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Selected Side-branch Predilation Before Provisional Main-vessel Stenting in Coronary Bifurcation Lesions: A Case Series With Bail-out Two-stent Conversion

Koroner Bifurkasyon Lezyonlarında Provizyonel Ana Dal Stentleme Öncesinde Seçilmiş Yan Dal Predilatasyonu: Bail-out İki Stente Dönüşüm İçeren Bir Olgu Serisi

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Abstract

Objective: Provisional stenting is the preferred initial strategy for most coronary bifurcation lesions. However, optimal side-branch management, particularly the roles of side-branch predilation and bail-out conversion, remains clinically relevant. This case series evaluated the procedural characteristics and one-year outcomes of lesions treated with planned provisional stenting, initiated by side-branch predilation.

Material and Methods: Nineteen consecutive patients with coronary bifurcation lesions who were planned for provisional bifurcation percutaneous coronary intervention and whose procedures, which began with side-branch predilation before main-vessel stent implantation, were performed between January 2024 and March 2025, were retrospectively evaluated. According to the final procedural pathway, cases were classified as either completed with a final provisional strategy or converted to a bail-out two-stent technique when side-branch flow or angiographic results remained suboptimal despite balloon-based optimization. Target vessel revascularization (TVR) was assessed separately. Major adverse cardiovascular events were defined as cardiac death, myocardial infarction, or stroke.

Results: Of the 19 patients, 14 were treated with a final provisional strategy, whereas 5 required bail-out conversion to a two-stent technique. Among bail-out cases, 3 underwent T-and-protrusion stenting and 2 underwent culotte stenting. Final thrombolysis in myocardial infarction 3 flow was achieved in both the main vessel and the side branch in all patients. Eighteen patients had final side-branch residual stenosis ≤30%. No cardiac deaths, myocardial infarctions, or stent thromboses occurred during the one-year follow-up. One patient experienced a stroke in the first month, while TVR due to stent restenosis was required in 2 patients.

Conclusion: In selected coronary bifurcation lesions, provisional stenting after side-branch predilation appears technically feasible. However, side-branch predilation should not be considered routine. It may be used selectively in anatomically suitable or potentially high-risk side branches, provided that the operator follows a structured provisional algorithm and is prepared for balloon optimization, proximal optimization technique, or bail-out two-stent conversion when necessary.

Keywords: Coronary bifurcation lesions, provisional stenting, side-branch predilation, percutaneous coronary intervention, bail-out stenting, proximal optimization technique

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Öz

Amaç: Provizyonel stentleme, koroner bifurkasyon lezyonlarının çoğunda tercih edilen başlangıç stratejisidir. Bununla birlikte, bu yaklaşımda yan dalın optimal yönetimi, özellikle yan dal predilatasyonu ve bail-out dönüşümün rolü, klinik açıdan önemini korumaktadır. Bu olgu serisinde, provizyonel stentleme planlanan ve işleme yan dal predilatasyonu ile başlanan lezyonlarda prosedürel özellikler ve bir yıllık klinik sonuçlar değerlendirildi.

Gereç ve Yöntemler: Ocak 2024 ile Mart 2025 arasında provizyonel bifurkasyon perkütan koroner girişim planlanan ve işlemi ana damar stent implantasyonu öncesinde yan dal predilatasyonu ile başlatılan koroner bifurkasyon lezyonlu 19 ardışık hasta retrospektif olarak değerlendirildi. Nihai prosedürel yaklaşıma göre olgular, final provizyonel strateji ile tamamlananlar ve balon temelli optimizasyona rağmen yan dal akımı veya anjiyografik sonucu suboptimal kalanlarda bail-out iki stent tekniğine dönüştürülenler olarak sınıflandırıldı. Hedef damar revaskülarizasyonu (TVR) ayrı değerlendirildi. Majör advers kardiyovasküler olaylar; kardiyak ölüm, miyokart enfarktüsü veya inme olarak tanımlandı.

Bulgular: On dokuz hastanın 14'ü final provizyonel strateji ile tedavi edilirken, 5 hastada bail-out iki stent tekniğine dönüşüm gerekti. Bail-out olgularının 3'ünde T-and-protrusion, 2'sinde culotte stentleme uygulandı. Tüm hastalarda hem ana damarda hem yan dalda final thrombolysis in myocardial infarction 3 akım elde edildi. On sekiz hastada final yan dal rezidüel darlığı ≤%30 idi. Bir yıllık takipte kardiyak ölüm, miyokart enfarktüsü veya stent trombozu gözlenmedi. Bir hastada ilk ayda inme gelişirken, 2 hastada stent restenozuna bağlı TVR gerekti.

Sonuç: Seçilmiş koroner bifurkasyon lezyonlarında, yan dal predilatasyonu sonrası provizyonel stentleme teknik olarak uygulanabilir görünmektedir. Ancak yan dal predilatasyonu rutin bir basamak olarak değerlendirilmemelidir. Anatomik olarak uygun veya yüksek riskli yan dallarda, yapılandırılmış provizyonel algoritma izlenmesi ve gerektiğinde balon optimizasyonu, proksimal optimizasyon tekniği veya bail-out iki stente dönüşüm hazırlığı olması koşuluyla seçici olarak kullanılabilir.

Anahtar Kelimeler: Koroner bifurkasyon lezyonları, provizyonel stentleme, yan dal predilatasyonu, perkütan koroner girişim, bail-out stentleme, proksimal optimizasyon tekniği

INTRODUCTION

Coronary bifurcation lesions remain among the most challenging lesion subsets encountered in percutaneous coronary intervention (PCI), because treatment must adequately expand the main vessel while preserving the patency and clinical significance of the side branch. Although several two-stent techniques have been developed for complex bifurcation anatomies, randomized data and expert consensus generally support a simple, stepwise provisional strategy as the preferred initial approach for most coronary bifurcation lesions (1-3). This strategy allows the operator to begin with main-vessel stenting and reserve additional side-branch treatment or a second stent only for cases in which flow impairment, severe residual stenosis, dissection, or another suboptimal angiographic outcome develops.

Management of the side branch before main vessel stenting remains an important technical issue. Routine side-branch predilation is generally not recommended because it may increase the risk of side-branch dissection and complicate subsequent re-crossing or device advancement. However, this recommendation should not be interpreted as an absolute rule. In selected cases, particularly when the side-branch ostium is severely stenotic, access to the side branch is considered important or difficult, the lesion is calcified or diffuse, or side-branch compromise is anticipated, predilation may be used as a procedural step to preserve side-branch access and improve immediate flow before main vessel stent implantation (4,5).

The available data on side-branch predilation are limited and somewhat heterogeneous. In a randomized study, Pan et al. (6) reported that side-branch predilation before provisional T-stenting was associated with improved side-branch thrombolysis in myocardial infarction (TIMI) flow after main vessel stenting and a reduced need for subsequent side-branch treatment. In contrast, registry data suggest that although predilation may improve some acute angiographic or procedural parameters, these improvements do not necessarily translate into better long-term clinical outcomes (7). Therefore, side-branch predilation should be viewed as a selective procedural tool rather than a routine component of provisional bifurcation PCI.

In clinical practice, the provisional strategy may follow different pathways after main vessel stenting. Some cases can be completed with main vessel stenting alone, whereas others may require additional side-branch ballooning, kissing-balloon inflation, proximal optimization, or bail-out conversion to a two-stent technique such as T-and-protrusion (TAP) or culotte stenting. The aim of this case series was to characterize the procedural features and one-year clinical outcomes of coronary bifurcation lesions treated with planned provisional stenting initiated by side-branch predilation, with a particular focus on the frequency and technical context of bail-out two-stent conversion.

MATERIAL AND METHODS

Study Design and Patient Population

This retrospective case series included 19 consecutive patients with coronary bifurcation lesions who underwent PCI, for whom a provisional bifurcation strategy was initially planned and whose procedures began with side-branch predilation prior to main-vessel stent implantation. All cases involved bifurcation lesions in which both the main vessel and the side branch were considered clinically and angiographically relevant by the treating interventional cardiologist.

Bifurcation lesions were eligible if the side-branch diameter was greater than 2.5 mm, or if it was 2.0 mm or greater and the side-branch supplied a clinically relevant myocardial territory. Patients were included if both the main vessel and side branch were wired, side branch predilation was performed as the initial bifurcation-related step, and main vessel drug-eluting stent implantation was subsequently undertaken as part of a provisional strategy.

Patients were excluded if the procedure was initially planned as an elective two-stent strategy, if side-branch predilation was not performed during lesion preparation, if the target lesion was not a coronary bifurcation, or if angiographic images, procedural records, or follow-up data were insufficient for analysis. Bifurcation interventions involving bypass grafts, cases with significant image-quality limitations, and complex reinterventions that could compromise the consistency of the analysis were also excluded.

All patients were treated with dual antiplatelet therapy according to contemporary guideline-based clinical practice after PCI. Information on the continuation of antiplatelet therapy during follow-up was obtained from hospital records, outpatient visits, and, when available, patient interviews.

Procedural Strategy

All procedures were performed according to standard interventional cardiology practice. After diagnostic angiography, both the main vessel and the side branch were wired. The procedure began with predilation of the side branch. The main vessel lesion was then prepared based on its characteristics, and a drug-eluting stent was implanted.

Side-branch predilation was not guided by a prespecified protocol. The decision was made by the operator after angiographic assessment, considering side-branch size and clinical relevance, ostial lesion severity, lesion extent, bifurcation angle, calcification or tortuosity, anticipated difficulty in maintaining or regaining access, and the perceived risk of side-branch compromise after main-vessel stenting.

After main vessel stenting, the angiographic result for the side branch was reassessed. If the side-branch flow and ostial result were acceptable, the procedure was completed using a provisional single-stent strategy. In cases with severe residual side-branch stenosis, impaired side-branch flow, or an angiographically suboptimal ostial result, additional side-branch balloon dilatation and/or kissing balloon inflation were performed.

In single-stent cases without further side-branch intervention and with an acceptable angiographic result, the proximal optimization technique (POT) was performed at the operator's discretion. Whenever side-branch ballooning, kissing balloon inflation, or bail-out two-stent conversion was required, the procedure was completed with proximal optimization.

Bail-out two-stent implantation was performed when, despite balloon-based optimization, persistent side-branch flow compromise, severe residual stenosis, dissection, or an inadequate angiographic result were present. The choice of rescue technique, including TAP or culotte stenting, was left to the operator's discretion, based on bifurcation anatomy and procedural findings.

Data Collection and Definitions

Demographic, clinical, angiographic, procedural, and follow-up data were obtained from hospital records, angiography reports, procedural notes, outpatient visits, and patient follow-up files. Procedural variables included target vessel, bifurcation location, Medina classification, bifurcation angle, stent dimensions, side-branch predilation balloon characteristics, additional side-branch ballooning, kissing balloon inflation, POT, final TIMI flow, residual stenosis, and bail-out two-stent conversion.

Procedural success was defined as stent implantation with final TIMI 3 flow in the main vessel and preservation of side-branch flow, without major in-hospital complications. Major adverse cardiovascular events (MACE) were defined as a composite endpoint comprising cardiac death, myocardial infarction, and stroke. Target vessel revascularization (TVR) was evaluated separately and was not included in the MACE definition.

Follow-up

Clinical follow-up data were collected from outpatient visits and hospital records, and from telephone interviews when necessary. One-year outcomes, including cardiac death, myocardial infarction, stroke, TVR, and stent thrombosis, were evaluated.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or median and interquartile range (IQR) according to data distribution. Categorical variables were presented as counts and percentages. Because of the small sample size and case series design, the primary analysis was descriptive.

Exploratory comparisons were performed between patients who completed the procedure with a final provisional strategy and those who required bail-out two-stent conversion. Continuous variables were compared using the Mann-Whitney U test, and categorical variables were compared using Fisher's exact test. P-values were considered exploratory and not interpreted as definitive evidence of between-group differences. Multivariable regression analysis was not performed because of the limited sample size and the low number of clinical events. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 30.0 (IBM Corp., Armonk, NY, USA).

Ethics Statement

This study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by the Local Ethics Committee of Sakarya University (decision no: 335, approval no: E-43012747-050.04-583030-335, date: 24 April 2026). The requirement for written informed consent was waived by the ethics committee because of the retrospective design and use of anonymized data.

RESULTS

Baseline Clinical Characteristics

A total of 19 patients with coronary bifurcation lesions treated with an initial side-branch predilation and provisional stenting strategy were included in the study. The median age was 63.0 years (IQR: 53.5-67.0); 4 patients (21.1%) were female. The clinical presentations were unstable angina in 8 patients (42.1%), non-ST-elevation myocardial infarction (NSTEMI) in 6 patients (31.6%), and STEMI in 5 patients (26.3%). Histories of coronary artery disease, diabetes mellitus, hypertension, and hyperlipidemia were present in 10 (52.6%), 7 (36.8%), 15 (78.9%), and 8 (42.1%) patients, respectively. The median left ventricular ejection fraction was 50.0% (IQR: 45.0-60.0). Baseline clinical characteristics of the overall cohort and exploratory comparisons according to the final treatment strategy are summarized in Table 1.

Of the 19 procedures, 14 (73.7%) were completed with a final provisional strategy, whereas 5 (26.3%) required bail-out conversion to a two-stent technique. Baseline variables were generally comparable between the final- provisional and bail-out two-stent groups. Some variables appeared numerically different between groups; however, given the very small sample size and exploratory nature of the analysis, these findings should not be interpreted as definitive group-level differences.

Table 1. Baseline clinical characteristics

Variable	Total (n=19)	Final provisional (n=14)	Bail-out two-stent (n=5)	Exploratory p†
Age, years	63.0 (53.5-67.0)	63.5 (52.8-67.5)	56.0 (56.0-65.0)	0.643
Female sex	4 (21.1)	2 (14.3)	2 (40.0)	0.272
Clinical diagnosis				
UAP	8 (42.1)	6 (42.9)	2 (40.0)	NA
NSTEMI	6 (31.6)	3 (21.4)	3 (60.0)	NA
STEMI	5 (26.3)	5 (35.7)	0 (0.0)	NA
Previous CAD	10 (52.6)	8 (57.1)	2 (40.0)	0.628
Diabetes mellitus	7 (36.8)	5 (35.7)	2 (40.0)	1.000
Hypertension	15 (78.9)	11 (78.6)	4 (80.0)	1.000
Hyperlipidemia	8 (42.1)	8 (57.1)	0 (0.0)	0.045
Chronic kidney disease	1 (5.3)	1 (7.1)	0 (0.0)	1.000
Previous MI	8 (42.1)	8 (57.1)	0 (0.0)	0.045
Previous PCI	8 (42.1)	8 (57.1)	0 (0.0)	0.045
LVEF, %	50.0 (45.0-60.0)	47.5 (45.0-60.0)	55.0 (50.0-60.0)	0.322

Values are presented as median (interquartile range) or n (%)
†: Exploratory p-values only; Mann-Whitney U test was used for continuous variables and Fisher's exact test for binary categorical variables
CAD: Coronary artery disease, LVEF: Left ventricular ejection fraction, MI: Myocardial infarction, NSTEMI: Non-ST-elevation myocardial infarction, PCI: Percutaneous coronary intervention, STEMI: ST-elevation myocardial infarction, UAP: Unstable angina pectoris, NA: Indicates not applicable/no variability or a descriptive multi-category variable

Angiographic and Procedural Characteristics

The most common bifurcation site was the left anterior descending artery-diagonal bifurcation, observed in 12 patients (63.2%), followed by the circumflex-obtuse marginal bifurcation in 7 patients (36.8%). According to the Medina classification, 7 lesions (36.8%) were classified as 1,1,1; 5 lesions (26.3%) were classified as 1,0,1; and 7 lesions (36.8%) were classified as 0,1,1. The median bifurcation angle was 56.0 degrees (IQR: 43.0-63.5). Lesion morphology, procedural characteristics, and exploratory comparisons between the final provisional and bail-out two-stent groups are presented in Table 2.

The median reference diameters were 3.5 mm (IQR: 3.0-3.5) for the main branch and 2.5 mm (IQR: 2.0-2.8) for the side branch. Baseline stenosis was severe in both the main vessel and the side branch, with median values of 90.0% (IQR: 90.0-99.5) and 90.0% (IQR: 80.0-95.0), respectively. Calcification, tortuosity, and thrombus were present in 7 (36.8%), 10 (52.6%), and 10 (52.6%) patients, respectively.

All procedures began with side-branch predilation. The median side-branch predilation balloon diameter was 2.0 mm (IQR: 2.0-2.5), and the median balloon length was 12.0 mm (IQR: 11.0-15.0). After side-branch predilation, the median residual side-branch stenosis was 30.0% (IQR: 20.0-40.0), and TIMI 3 flow was maintained in most cases.

After main- vessel stenting, additional side-branch balloon dilatation was performed in 15 patients (78.9%) and kissing balloon inflation in 12 patients (63.2%). Final POT was performed in 16 patients (84.2%). In single-stent cases without additional side-branch intervention and with an acceptable angiographic result, POT was performed at the operator's discretion. However, all cases requiring post-stent side-branch intervention or bail-out two-stent conversion were completed with POT.

Bail-out conversion to a two-stent technique was required in 5 patients (26.3%) because of inadequate side-branch results after the provisional approach. Among these patients, TAP stenting was used in 3 cases and culotte stenting in 2 cases. Procedure duration was longer in the bail-out two-stent group than in the final provisional group, with durations of 40.0 minutes (IQR: 35.0-45.0) versus 31.0 minutes (IQR: 26.2-35.0) (exploratory p=0.029). Final residual side-branch stenosis was lower in the bail-out two-stent group, an expected angiographic finding associated with side-branch stent implantation.

Procedural and Clinical Outcomes

Angiographic procedural success was achieved in all patients. Final TIMI 3 flow was achieved in both the main vessel and the side branch in all 19 patients (100%). Eighteen patients (94.7%) had a final residual side-branch stenosis of ≤30%. No procedural myocardial infarction occurred. No-reflow phenomenon was observed in 1 patient (5.3%). Procedural success and one-year clinical outcomes are shown in Table 3. Individual case-level clinical, angiographic, procedural, and outcome data are provided in Supplementary Table 1.

No cardiac deaths, myocardial infarctions, or stent thromboses were observed during the one-year follow-up period. One patient developed a stroke, resulting in a MACE rate of 5.3%, based on the predefined composite endpoint of cardiac death, myocardial infarction, or stroke. TVR, which was evaluated separately from MACE, was required in 2 patients (10.5%). TVR occurred in 1 patient in each of the final provisional and bail-out two-stent groups.

Table 2. Lesion and procedural characteristics

Variable	Total (n=19)	Final provisional (n=14)	Bail-out two-stent (n=5)	Exploratory p†
Final technique				
Provisional	14 (73.7)	14 (100.0)	0 (0.0)	NA
TAP	3 (15.8)	0 (0.0)	3 (60.0)	NA
Culotte	2 (10.5)	0 (0.0)	2 (40.0)	NA
Medina classification				
1,1,1	7 (36.8)	6 (42.9)	1 (20.0)	NA
1,0,1	5 (26.3)	4 (28.6)	1 (20.0)	NA
0,1,1	7 (36.8)	4 (28.6)	3 (60.0)	NA
Bifurcation location				
LAD-D	12 (63.2)	8 (57.1)	4 (80.0)	NA
CX-OM	7 (36.8)	6 (42.9)	1 (20.0)	NA
Bifurcation angle, degrees	56.0 (43.0-63.5)	46.5 (38.8-61.8)	58.0 (56.0-72.0)	0.105
Main branch reference diameter, mm	3.5 (3.0-3.5)	3.5 (3.0-3.5)	3.0 (3.0-3.5)	0.769
Main branch lesion length, mm	18.0 (15.5-28.5)	23.5 (16.5-30.0)	16.0 (15.0-18.0)	0.077

Table 2. Continued

Variable	Total (n=19)	Final provisional (n=14)	Bail-out two-stent (n=5)	Exploratory p†
Side branch reference diameter, mm	2.5 (2.0-2.8)	2.2 (2.0-2.7)	2.5 (2.5-2.8)	0.146
Side branch lesion length, mm	10.0 (8.0-10.0)	10.0 (8.0-10.0)	10.0 (10.0-10.0)	0.772
Main branch stent diameter, mm	3.0 (2.8-3.0)	3.0 (2.8-3.0)	2.8 (2.8-3.0)	0.922
Main branch stent length, mm	24.0 (20.0-33.0)	30.0 (21.5-37.0)	18.0 (18.0-20.0)	0.014
Baseline main branch stenosis, %	90.0 (90.0-99.5)	95.0 (90.0-99.8)	90.0 (80.0-90.0)	0.233
Baseline side branch stenosis, %	90.0 (80.0-95.0)	90.0 (90.0-98.0)	80.0 (80.0-90.0)	0.161
Calcification	7 (36.8)	5 (35.7)	2 (40.0)	1.000
Tortuosity	10 (52.6)	9 (64.3)	1 (20.0)	0.141
Thrombus	10 (52.6)	8 (57.1)	2 (40.0)	0.628
Initial SB predilation balloon diameter, mm	2.0 (2.0-2.5)	2.0 (2.0-2.0)	2.5 (2.5-2.5)	0.010
Initial SB predilation balloon length, mm	12.0 (11.0-15.0)	12.0 (10.0-12.0)	15.0 (15.0-15.0)	0.003
SB predilation pressure, atm	12.0 (12.0-14.0)	14.0 (12.0-14.0)	12.0 (12.0-12.0)	0.153
Residual SB stenosis after predilation, %	30.0 (20.0-40.0)	25.0 (20.0-30.0)	40.0 (30.0-40.0)	0.050
SB TIMI flow after predilation	3.0 (3.0-3.0)	3.0 (3.0-3.0)	3.0 (3.0-3.0)	0.633
SB TIMI flow after main branch stenting	2.0 (2.0-2.5)	2.0 (2.0-3.0)	2.0 (1.0-2.0)	0.104
SB balloon after main branch stenting	15 (78.9)	10 (71.4)	5 (100.0)	0.530
Kissing balloon after main branch stenting	12 (63.2)	7 (50.0)	5 (100.0)	0.106
Final POT performed	16 (84.2)	11 (78.6)	5 (100.0)	0.530
Bail-out conversion to two-stent	5 (26.3)	0 (0.0)	5 (100.0)	NA
Final main branch TIMI flow	3.0 (3.0-3.0)	3.0 (3.0-3.0)	3.0 (3.0-3.0)	NA
Final side branch TIMI flow	3.0 (3.0-3.0)	3.0 (3.0-3.0)	3.0 (3.0-3.0)	NA
Final residual side branch stenosis, %	20.0 (10.0-30.0)	30.0 (20.0-30.0)	0.0 (0.0-0.0)	<0.001
Procedure duration, min	33.0 (27.5-36.5)	31.0 (26.2-35.0)	40.0 (35.0-45.0)	0.029

Values are presented as median (interquartile range) or n (%)
†: Exploratory p-values only; Mann-Whitney U test was used for continuous variables and Fisher's exact test for binary categorical variables, CX-OM: Circumflex-obtuse marginal branch, LAD-D: Left anterior descending artery-diagonal branch, MB: Main branch, POT: Proximal optimization technique, SB: Side branch, TAP: T-and-protrusion, TIMI: Thrombolysis in myocardial infarction, NA: Indicates not applicable/no variability or a descriptive multi-category variable

Table 3. Procedural and clinical outcomes

Variable	Total (n=19)	Final provisional (n=14)	Bail-out two-stent (n=5)	Exploratory p†
Angiographic procedural success (final MB/SB TIMI 3)	19 (100.0)	14 (100.0)	5 (100.0)	NA
Final residual SB stenosis ≤30%	18 (94.7)	13 (92.9)	5 (100.0)	1.000
Procedural MI	0 (0.0)	0 (0.0)	0 (0.0)	NA
No-reflow	1 (5.3)	1 (7.1)	0 (0.0)	1.000
MACE (stroke, myocardial infarction, or cardiac death)	1 (5.3)	1 (7.1)	0 (0.0)	1.000
Death within 30 days	0 (0.0)	0 (0.0)	0 (0.0)	NA
Death within 1 year	0 (0.0)	0 (0.0)	0 (0.0)	NA
TVR within 30 days	0 (0.0)	0 (0.0)	0 (0.0)	NA
TVR within 1 year	2 (10.5)	1 (7.1)	1 (20.0)	0.468
Stent thrombosis	0 (0.0)	0 (0.0)	0 (0.0)	NA
Any recorded adverse event*	4 (21.1)	3 (21.4)	1 (20.0)	1.000

Values are presented as n (%)
†: Exploratory p-values only; Fisher's exact test was used for binary categorical variables. MACE was defined as stroke, myocardial infarction, or cardiac death. TVR was reported separately and was not included in the MACE definition, *: Any recorded adverse event included no-reflow, stroke, target vessel revascularization, or any other documented clinically relevant procedural or follow-up event, MACE: Major adverse cardiovascular events, MB: Main branch, SB: Side branch, TIMI: Thrombolysis in myocardial infarction, TVR: Target vessel revascularization, NA: Indicates not applicable/no variability

DISCUSSION

This case series describes a selected group of coronary bifurcation lesions in which the procedure was planned using a provisional strategy but initiated by side-branch predilation. The main finding was that this approach was technically feasible in selected lesions, with high final angiographic success and acceptable one-year clinical outcomes. However, the results should be interpreted as descriptive and hypothesis-generating because of the small sample size, retrospective design, and the absence of a control group that received conventional provisional stenting without side-branch predilation.

The provisional approach remains the primary treatment strategy for many bifurcation lesions, as it allows the operator to begin with the simplest reasonable strategy and to escalate treatment only when the side branch requires further intervention. This stepwise philosophy is consistent with the European Bifurcation Club approach, which emphasizes preservation of side-branch access, careful reassessment after main vessel stenting, and side-branch treatment or dual stenting only when the angiographic result is unacceptable (8). Our series reflects this concept in daily practice: all procedures were initiated with provisional intent, but the final strategy was determined by the side-branch result after main vessel stenting.

Side-branch compromise following main-vessel stenting is a major concern during bifurcation PCI. In the COBIS II registry, side-branch occlusion after main vessel stenting was associated with adverse clinical outcomes, and predictors included significant side-branch stenosis, proximal main vessel stenosis, side-branch lesion length, and presentation with acute coronary syndrome (9). These findings help explain why operators may choose to prepare or preserve the side branch before main-vessel stent implantation. In the present series, side-branch predilation was not used routinely for all bifurcation lesions, but was employed selectively as part of a procedural strategy in lesions where side-branch preservation was considered clinically important.

The role of side-branch predilation before provisional stenting remains controversial. Data from the COBIS II registry suggest that side-branch predilation may improve acute angiographic or procedural outcomes but does not necessarily improve long-term clinical outcomes (7). Similarly, the randomized study by Pan et al. (6) showed that predilation may improve early side-branch flow and reduce the need for subsequent side-branch treatment, but this does not imply that predilation should be routinely applied in all bifurcation cases. Therefore, our findings should be interpreted with caution. They support the feasibility of side-branch predilation in selected patients but do not demonstrate superiority over conventional provisional stenting without predilation.

Another important technical point in this series is the use of POT. In our procedural approach, POT was performed at the operator's discretion in single-stent cases when no further side-branch intervention was required and the angiographic result was acceptable. However, when side-branch ballooning, kissing balloon inflation, or bail-out conversion to a two-stent configuration was required, the procedure was completed with POT. POT improves proximal main vessel stent expansion, facilitates side-branch access, and corrects malapposition related to vessel diameter mismatch. In a large bifurcation registry, POT was associated with lower rates of target lesion failure and stent thrombosis, supporting its role as a key optimization step in bifurcation PCI (10).

Five patients in this series required bail-out conversion to a two-stent strategy. The 26.3% bail-out rate was higher than the 4% side-branch stenting rate reported in the predilation arm of the randomized study by Pan et al. (6). This difference likely reflects our selected cohort, which included clinically relevant side branches with severe disease and an anticipated risk of compromise. Given the small sample size and the lack of a control group, the observed rate should not be interpreted as an effect of predilation itself. This finding is important because it demonstrates that starting with a provisional strategy does not entail insisting on a single-stent result under all circumstances. When side-branch flow remains compromised, residual stenosis is severe, or dissection threatens the side branch despite balloon-based optimization, conversion to a two-stent technique is an appropriate step in the provisional algorithm. In our cases, TAP and culotte techniques were used according to anatomical and procedural requirements. The European Bifurcation Club white paper emphasizes that bifurcation techniques should be clearly selected and reported, as the final stent configuration may influence procedural and clinical outcomes (11). The BBK II study also demonstrated that the choice between culotte and TAP stenting in lesions requiring side-branch stenting may influence angiographic restenosis, although clinical differences may be less pronounced (12).

Our findings should also be interpreted in the context of lesion complexity. The DEFINITION II study showed that planned dual-stent strategies may provide better outcomes than provisional stenting in selected complex bifurcation lesions (13). However, the present study was not designed to compare planned two-stent PCI with provisional PCI. Instead, it describes a real-world procedural pathway in which the operator plans provisional stenting, starts with side-branch predilation, and proceeds to a second stent only when necessary. This distinction is important. Our findings should not be interpreted as evidence against planned two-stent treatment in complex bifurcations; rather, they support a selective, anatomy-based, stepwise approach.

The observed one-year clinical outcomes were generally acceptable. No cardiac death, myocardial infarction, or stent thrombosis occurred during follow-up. The only MACE event was a stroke; TVR was evaluated separately and occurred in two patients. Because of the small sample size, these event rates are not definitive and should be considered descriptive. Furthermore, the need for rescue side-branch stenting may identify a more complex procedural subgroup. Previous data from acute coronary syndrome populations suggest that patients requiring rescue stenting may have higher late-event rates than those treated with a single-stent strategy (14). Therefore, in the present series, bail-out conversion should be viewed primarily as a marker of procedural complexity rather than as a failure of the initial strategy.

Overall, this case series offers a practical message. Side-branch predilation should not be performed routinely before provisional bifurcation PCI. However, in carefully selected bifurcation lesions involving a relevant side branch, particularly when there is severe ostial disease, anticipated access difficulty, or concern for side-branch compromise, it may be used as part of a controlled, stepwise strategy. The value of this approach lies in maintaining the simplicity of provisional stenting while keeping options open for balloon optimization, kissing balloon inflation, POT, and bail-out two-stent conversion when the side-branch outcome requires it.

Study Limitations

The primary strength of this study is that it reflects a clear and reproducible real-world procedural pathway. All cases were initiated with side-branch predilation within a planned provisional strategy, and the final treatment pathway was determined according to the angiographic result after main vessel stenting. This makes the series useful not only as a results report but also as a technical description of how a provisional bifurcation strategy may evolve during the procedure.

Another strength is the reporting of both angiographic and clinical outcomes. Procedural success, final TIMI flow, residual side-branch stenosis, kissing balloon inflation, POT, and bail-out conversion were evaluated together. In addition, reporting TVR separately from MACE avoids overloading the composite endpoint and provides a clearer clinical interpretation.

The study also has several important limitations. First, the sample size is small; therefore, the results should be interpreted descriptively. The study is not adequately powered to compare final provisional stenting with bail-out two-stent conversion. Second, the single-center, retrospective design may have introduced selection bias and may have limited the generalizability of the findings. Both side-branch predilation and bail-out conversion were operator-dependent. Third, there was no control group treated with conventional provisional stenting without side-branch predilation. Therefore, the present data do not demonstrate that side-branch predilation improves procedural or clinical outcomes. Fourth, intravascular imaging and physiological assessment were not systematically available, which may have limited the objective evaluation of lesion complexity, stent expansion, and side-branch significance. Finally, follow-up was limited to one year, and longer-term data are required to more reliably assess late restenosis, very late stent thrombosis, and repeat revascularization.

CONCLUSION

In this retrospective case series, a provisional stenting strategy initiated with side-branch predilation was technically feasible in selected coronary bifurcation lesions. Most patients were successfully treated without a second stent, whereas bail-out conversion to a two-stent technique was reserved for cases with suboptimal side-branch outcomes. Final angiographic success was high, and one-year clinical outcomes were acceptable.

These findings do not support routine side-branch predilation before all provisional bifurcation procedures. Instead, side-branch predilation may be considered a selective step in anatomically suitable or potentially high-risk side branches, provided that the operator follows a structured provisional algorithm and is prepared to perform balloon optimization, POT, or bail-out two-stent conversion when necessary.

*Ethics

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by the Local Ethics Committee of Sakarya University (decision no: 335, approval no: E-43012747-050.04-583030-335, date: 24 April 2026).

Informed Consent: The requirement for written informed consent was waived by the ethics committee because of the retrospective design and use of anonymized data.

Declaration on the Use of Artificial Intelligence (AI)

For transparency, the authors note that an artificial intelligence assisted language model was utilized to support text editing and language correction. This assistance was limited to linguistic refinement; all scientific content, critical analysis, and final editorial decisions were made exclusively by the authors.

Footnotes

Authorship Contributions

Surgical and Medical Practices: F.T., A.B., Concept: F.T., Design: F.T., Data Collection or Processing: F.T., A.B., Analysis or Interpretation: F.T., Literature Search: F.T., A.B., Writing: F.T.

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Supplementary Table 1: https://d2v96fxpocvxx.cloudfront.net/cf9d60d6-523c-458a-a2e6-78728d3ffbb0/content-images/d05839fa-32b5-4085-aa71-2b484dd161bd.pdf

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