHO = Echocardiogram
6. EF = Ejection Fraction
7. FFR = Fractional Flow Reserve
8. ISR = In-Stent Restenosis
9. IVUS = Intravascular Ultrasound
10. KBT = Kissing Balloon Technique
11. LAD = Left Anterior Descending Artery
12. LCX = Left Circumflex
13. LM = Left Main
14. LMCA = Left Main Coronary Artery
15. LV = Left Ventricle
16. MB = Main Branch
17. MI = Myocardial Infarction
18. MLA = Minimal Lumen Area
19. MV = Main Vessel
20. NSTEMI = Non-ST-Elevation Myocardial Infarction
21. OM = Obtuse Marginal
22. PCI = Percutaneous Coronary Intervention
23. POT = Proximal Optimisation Technique
24. SB = Side Branch
25. TVD = Triple Vessel Disease

References

1. Authors/Task Force members; Windecker S, Kolh P, Alfonso F, Jean-Philippe C, Jochen C, et al. (2014) 2014 ESC/EACTS Guidelines on myocardial revascularization: The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS) Developed with the special contribution of the European Association of Percutaneous Cardiovascular Interventions (EAPCI). EuroIntervention 35: 2541-2619. Link: https://bit.ly/2MZwHjK
2. Naganuma T, Chieffo A, Meliga E, Davide C, Seung-Jung P, et al. (2013) Long-term clinical outcomes after percutaneous coronary intervention for ostial/mid-shaft lesions versus distal bifurcation lesions in unprotected left main coronary artery: the DELTA Registry (drug-eluting stent for left main coronary artery disease): a multicenter registry evaluating percutaneous coronary intervention versus coronary artery bypass grafting for left main treatment. JACC Cardiovasc Interv 6:1242-1249. Link: https://bit.ly/3QwPZsl
3. Kim WJ, Kim YH, Park DW, Shubin Q, Yongjian Wu, et al. (2011) Comparison of single- versus two-stent techniques in treatment of unprotected left main coronary bifurcation disease. Catheter Cardiovasc Interv 77: 775-82. Link: https://bit.ly/3ArlQVG

4. Palmerini T, Marzocchi A, Tamburino C, Imad S, Massimo M, et al. (2008) Impact of bifurcation technique on 2-year clinical outcomes in 773 patients with distal unprotected left main coronary artery stenosis treated with drug-eluting stents. Circ Cardiovasc Interv 1: 185-192. Link: https://bit.ly/3ppqtsT

5. Song YB, Hahn JY, Yang JH, Seung-Hyuk C, Jin-Ho C, et al. (2014) Differential prognostic impact of treatment strategy among patients with left main versus non-left main bifurcation lesions undergoing percutaneous coronary intervention: results from the COBIS (Coronary Bifurcation Stenting) Registry II. JACC Cardiovasc Interv 7: 255-263. Link: https://bit.ly/3SZFG1m

6. Toyofuku M, Kimura T, Morimoto T, Yasuhiko H, Hiroaki U, et al. (2009) Three-year outcomes after sirolimus-eluting stent implantation for unprotected left main coronary artery disease: insights from the j-Cypher registry. Circulation 120: 1866-1874. Link: https://bit.ly/3AtPKIR

7. Lassen JF, Holm NR, Stankovic G, Thierry L, Alaide Ch, et al. (2014) Percutaneous coronary intervention for coronary bifurcation disease: consensus from the first 10 years of the European Bifurcation Club meetings. EuroIntervention 10: 545-560. Link: https://bit.ly/3Arnwys

8. Oviedo C, Maehara A, Mintz GS, Hiroshi A, So-Yeon C, et al. (2010) Intravascular ultrasound classification of plaque distribution in left main coronary artery bifurcations: where is the plaque really located? Circ Cardiovasc Interv 3: 105-112. Link: https://bit.ly/3jacoxA

9. Kang SJ, Mintz GS, Oh JH, Duk-Woo P, Seung-Whan L, et al. (2013) Intravascular ultrasound assessment of distal left main bifurcation disease: the importance of the polygon of confluence of the left main, left anterior descending, and left circumflex arteries. Catheter Cardiovasc Interv 82: 737-745. Link: https://bit.ly/3d3qVXV

10. Hahn J-Y, Chun WJ, Kim J-H, Young Bin S, Ju Hyeon O, et al. (2013) Predictors and Outcomes of Side Branch Occlusion After Main Vessel Stenting in Coronary Bifurcation Lesions: Results from the COBIS II Registry (COronary BIfurcation Stenting). J Am Coll Cardiol 62: 1654-1659. Link: https://bit.ly/3j7rlRg

11. Park SJ, Kim YH, Park DW, Seung-Whan L, Won-Jang K, et al. (2009) Impact of intravascular ultrasound guidance on long-term mortality in stenting for unprotected left main coronary artery stenosis. Circ Cardiovasc Interv 2:167-177. Link: https://bit.ly/3j4UZGH

12. De la Torre Hernandez JM, Baz Alonso JA, Gomez Hospital JA, Fernando Alfonso M, Tamara Garcia C, et al. (2014) Clinical impact of intravascular ultrasound guidance in drug-eluting stent implantation for unprotected left main coronary disease: pooled analysis at the patient-level of 4 registries. JACC Cardiovasc Interv 7: 244-254. Link: https://bit.ly/3qjawnI

13. Sato K, Naganuma T, Costopoulos C, Hideo T, Kenji G, et al. (2014) Calcification analysis by intravascular ultrasound to define a predictor of left circumflex narrowing after cross-over stenting for unprotected left main bifurcation lesions. Cardiovasc Revasc Med 15: 80-85. Link:https://bit.ly/3dEXmiz

14. Yoshitaka Goto Y, Kawasaki T, Koga N, Hidenori T, Hisashi K, et al. (2012) Plaque distribution patterns in left main trunk bifurcations: prediction of branch vessel compromise by multidetector row computed topography after percutaneous coronary intervention. EuroIntervention 8: 708-716. Link: https://bit.ly/3dG8QlS

15. Koo BK, Waseda K, Kang HJ, Hyo-SK, Chang-WN, et al. (2010) Anatomic and functional evaluation of bifurcation lesions undergoing percutaneous coronary intervention. Circ Cardiovasc Interv 3: 113-119. Link: https://bit.ly/3CdlWRT

16. Ormiston JA, Webster MWI, Webber B, James TS, Peter NR, et al. (2008) The "Crush" Technique for Coronary Artery Bifurcation Stenting: Insights from Micro-Computed Tomographic Imaging of Bench Deployments. JACC Cardiovasc Interv 1: 351-357. Link: https://bit.ly/3OYis9E

17. Chen S-L, Xu B, Han Y-L, James TS, Peter NR, et al. (2013) Comparison of Double Kissing Crush Versus Culotte Stenting for Unprotected Distal Left Main Bifurcation Lesions: Results from a Multicenter, Randomized, Prospective DKCRUSH-III Study. J Am Coll Cardiol 61: 1482-1488. Link: https://bit.ly/3OYis9E

18. Mintz GS, Lefèvre T, Lassen JF, Luca T, Manuel P, et al. (2018) Intravascular ultrasound in the evaluation and treatment of left main coronary artery disease: a consensus statement from the European Bifurcation Club. EuroIntervention 14: e467-e474. Link: https://bit.ly/3w7NioM

19. Hahn JY, Chun WJ, Kim J-H, Young Bin S, Ju H, et al. (2013) Predictors and Outcomes of Side Branch Occlusion After Main Vessel Stenting in Coronary Bifurcation Lesions: Results from the COBIS II Registry (COronaryBIfurcation Stenting) J Am Coll Cardiol 62: 1654-1659. Link: https://bit.ly/3j7rlRg

20. Elgendy IY, Conti CR, Bavry AA (2014) Fractional flow reserve: an updated review. Clin Cardiol 37: 371-380. Link: https://bit.ly/3QVDqXj