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Two-Stent Strategy for Bifurcation Lesions in Percutaneous Transluminal Coronary Angioplasty: Real-World Evidence

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Abstract

Background: Bifurcation lesions pose a high risk for adverse events after percutaneous coronary intervention (PCI). Evidence supporting the benefits of the two-stent strategy (2SS) for treating coronary bifurcation lesions in India is limited. This study aimed to evaluate the clinical outcomes of various 2SSs for percutaneous transluminal coronary angioplasty for bifurcation lesions in India. **Materials and Methods:** This retrospective, observational, multicentric, real-world study included 64 patients over 8 years. Data on demographics, medical history, PCI procedures, and outcomes were recorded. Descriptive statistics were computed using the SPSS software. **Results:** Patients (n = 64) had an average age of 65.3 ± 11.1 years, with 78.1% males. Acute coronary syndrome was reported in 18.8%, chronic stable angina in 40.6%, and unstable angina in 34.4% of participants. Two-vessel disease was observed in 98.4% of patients, and 99.4% had true bifurcation lesions. The commonly involved vessels were the left anterior descending artery (50%), left circumflex coronary artery (34.4%), and first diagonal artery (43.8%). Mean percent diameter stenosis was 87.2% ± 10.1%. The mean number of stents used was 2.00 ± 0.34. The 2SS techniques included the T and small protrusion (TAP) (39.1%), double kissing (DK) crush (18.8%), and the culotte techniques (14.1%). Procedural and angiographic success rate was 92.18%. Major adverse cardiovascular events at 1-year follow-up occurred in 7.8% of cases. **Conclusion:** The 2SS for bifurcation lesions showed favorable in-hospital and follow-up outcomes. Findings can serve as a resource for bi-

furcation angioplasty in India. Larger real-world studies with robust methodology are needed to validate these results.

Keywords

Bifurcation Stenting, Coronary Bifurcation Lesions, Percutaneous Transluminal Coronary Angioplasty, Two-Stent Strategy

1. Introduction

Percutaneous coronary intervention (PCI) or percutaneous transluminal coronary angioplasty (PTCA) is the preferred approach for treating bifurcation lesions [1]. Coronary bifurcation lesions (CBLs) occur in 15% - 20% of all PCIs and are associated with greater probabilities of unfavorable outcomes as compared to non-bifurcation lesions [2] [3] [4]. According to data from the National Interventional Council (India, 2018), 4.32% of all PCIs in India required bifurcation coronary stenting [5].

Bifurcation lesions are susceptible to atherosclerosis because of their distinctive local blood flow patterns and endothelial shear stress in the areas where they occur. Although the relatively high blood flow rates in these areas prevent atheroma development in the carina, plaques develop opposite to the carina owing to reduced endothelial shear stress [6]. As these lesions may have highly variable anatomies, structures, pathological conditions, and severities, no single strategy is applicable to their treatment [5] [7].

Drug-eluting stent (DES) devices have progressively replaced balloon angioplasty and bare metal stents (BMSs). Compared with BMSs, first-generation DESs significantly decreased the likelihood of restenosis, although this benefit was negated by their association with late stent thrombosis. However, with second-generation DESs, the occurrence of 1-year stent thrombosis is <1%. The DESs currently used are sirolimus, everolimus, and zotarolimus [8].

The decision to use provisional stenting (PS) or a two-stent strategy (2SS) in different anatomic scenarios has been a challenge for many interventionalists [5]. The 2019 European Bifurcation Club (EBC) recommends the PS strategy technique as the preferred technique for treating CBLs and restricts the use of upfront 2SS in selected cases with adequate preparation of the lesion, proximal optimization technique (POT), and final kissing balloon inflation (FKBI) [3] (Park 2022). The presence of a large side branch (SB) in a bifurcation lesion also warrants treatment of the SB [4].

Although PS is the preferred strategy for treating CBLs, it is associated with complications such as ostial occlusion of the SB, stent deformation, malpositioning, fracture, plaque shift, and changes in bifurcation angle [9]. However, 2SS involves the overlapping of multiple layers of the stent, resulting in the formation of a neocarina, which may cause major adverse cardiac events (MACEs) [10].

The appropriate technique for upfront double stenting is selected based on the anatomy and complexity of the lesion [7]. However, there is no agreement on a standard management technique for CBLs in which the application of second generation DESs does not improve outcomes after PCI [11].

Although several bifurcation coronary stenting (BCS) strategies are used in PCIs, it is unclear which is ideal for achieving optimal results when treating CBLs [5]. In addition, there is limited systematic data on the use of different BCS strategies and their outcomes in Indian settings. This real-world study assessed the clinical outcomes of using various 2SSs for the PTCA of bifurcation lesions in India.

2. Materials and Methods

2.1. Ethical Consideration

This retrospective, observational, multicenter, real-world study included all coronary bifurcation cases requiring PCI during 2014-2022. Ethical approval and written informed consent were obtained from all the patients. This study was conducted in compliance with the principles of the Declaration of Helsinki.

2.2. Study Population

A total of sixty-four patients were enrolled in the study using convenience sampling. The sample size for the study was estimated using G* Power 3.1.9.2 software keeping power of the study as 80%, alpha error as 0.5, and the effect size as 0.2. The study employed a targeted approach to participant selection, focusing on patients with specific clinical indications for bifurcation PCI using a two-stent strategy, and used convenience sampling to recruit participants based on their availability and willingness to participate. The study included patients who had a history of acute coronary syndrome (ACS), chronic stable angina (CSA), or myocardial infarction (MI) and were undergoing coronary stenting for bifurcation lesions. The key inclusion criteria were patients requiring bifurcation percutaneous coronary intervention (PCI) with a two-stent strategy (2SS). The exclusion criteria were patients who were in cardiogenic shock at the time of the procedure and those undergoing routine hemodialysis before the procedure.

2.3. Study Data Collection

Data on demographics and comorbidities (diabetes mellitus [DM], hypertension, smoking, and antiplatelet therapy) of the patients were collected. Coronary angiogram was performed to detect any obstructions in the coronary arteries. The CBLs were categorized according to the Medina classification system. The characteristics of the lesions that were noted included the type of the lesion, length of the lesion, severity of coronary stenosis, local presence of thrombus, and the presence/extent of calcification. The data regarding all the variables were retrospectively reviewed in detail and collected from the hospital records where these patients were operated on. If necessary, further data on the patients were col-

lected via telephonic conversations with the hospital personnel and the patients themselves.

The procedural characteristics included access location, size of guiding catheters, type of stent used, number of stents placed per patient, stent diameter and length, type of DES used, and grade of thrombolysis in myocardial infarction (TIMI) flow grade. The use of POT, FKBI, and intravascular ultrasound (IVUS) was also recorded. The details of the stents used are provided in **Supplementary Table S1**.

2.4. PCI Procedure

Before enrolment in the study, the patients were on antiplatelets (64%), statins (43.8%), nitrates (21.9%), antidiabetic drugs (34.4%), beta-blockers (4.7%), and ivabradine (3.1%). The procedures were performed according to the standard protocols. Factors such as access location, use of diagnostic and guiding catheters, choice of treatment strategy, stenting method, generation of DES, POT, FKBI, and IVUS were included in the judgment of the investigators involved in the study. Achieving TIMI grade 3 flow in treated vessels served as a measure of angiographic success. A successful angiographic result without the incidence of any serious complication (death, MI, or coronary artery bypass graft) before discharge was considered a procedural success. Stent thrombosis was the safety endpoint. Drugs such as statins (100%), ticagrelor (100%), nitrates (100%), aspirin (100%), angiotensin-converting enzyme inhibitors (73.4%), beta-blockers (96.9%), antidiabetic drugs (34.4%), angiotensin receptor neprilysin inhibitors (15.6%), ivabradine (6.3%), and angiotensin receptor blockers (25%) were prescribed to the patients after PCI.

2.5. Follow-Up

A 12-month clinical follow-up was achieved for all patients (via visits to the clinic or telephonic conversations). Follow-up MACEs were defined as the occurrence of cardiac death, nonfatal MI, or target lesion revascularization.

2.6. Statistical Analysis

The statistical analysis was performed using SPSS (version 20.0; IBM, SPSS Inc., Chicago, IL, USA). Categorical variables are presented as frequencies and percentages (%) and continuous variables were presented as mean ± SD and median.

3. Results

Table 1 outlines the patient-related characteristics. Most patients were men (78.1%); the mean age was 65.3 ± 11.1 years; and the mean body mass index was 25.59 ± 3.95 kg/m^2. Comorbidities such as DM, hypertension, and smoking were present in 32.8%, 64.1%, and 18.8% of the patients, respectively. ACS was reported in 18.8%, CSA in 40.6%, and unstable angina (UA) in 34.4% of the

Table 1. Baseline clinical characteristics of patients included in this study (N = 64).

Variables	Values
Age (years) (mean ± SD; range)	65.3 ± 11.1; 40 - 91
Gender (male/female) N (%)	50/14 (78.1/21.9)
BMI (mean ± SD; range)	25.59 ± 3.95; 19.92 - 31.63
Medical history and risk factors	**N (%)**
Hypertension	41 (64.1)
Diabetes mellitus	21 (32.8)
Smoking habits	12 (18.8)
Antiplatelet therapy	64 (100)
Diagnosis	**N (%)**
CSA	26 (40.6)
UA	22 (34.4)
ACS	12 (18.8)
NSTEMI	1 (1.6)
AWMI	2 (3.1)
IWMI	1 (1.6)

ACS: Acute coronary syndrome; AWMI: Anterior wall myocardial infarction; BMI: Body mass index; CSA: Chronic stable angina; IWMI: Inferior wall myocardial infarction; NSTEMI: Non-ST-elevation myocardial infarction; SD: Standard deviation; UA: Unstable angina.

participants. All the patients were on antiplatelet therapy.

The two-vessel disease was observed in 98.4% of the patients. The vessels commonly involved in bifurcation lesions were the left anterior descending (LAD; 50%), left circumflex coronary artery (LCX; 34.4%), left main coronary artery-left anterior descending (LMCA-LAD; 3.1%), and first diagonal artery (D1; 43.8%). Both true and nontrue Medina CBLs were included in the study. True CBLs were found in 98.4% of the patients. Most of the patients (68.8%) had type B lesions. Thrombus and calcified lesions were seen in 10.9% and 25% of the patients, respectively. In 43.7% of the patients, the main branch (MB) lesion was more than 20 mm in length. The mean percent diameter stenosis was 87.2% ± 10.1% (Table 2).

The procedural details of the PCIs are shown in Table 3. The femoral route was used in 57.8% of the patients and a guide catheter of size 6 was used in 64.1% of the patients. Two stents were implanted in 98.4% of the patients. The mean number of stents used in the study was 2.09 ± 0.34. Some of the 2SSs used were the TAP technique (39.1%), the DK crush (18.8%), and the culotte technique (14.1%). Sirolimus-, everolimus-, and zotarolimus-containing DESs were used in 52.3%, 34.4%, and 13.3% of the patients, respectively. The FKBI and POT sequences were performed in 85.9% and 79.7% of the patients, respectively, and TIMI grade 3 flow was achieved in 100% of the patients.

Table 2. Lesion characteristics (N = 64).

Variables	Values N (%)
Extent of CAD	
Two vessels	63 (98.4)
Three vessels	1 (1.6)
Bifurcation lesion location	
LAD	32 (50)
LCX	22 (34.4)
LMCA-LAD	2 (3.1)
LMCA-LCX	5 (7.8)
LPDA	1 (1.6)
PDA	1 (1.6)
RCA-PDA	2 (3.1)
SVG-PDA	1 (1.6)
PLV	4 (6.3)
D1	28 (43.8)
D2	3 (4.7)
OM1	6 (9.4)
OM2	6 (9.4)
OM1 and OM2	1 (1.6)
Lesion type	
Type B	44 (68.8)
Type C	20 (31.3)
Medina classification	
1, 1, 1	40 (62.5)
0, 1, 1	20 (31.3)
1, 0, 1	3 (4.7)
1, 1, 0	1 (1.6)
Main branch lesion length	
<20 mm lesion	36 (56.3)
>20 mm lesion	28 (43.7)
Thrombus	7 (10.9)
Calcium	16 (25)
Main branch percent diameter stenosis (mean ± SD)	87.2% ± 10.1%

CAD: Coronary artery disease; D1: First diagonal artery; D2: Second diagonal artery; LAD: Left anterior descending; LCX: Left circumflex coronary artery; LMCA-LAD: Left main coronary artery-left anterior descending; LMCA-LCX: Left main coronary artery-left circumflex coronary artery; LPDA: Left posterior descending artery; OM: Obtuse marginal artery; OM1: First obtuse marginal artery; OM2: Second obtuse marginal artery; PDA: Posterior descending artery; PLV: Posterior left ventricular; RCA-PDA: Right coronary artery-posterior descending artery; SD: Standard deviation; SVG-PDA: Saphenous vein graft-posterior descending artery.

Table 3. Procedural characteristics (N = 64).

Variables	Values
Two-stent techniques	**N (%)**
Culotte technique	9 (14.1)
DK crush	12 (18.8)
Kissing	2 (3.1)
Mini-crush	6 (9.4)
Nano-crush	1 (1.6)
Reverse mini-crush technique	1 (1.6)
SKS	2 (3.1)
Stent plus DEB	1 (1.6)
T stenting	5 (7.8)
TAP technique	25 (39.1)
Stents placed per patient	**N (%)**
2	63 (98.4)
3	1 (1.6)
Mean ± SD	2.09 ± 0.34
Stenting technique	**N (%)**
Sirolimus-eluting stent	67 (52.3)
Everolimus-eluting stent	44 (34.4)
Zotarolimus-eluting stent	17 (13.3)
Access site	**N (%)**
Femoral	37 (57.8)
Radial	27 (42.2)
Guide catheter	**N (%)**
6	41 (64.1)
7	23 (35.9)
Final kissing balloon inflation	55 (85.9)
Proximal optimization technique	51 (79.7)
Intravascular ultrasonography	6 (9.4)
TIMI grade 3 flow	64 (100)

DEB: Drug-eluting balloon; DK: Double kissing; MB: Main branch; SB: Side branch; SD: Standard deviation; SKS: Simultane ous kissing stent; TAP: T and protrusion; TIMI: Thrombolysis in myocardial infarction.

The outcomes of the PCI procedures are shown in Table 4. At follow-up, MACE was reported in five patients (7.8%). Of these, one patient (1.6%) experienced cardiogenic shock, another patient (1.6%) experienced chest pain/angina, and three of the patients (4.7%) died due to stent thrombosis. The procedural and angiographic success rate considering the MACE events was 92.18%.

Table 4. Outcome characteristics (in-hospital and follow-up) (N = 64).

Variables	N (%)
Cardiogenic shock	1 (1.6)
Chest pain, angina	1 (1.6)
Expired due to stent thrombosis	3 (4.7)

4. Discussion

This study indicates that the application of the 2SS in the Indian context has favorable in-hospital and follow-up outcomes. This is one among the initial studies in the Indian population, which examines the outcomes of using a 2SS for treating complex lesions in a sample of 64 patients. Coronary bifurcation lesions can vary significantly in the angles of the bifurcations as well as in the sizes of the side branch and main vessel [12]. Although two large randomized controlled trials, the Nordic bifurcation study (NORDIC I) and the British Bifurcation Coronary Study (BBC ONE), support PS over 2SS (as the latter approach resulted in higher rates of in-hospital adverse cardiovascular events), it should be noted that these studies did not differentiate between true and non-true bifurcations. In addition, FKBI and POT were not employed in all the patients, thereby contributing to the reported results [13] [14] [15]. The EBC recommends the use of stepwise layered PS strategy in cases with CBL, wherein a single stent is planned and when a 2SS is anticipated pre-procedurally [16].

Nevertheless, there are also several reports favoring 2SS over PS in CBL. According to the multicenter randomized DEFINITION II trial, which compared the use of 2SS with that of PS among 653 patients with CBL, the 2SS approach demonstrated a significant enhancement in the clinical outcomes with respect to target lesion failure, target vessel myocardial infarction, and clinically-driven target lesion revascularization when compared to the PS approach [12]. The European Bifurcation Coronary TWO (EBC TWO) study comparing the use of PS and 2SS among 200 patients with large caliber true bifurcation lesions demonstrated that both techniques were comparable with respect to death, myocardial infarction, and target vessel revascularization at a follow-up of 12 months [17].

Similar results were reported by the Nordic-Baltic Bifurcation Study-IV, a randomized multicentric study wherein MACE at 2 years was 12.9% in the PS group and 8.4% in the 2SS group; the differences in MACE between these two groups were not statistically significant [18]. Studies in the literature have used different techniques of double-stenting strategy, few have included only left main bifurcations and others excluded left main bifurcations. In addition, many of these studies vary in the sizes of the MB and SB values. **Table 5** shows a compilation of studies that investigated the use of a 2SS in treating CBLs between 2004 and 2021 [19]-[38].

The preponderance of males undergoing PCIs in this study is a commonly occurring pattern and is supported by various meta-analyses [39] [40] [41] [42]

Table 5. Summary of studies with a two-stent strategy for the treatment of coronary bifurcation lesion.

Study	Interventions	Sample size	Age (years) mean ± SD	Male n (%)	Final KB n (%)	Procedural success n (%)
Pan *et al.* 2004 [19]	T/TAP	44	58 ± 11	38 (86)	34 (77)	43 (97)
Colombo *et al.* 2004 [20]	T/TAP	63	63 ± 10	48 (76)	57 (90)	58 (92)
DK-Crush I 2008 [21]	Crush	156	64 ± 9	109 (70)	124 (76)	142 (91.1)
	DK crush	155	64 ± 9	118 (76)	161 (100)	149 (96.1)
CACTUS 2009 [22]	Crush	177	65 ± 10	142 (80)	163 (92)	160 (90)
Hildick-Smith *et al.* 2010 [14]	2-stent	25	64 ± 11	193 (77)	189 (76)	234 (94)
DK-Crush II 2011 [23]	DK	185	64 ± 11	146 (79)	183 (100)	179 (96.8)
Ye *et al.* 2012 [24]	DK crush	38	63 ± 10	24 (63)	38 (100)	38 (100)
NSTS 2013 [25]	Crush	209	65 ± 10	149 (71)	177 (85)	205 (98)
	Culotte	215	65 ± 11	154 (71)	197 (92)	210 (98)
NBS 2013 [26]	2-stent	202	63 ± 10	162 (79)	152 (74)	194 (97)
Ruiz-Salmerón *et al.* 2013 [27]	T-stenting	36	64 ± 13	28 (78)	23 (64)	34 (94)
DK-Crush III 2015 [28]	DK crush	210	64 ± 10	162 (77)	209 (99)	203 (97)
	Culotte	209	63 ± 9	167 (80)	208 (99)	201 (96)
BBK I 2015 [29]	T-stenting	101	67 ± 10	79 (78)	101 (100)	-
PERFECT 2015 [30]	Crush	213	61 ± 9	160 (75)	-	-
Zhang *et al.* 2016 [31]	Culotte	52	64 ± 7	43 (83)	48 (92)	51 (98)
Hildick-Smith *et al.* 2016 [17]	Culotte	97	63 ± 12	76 (78)	93 (96)	95 (98)
BBK II 2016 [32]	Culotte	150	66 ± 11	107 (71)	150 100)	150 (100)
	TAP	150	69 ± 10	114 (76)	150 100)	148 (99)
Zheng *et al.* 2016 [33]	Crush	150	63 ± 8	109 (73)	145 (97)	145 (97)
	Culotte	150	64 ± 9	111 (74)	148 (99)	148 (99)
DK-Crush IV 2017 [34]	DK crush	183	64 ± 11	145 (79)	183 (100)	183 (100)
DK-Crush V 2019 [35]	DK crush	240	65 ± 9	199 83)	236 (98)	236 (98)
NBBS IV 2020 [18]	2-stent	228	63 ± 11	-	208 (91.2)	226 (98.7)
DEFINITION II 2020 [36]	2-stent	328	63 ± 11	255 (78)	323 (99)	323 (99)
SMART STRATEGY 2020 [37]	2-stent	23	66 ± 11	16 (70)	22 (96)	-
EBC Main 2021 [38]	2-stent	237	71 ± 10	177 (74)	219 (92)	219 (92)
Current study	2-stent	64	65.3 ± 11.1	50 (78.1)	55 (85.9)	63 (98.4)

BBK: Bifurcations Bad Krozingen; CACTUS: Coronary bifurcations: Application of the crushing technique using sirolimus-eluting stents; DK: Double kissing; EBC: European bifurcation coronary; KB: Kissing balloon; NBBS: Nordic-Baltic bifurcation study; NBS: Nordic bifurcation study; NSTS: Nordic stent technique study; SMART: Smart angioplasty research team.

[43]. The mean age of patients (65.3 ± 11.1 years) undergoing PCIs in this study falls within the confidence limits reported by other studies (58 ± 11 years to 71 ± 10 years; **Table 5**). The percentages of comorbidities, such as hypertension, DM, and smoking, reported in this study are also comparable to those in previous studies [4] [19]-[38]. Additionally, the percentages of patients presenting with CSA, UA, and ACS are similar to those of previous findings [15] [19] [41].

The longer length of the lesion is a well-established causative factor for stent failure [42]. The literature gives a range of mean MB lesion lengths (8.4 - 42.2 mm). In this study, 43.7% of the lesions were more than 20 mm in length. The use of the American College of Cardiology and the American Heart Association lesion classification system indicated that most of the lesions included in this study were type B (68.8%); the rest were type C. The characteristics of each lesion type is based on the extent of proximal tortuosity, angulation within the narrowed segment, the length of the lesion, and the occurrence of total occlusion, bifurcation lesions, thrombus, or fragile vein graft lesions [44]. The success rates associated with operating on type B and C lesions are moderate (60% - 85%; moderate risk) and low (<60%; high risk), respectively [44]. In the present study, the success rate was reported to be 92.18% which is higher than the specified success range reported by Klein (2008) [44]. The percentage occurrences of LAD (50%), LCX (34.4%), LMCA-LAD (3.1%), and D1 (43.8%) that were observed in this study are in concordance with the meta-analyses reported by Fujisaki (2022) and Kan (2022) [19] [41].

The results of BCS are significantly influenced by procedures such as FKBI and POT [5]. POT was performed in 80% of the patients in this study as per the 2019 EBC recommendation of using POT consistently for all CBLs [45]. POT is highly recommended regardless of the 2SS techniques chosen as it can repair distortion and improve the apposition of the main vessel stent following FKBI, thereby leading to enhanced procedural success as observed in the present study [12]. Likewise, kissing ballon inflation plays role in optimizing stent apposition, correcting the stent distortion or deformation, and improving access to the side branch [46]. The use of FKBI in 85.9% of the patients is similar to those reported in previous studies, which report that FKBI is used in 64% - 100% of 2SS procedures [40] [41]. The achievement of post procedure TIMI grade 3 flow in all patients suggests the absence of any ischemic myocardial areas. A similar finding was reported by Yurtdas *et al.* [4].

The literature in this field clearly shows procedural success rates for CBLs as 91% - 100%, and this study reinforces this evidence by reporting a success rate of 92.18% [41] [42]. A review by Jyotsana *et al.* providing evidence from 12 studies on MACE in patients operated with 2SS versus one-stent strategy reported that the incidence of MACE varied from 3.4% to 23% [47]. The present study reported MACE in only 7.8% of the cases which is similar to the MACE occurrences reported in literature The use of IVUS offers tomographic images depicting the structure of the coronary arteries and serves as a valuable tool for assessing lesion geometry, the condition of the reference vessel, and optimizing stent

placement [48]. Although the use of IVUS can considerably reduce the occurrence of adverse events during and after PCIs, it should be noted that its use in the present study was reported in only 9.4% of the patients [19] [42] [43].

5. Limitations

This study has the inherent limitations of a retrospective study design. The small sample size has limited the use of statistical analysis, and many comparisons between different stenting techniques and types of stents used could not be performed. In addition, lesion length in the SB was not used as a marker of the severity of the lesion in this study. Furthermore, the PCI procedure was left to the operator's discretion. IVUS was not used routinely, and only individuals with symptoms underwent angiograms at follow-up; all these factors may have influenced the outcomes of the analyses in this study.

6. Conclusion

The application of 2SS is a relatively safe and feasible procedure with a superior procedural success rate for the treatment of complex CBLs. The treatment of these lesions requires meticulous planning and anticipation of the potential challenges. Interventional cardiologists should consider a combination of clinical and procedural criteria along with lesion complexity to predict and improve outcomes with 2SS. They should be updated with the latest practice guidelines and the use of newer-generation stents, adjunctive treatments, and the latest imaging technologies for favorable outcomes. Further studies with larger sample sizes are required to validate the findings of this study.

7. Clinical Implications

This retrospective study provides the first evidence of how 2SS improves procedural success for treating complex CBLs in an Indian setting. Coronary bifurcation PCI may be operated safely using an upfront two-stent approach.

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Authors' Contributions

All authors made significant and equal contributions to this study. They collaborated on study design, collected and analyzed the data, interpreted the results, and drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Supplementary

Table S1. Details of stents used in the study.

Stent type	N	%
Biotronik AG	1	1.6
Cruz	9	14.1
Endeavor Sprint	1	1.6
Endeavor Sprint/Promus	1	1.6
Endeavor Resolute	1	1.6
Evermine/Biomime Branch	3	4.7
Integrity	1	1.6
Integrity/Yukon Choice PC	1	1.6
Orsiro/Yukon Choice Flex	1	1.6
Promus/Ultimaster	1	1.6
Promus Premier	1	1.6
Promus Premier/Integrity	1	1.6
Promus/Yukon	1	1.6
Resolute Integrity/Xience Xpedition	1	1.6
Resolute Onyx	2	3.1
Supraflex Cruz	3	4.7
Supraflex Cruz/Tetrilimus	1	1.6
Tetriflex/Biomime Branch	1	1.6
Tetriflex/Siromolint	1	1.6
Tetrilimus	12	18.8
Tetrilimus/Promus	1	1.6
Tetrilimus/Promus Elite	1	1.6
Tetrilimus/Ultimaster	1	1.6
Ultimaster	3	4.7
Xience Alpine/Promus	1	1.6
YCPC/Ultimaster	1	1.6
Yukon Choice PC	9	14.1
Yukon Choice PC/Xience Pro	1	1.6
Yukon Choice PC/Integrity	1	1.6
Yukon Choice PC/Synergy	1	1.6