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# Three-Year Outcomes of the DKCRUSH-V Trial Comparing DK Crush With Provisional Stenting for Left Main Bifurcation Lesions

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#### ABSTRACT

**OBJECTIVES** The present study aimed to investigate the difference in target lesion failure (TLF) at 3 years after double kissing (DK) crush stenting versus provisional stenting (PS) for unprotected left main distal bifurcation (UPLMb) lesions.

**BACKGROUND** The multicenter and randomized DKCRUSH-V (Double Kissing Crush versus Provisional Stenting for Left Main Distal Bifurcation Lesions: The DKCRUSH-V Randomized Trial) study showed fewer 1-year TLF after DK crush for UPLMb lesions compared with PS. The study reports the 3-year clinical outcome of the DKCRUSH-V study.

**METHODS** A total of 482 patients with UPLMb lesions who were randomly assigned to either the DK crush group (DK group) or PS group in the DKCRUSH-V study were followed for 3 years. The primary endpoint was the occurrence of a TLF at 3 years. Stent thrombosis (ST) was the safety endpoint. Patients were classified by lesion's complexity and NERS (New Risk Stratification) II or SYNTAX (Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery) score.

**RESULTS** At 3 years, TLF occurred in 41 (16.9%) patients in the PS group and in 20 (8.3%) patients in the DK group (p = 0.005), mainly driven by increased target vessel myocardial infarction (5.8% vs. 1.7%; p = 0.017) and target lesion revascularization (10.3% vs. 5.0%; p = 0.029). Definite or probable ST rate at 3 years was 4.1% in the PS group and 0.4% in the DK group (p = 0.006). Notably, DK crush was associated with a significant reduction in both primary and secondary endpoints for patients with complex lesions or at high risk.

**CONCLUSIONS** Provisional stenting for UPLMb lesions was associated with significantly increased rates of TLF and ST over 3 years of follow-up. Further randomized study is warranted to confirm the benefits of DK crush stenting for complex UPLMb lesions. (Double Kissing and Double Crush versus Provisional T Stenting Technique for the Treatment of Unprotected Distal Left Main True Bifurcation Lesions: A Randomized, International, Multi-center Clinical Trial; ChiCTR-TRC-11001213). (J Am Coll Cardiol Intv 2019; **=**:**=**-**=**) © 2019 by the American College of Cardiology Foundation.

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### ABBREVIATIONS AND ACRONYMS

CABG = coronary artery bypass grafting

DK = double kissing

IVUS = intravascular ultrasound

MI = myocardial infarction

PCI = percutaneous coronary intervention

PS = provisional stenting

SB = side branch

ST = stent thrombosis

TLF = target lesion failure

TLR = target lesion revascularization

TVMI = target vessel myocardial infarction

UPLMb = unprotected left main distal bifurcation lesions

ost patients with unprotected left main (LM) coronary artery disease have involvement of the distal LM bifurcation (1,2), which is associated with inferior outcomes after percutaneous coronary intervention (PCI) compared with isolated ostial or shaft treatment (3,4). Although coronary artery bypass grafting (CABG) remains the standard treatment for patients with LM disease (5), recently the EXCEL (Evaluation of XIENCE Everolimus Eluting Stent Versus Coronary Artery Bypass Surgery for Effectiveness of Left Main Revascularization) trial (1) showed that PCI using second generation drug-eluting stents provided comparable 3-year composite rates of death, myocardial infarction (MI), or stroke compared with CABG. In that study, in line with the NOBEL (Nordic-Baltic-British Left Main Revascularization Study) study (2), provisional stenting (PS) was the main stenting techniques for distal LM lesions, which has been shown to be superior to a planned 2-stent approach in most randomized trials of non-LM bifurcation lesions (6-9). However, the DK crush planned 2-stent technique resulted in lower rates of target lesion revascularization (TLR) compared with PS in non-LM coronary bifurcation lesions (10), and lower rates of target vessel revascularization, stent thrombosis (ST), and composite major adverse cardiac events compared with culotte stenting in unprotected LM distal bifurcation (UPLMb) lesions (11,12). In the randomized DKCRUSH-V (Double Kissing Crush versus Provisional Stenting for Left Main Distal Bifurcation Lesions: The DKCRUSH-V Randomized Trial) study (13), we compared double kissing (DK) crush stenting and PS techniques for UPLMb lesions and observed fewer target lesion failures (TLF) and STs at 1-year follow-up in the DK crush group. There are no data showing the long-term benefits of DK crush compared with PS for UPLMb lesion treatment. Accordingly, the aim of this study was to evaluate the 3-year clinical outcomes after DK crush and PS for the patient population from DKCRUSH-V study. The outcome in those patients was also compared in a subgroup stratified by NERS (New Risk Stratification) II score (14) or SYN-TAX (Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery) score (15), 2 stratification systems used to differentiate lowerrisk from high-risk UPLMb lesions.

### METHODS

**STUDY DESIGN AND PATIENT POPULATION.** The DKCRUSH-V trial was an international (6 countries),

multicenter (n = 27), randomized study that was designed to compare the DK crush and the PS for patients with UPLMb lesions (13). The primary endpoint was TLF (the composite of cardiac death, target vessel MI [TVMI], or clinically driven TLR) at 1year follow-up, whereas angiographic follow-up was performed 13 months after the indexed procedures. The study protocol was approved by the Ethics Committee of all participating centers, and written consent was obtained from all patients. The recruitment of participating centers was strictly according to our study protocol (16). The clinical follow-up was scheduled to be performed as 3 years, as shown in Figure 1. Finally, between December 27, 2011, and February 21, 2016, a total of 482 patients were enrolled (240 in the DK crush and 242 in the PS group). In brief, patients were eligible if they had ischemic symptoms or evidence of myocardial ischemia in the presence of a Medina (17) 1,1,1 or 0,1,1 de novo UPLMb lesions. For inclusion, non-LM lesions in the left anterior descending artery, left circumflex, or right coronary artery, if present, had to be treatable by no more than 2 additional stents. The exclusion criteria have been described in detail previously (13,16). Patients were randomly assigned to the study groups in a 1:1 ratio immediately after angiography. The main stenting techniques were described previously (13). For both provisional and DK crush stenting, the proximal optimization technique was used for all LM stents, and post-dilatation of all stents was recommended with noncompliant balloons at  $\geq$ 18 atm pressure. The recommended drug-eluting stents were Xience Prime (Abbott Vascular, Santa Clara, California) and Resolute (Medtronic, Santa Rosa, California).

**MEDICATIONS.** All patients were treated with aspirin pre-procedure and were administered a 300-mg loading dose of clopidogrel if not on chronic dual antiplatelet therapy. After intervention, all patients received 100 mg/day aspirin indefinitely and clopidogrel 75 mg/day for at least 12 months. Additional medications for secondary prevention, including statins,  $\beta$ -blockers, and angiotensin-converting enzyme inhibitors, were prescribed according to current guidelines.

**DEFINITION OF STUDY ENDPOINTS.** The primary endpoint was TLF at 3 years, which included cardiac death, TVMI, or clinically driven TLR. ST defined by the Academic Research Consortium definite or probable criteria (18) was the major safety endpoint. Death from cardiac causes was defined as any death without a clear noncardiac cause. Protocoldefined periprocedural MI was defined as creatine

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kinase-myocardial band  $>10\times$  the upper reference limit of the assay, or  $>5 \times$  upper reference limit plus: 1) new pathological Q waves in  $\geq 2$  contiguous leads or new left bundle branch block; ii) angiographically documented graft or coronary artery occlusion or new severe stenosis with thrombosis; or 3) imaging evidence of new loss of viable myocardium or new regional wall motion abnormality. Spontaneous MI (after 72 h) was defined as a clinical syndrome consistent with MI with creatine kinase-myocardial band or troponin  $>1\times$  upper reference limit and new ST-segment elevation or depression or other findings as previously mentioned. Clinically driven TLR was defined as angina or ischemia referable to the target lesion requiring repeat PCI or CABG. All events were adjudicated by a central committee using original source documents blinded to treatment.

**STATISTICAL ANALYSIS.** The calculation of sample size was described previously (13). The chi-square test or Fisher's exact test was used to compare categorical variables. Student's *t*-test or Wilcoxon rank sum scores for non-normally distributed data were used to compare continuous variables. Time-to-first event

curves were generated by Kaplan-Meier analysis and compared using the log-rank test. Patients were classified by NERS II score or SYNTAX score. All outcome analyses were performed in the intention-to-treat population, regardless of treatment received. All statistical tests were 2-sided, and a p value of <0.05 was considered statistically significant. All analyses were performed with SPSS version 24.0 (IBM Corporation, Armonk, New York).

### RESULTS

**BASELINE CLINICAL, ANGIOGRAPHIC, AND PROCE-DURAL CHARACTERISTICS.** Baseline clinical, angiographic and procedural characteristics (**Table 1**) were well matched between the groups. Diabetes was present in 27.2% of patients, and most patients (72.2%) presented with unstable angina. The UPLMb was classified as Medina class 1,1,1 and 0,1,1 in 81.7% and 18.3% of cases, respectively. A total of 116 (47.1%) patients in the PS group required an additional side branch (SB) stent for suboptimal results after main vessel stenting. The final kissing balloon inflation were more frequently used in the DK group than the

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	Provisional			
	Stenting	DK Crush		
	(n = 242)	(n = 240)	P Value*	
Clinical				
Age, yrs	$64 \pm 10$	$65\pm9$	0.15	
Male	188 (77.7)	199 (82.9)	0.17	
Hyperlipidemia	115 (47.5)	114 (47.5)	1.00	
Hypertension	156 (64.5)	175 (72.9)	0.051	
Diabetes	62 (25.6)	69 (28.8)	0.47	
Prior MI	51 (21.1)	52 (21.7)	0.91	
Recent MI (>24 h)	26 (10.7)	31 (12.9)	0.49	
Angiographic				
Multivessel disease	216 (88.8)	211 (87.9)	0.78	
Calcification	96 (39.7)	89 (37.1)	0.58	
Chronic total occlusion	30 (12.4)	29 (12.1)	1.00	
SYNTAX score >32	88 (36.4)	91 (37.9)	0.72	
NERS II score ≥19	101 (41.7)	115 (47.9)	0.17	
Procedural				
Final kissing inflation	191 (78.9)	239 (99.6)	<0.001	
POT performed	239 (98.8)	238 (99.2)	0.39	
IVUS assessment	98 (40.5)	103 (42.9)	0.37	
Complete revascularization	168 (69.4)	174 (72.5)	0.48	
Angiographic success	235 (97.1)	236 (98.3)	0.54	
Procedural time, min	$66.1 \pm 34.5$	81.9 ± 37.6	< 0.001	
Contrast volume, ml	190.9 ± 73.8	$\textbf{226.7} \pm \textbf{81.4}$	< 0.001	

Values are mean  $\pm$  SD or n (%). The p values are from chi-square tests.

DK = double kissing; IVUS = intravascular ultrasound; MI = myocardial infarction; NERS = New Risk Stratification; POT = proximal optimization technique; SYNTAX = Synergy Between Percu-

taneous Coronary Intervention With TAXUS and Cardiac Surgery.

PS group. Rates of angiographic success and complete revascularization were similar in the 2 groups, although procedural time and contrast use were greater with DK crush stenting than PS.

CLINICAL OUTCOMES. Clinical follow-up was complete in all patients at 1 year, and no patient was lost to follow-up at 3 years (Table 2). At 3 years, dual antiplatelet therapy was prescribed in 181 (75.4%) patients in the DK group, nonsignificant at 183 (75.6%) patients in the PS group (p = 1.00).

Angiographic follow-up was completed in 158 (65.3%) patients in the PS group and 159 (66.3%) patients in the DK group at 13 months after indexed stenting procedures (13). After 13 months, repeat angiography was performed in 92 patients, with 45 (18.6%) in the PS group and 47 (19.6%) in the DK group (p = 0.82).

At 1-year follow-up (Table 2), there were more frequent TLF (10.7%) and TVMI (2.9%) in the PS group compared with the DK group (5.0%, p = 0.02; and 0.4%, p = 0.03). At 2- and 3-year follow-up, the cumulative incidences of TLF were 15.3% and 16.9% in the PS group, respectively, and 7.1% and 8.3% in the DK group, respectively (all p < 0.05) (Table 2), mainly driven by increased rates of TVMI (5.4% vs. 1.7%, p = 0.027; 5.8% vs. 1.7%; p = 0.017) in the PS group. The

TABLE 2 Clinical Outcomes at 1, 2, and 3 Years							
	Provisional Stenting (n = 242)	DK Crush (n = 240)	p Value				
1-yr follow-up							
Target lesion failure	26 (10.7)	12 (5.0)	0.02				
Cardiac death	5 (2.1)	3 (1.3)	0.48				
Target vessel MI	7 (2.9)	1 (0.4)	0.03				
Target lesion revascularization	19 (7.9)	9 (3.8)	0.06				
Stent thrombosis	9 (3.7)	3 (1.3)	0.10				
Definite	2 (0.8)	1 (0.4)	0.50				
Probable	6 (2.5)	0	0.03				
Definite/probable	8 (3.3)	1 (0.4)	0.02				
Possible	1 (0.4)	2 (0.8)	0.58				
2-yr follow-up							
Target lesion failure	37 (15.3)	17 (7.1)	0.005				
Cardiac death	10 (4.1)	5 (2.1)	0.20				
Target vessel MI	13 (5.4)	4 (1.7)	0.027				
Target lesion revascularization	23 (9.5)	12 (5.0)	0.06				
Stent thrombosis	12 (5.0)	5 (2.1)	0.09				
Definite	2 (0.8)	1 (0.4)	0.56				
Probable	8 (3.3)	0	0.005				
Definite/probable	10 (4.1)	1 (0.4)	0.006				
Possible	1 (0.4)	4 (1.7)	0.19				
3-yr follow-up							
Target lesion failure	41 (16.9)	20 (8.3)	0.005				
Cardiac death	12 (5.0)	8 (3.3)	0.37				
Target vessel MI	14 (5.8)	4 (1.7)	0.017				
Target lesion revascularization	25 (10.3)	12 (5.0)	0.029				
Stent thrombosis	14 (5.8)	6 (2.5)	0.07				
Definite	2 (0.8)	1 (0.4)	0.56				
Probable	8 (3.3)	0	0.005				
Definite/probable	10 (4.1)	1 (0.4)	0.006				
Possible	3 (1.2)	5 (2.1)	0.50				
All-cause death	18 (7.4)	16 (6.7)	0.74				

Values are mean  $\pm$  SD or n (%). The p values are from chi-square tests. Abbreviations as in Table 1.

median of follow-up for TLF was 1,822 (interquartile range: 1,323 to 2,219) days in the DK group and 1,828 (interquartile range: 1,324 to 2,214) days in the PS group (p = 0.964). At 3 years, the difference in the rate of TLR became significant between the PS (10.3%) and DK (5.0%) groups (p = 0.029). The rates of eventfree survival are shown in Figure 2. There was no significant difference in TLF or individual endpoint among centers or among countries.

By 3 years after the index procedures, the rate of definite and probable ST was 4.1% in the PS group and 0.4% in the DK group (p = 0.006) (Table 2). All patients having a definite or probable ST were taking dual antiplatelet therapy. Landmark analysis of the proportion of definite or probable ST is shown in Figure 3. The early (within 30 days), late ( $\leq 1$  year), and very late (>1 year) definite or probable ST occurred in 6 (2.5%), 2 (0.8%), and 2 (0.8%) patients, respectively, in the PS group, without occurrence after 1 year in the DK group. Of those 2 newly defined



PS was associated with significant increase of target lesion failure (TLF), target vessel myocardial infarction (TVMI), and target lesion revascularization (TLR) compared with the DK crush stent. There was no statistical difference in cardiac death. CI = confidence interval; HR = hazard ratio; other abbreviations as in Figure 2.

definite or probable STs in the PS group, 1 occurred at 570 days after T stenting (rescue SB stenting) and another occurred at 528 days after 1-stent technique, and both had TVMI but did not undergo primary PCI (all survived at the end of follow-up).

Of 196 patients with complex bifurcation lesions according to DEFINITION criteria (24), DK crush (n = 108) was most beneficial for patients with complex lesions with respect to TLF at 3-year follow-up (Figure 4).

A total of 192 patients had a NERS II score  $\geq$ 19 and 213 patients had a SYNTAX score >32 according to site reporting (13). On the basis of core lab analysis, 216

(44.8%) patients (101 in the PS group and 115 in the DK group) were classified by a NERS II score  $\geq$ 19 and 179 (37.1%) patients (88 in the PS group and 91 in the DK group) were classified by a SYNTAX score >32 (**Table 3**). There was no significant difference in TLF at 3-year follow-up between the PS and the DK groups in patients having either a NERS II score <19 or a SYNTAX score  $\leq$ 32 (Online Table 1). PS was associated with more frequent TLF at 3 years among patients having either a NERS II score  $\geq$ 19 (16.8%) (**Table 3**) or a SYNTAX score  $\geq$ 32 (20.5%) compared with the DK crush stent (5.2%, p = 0.007; and 5.5%, p = 0.004), largely driven by increased TVMI (5.9% vs. 0%,

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p = 0.009; or 8.0% vs. 1.1%, p = 0.028) and TLR (6.9% vs. 1.7%, p = 0.06; or 9.1% vs. 2.2%, p = 0.049) in the PS group. Definite or probable ST was also more commonly recorded in patients having higher NERS II or SYNTAX score after PS treatment, particularly in patients who underwent rescue SB stenting (Online Table 2). However, the interaction p values were nonsignificant (data not shown).

#### DISCUSSION

The DKCRUSH-V study for the first time evaluates the clinical outcomes after the DK crush stent technique versus a provisional approach for treatment of true distal LM bifurcation lesions. Our findings demonstrated that the difference in TLF between the 2 groups was sustainable and became more significant through 3-year follow-up (Central Illustration). Notably, the increased rate of definite and probable ST in the PS group, particularly in patients who underwent a rescue SB stenting, translated into more frequent TVMI.

For non-LM bifurcation lesions, in general, provisional SB stenting is noninferior to systematic 2-stent techniques according to previous clinical trials (6-9). In contrary, the prior DKCRUSH-II study reported a sustainable difference in TLR between the DK crush stent versus PS through 1 year (10) to 5 years (19). This controversy in clinical benefits by different stenting techniques raised issues in 2 directions: Does the difference in the study design affect final results? Is provisional T (usually TAP) stenting superior to all routine 2-stent techniques? Obviously, the answer for the first issue is yes, because CTO, UPLMb, and acute MI were all included in the DKCRUSH-II study (10,19) compared with other studies (6,8,9). For the second issue, Ferenc et al. (20) reported that culotte stenting was associated with less in-stent restenosis and fewer TLR compared with the TAP techniques. Taking the DKCRUSH-III study (showing that the DK crush was superior to culotte stenting) into consideration, we may conclude that the DK crush should be a better technique than provisional T stenting, which is consistent with the results from the DKCRUSH-II study (10). From the current study, almost 50% of UPLMb lesions were crossed over to the TAP arm with subsequent increased TLF and ST, suggestive of the superiority of DK crush over provisional T stenting for UPLMb. Compared with non-LM bifurcation lesions, true distal LM bifurcation lesions involve larger caliber vessels, have a wider bifurcation angle, and have more frequent involvement of 3-vessel segments (trifurcations) (1,2,4,21). Even though our results showed that DK crush stenting offered a durable lower rate of TLR for UPLMb (1- and 3-year TLR were 2.4% and 3.8%, respectively, in the DKCRUSH-III study) these rates were 3.8% at 1-year and 5.0% at 3-year follow-up from the current DKCRUSH-V study. The underlying mechanisms for improvements achieved by DK crush stenting may relate to a more



(A-C) Provisional stenting was comparable to DK crush for simple lesions. (D) However, DK crush was associated with less TLF for complex lesions. at 3-year follow-up. Also, DK crush tended to have a fewer rate of TVMI and TLR in patients with complex lesions, even it did not reach significant. Abbreviations as in Figures 2 and 3.

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TABLE 3 Clinical Outcomes in Patients Having Higher NERS II and SYNTAX Scores									
	NERS ≥19			SYNTAX Score >32					
	Provisional Stenting (n = 101)	DK Crush (n = 115)	p Value*	Provisional Stenting (n = 88)	DK Crush (n = 91)	p Value*			
TLF at 1 yr	10 (9.9)	3 (2.6)	0.027	10 (11.4)	4 (4.4)	0.09			
Cardiac death	2 (2.0)	1 (0.9)	0.48	2 (2.3)	2 (2.2)	0.96			
TVMI	4 (4.0)	0	0.032	5 (5.7)	1 (1.1)	0.09			
TLR	6 (5.9)	2 (1.7)	0.11	6 (6.8)	2 (2.2)	0.14			
Stent thrombosis	4 (4.0)	1 (0.9)	0.13	5 (5.7)	2 (2.2)	0.23			
Definite	0	0	NS	1 (1.1)	1 (1.1)	0.96			
Probable	4 (4.0)	0	0.032	4 (4.5)	0	0.041			
Definite/probable	4 (4.0)	0	0.032	5 (5.7)	1 (1.1)	0.09			
Possible	0	1 (0.9)	0.36	0	1 (1.1)	0.34			
TLF at 3 yrs	17 (16.8)	6 (5.2)	0.007	18 (20.5)	5 (5.5)	0.004			
Cardiac death	6 (5.9)	5 (4.3)	0.62	6 (6.8)	4 (4.4)	0.50			
TVMI	6 (5.9)	0	0.009	7 (8.0)	1 (1.1)	0.028			
TLR	7 (6.9)	2 (1.7)	0.06	8 (9.1)	2 (2.2)	0.049			
Stent thrombosis	6 (5.9)	3 (2.6)	0.22	8 (9.1)	3 (3.3)	0.11			
Definite	0	0	NS	1 (1.1)	1 (1.1)	0.96			
Probable	5 (5.0)	0	0.016	5 (5.7)	0	0.022			
Definite/probable	5 (5.0)	0	0.016	6 (6.8)	1 (1.1)	0.05			
Possible	1 (1.0)	3 (2.6)	0.39	2 (2.3)	2 (2.2)	0.96			
All-cause death	8 (7.9)	11 (9.6)	0.67	7 (8.0)	9 (9.9)	0.65			

Values are n (%). The p values are from chi-square tests.

TLF = target lesion failure; TLR = target lesion revascularization; TVMI = target vessel myocardial infarction; other abbreviations as in Table 1.

controlled strategy to treat the entire LM complex and affords more reliable lesion coverage and greater stent expansion of the ostial left circumflex artery (10,11,13).

For stenting bifurcation lesions, the complexity of stenting techniques should be objectively evaluated. Although the DK crush represents 1 of the "complex" 2-stent techniques that require multiple crushing, rewiring, and kissing (11,13), in the PS approach, the delivery of a "rescue" or bail-out SB stent through main vessel stent cells may be difficult or result in imprecise placement (14,15,25), incomplete expansion or asymmetry (22,23), or edge dissections (23,24), all of which may contribute to an increased rate of ST or clinically driven TLR during follow-up. On the other hand, lesion complexity also may be correlated with worse clinical events. First, short SB lesion length has been reported to be 1 of predictors for less clinical evens (26,27). The DEFINITION (Definitions and impact of complEx biFurcation lesIons on clinical outcomes after percutaNeous coronary IntervenTIOn using drug-eluting steNts) study indicated that an SB lesion length  $\geq$ 10 mm significantly increased the sensitivity and specificity for predicting clinical events (24). The EBC MAIN-2 (The European Bifurcation Club Left Main Study) study is ongoing, with inclusion of an SB lesion length minimum of 8 mm (27,28). Accordingly, it is not surprising that DK crush stenting is superior to the PS for UPLMb because of an average of SB lesion length ~16.4-mm and DS 65% by QCA in our study, compared with 2 registry studies (29,30). Second, both NERS II score  $\geq$ 19 and SYNTAX score >32 represent the complexity of UPLMb lesions (14,15). Consistent findings from the current study were that DK crush stenting resulted in fewer TLF, TVMI, TLR, and ST through 3-year follow-up compared with the PS approach. Of note, the finding that the difference in clinically driven TLR between 2 groups was significant through 3-year follow-up may indicate the need of a further clinical trial to identify the importance of routine kissing inflation after PS (main vessel stenting).

**STUDY LIMITATIONS.** First, intravascular ultrasound (IVUS) assessment was performed in less than half of all procedures. The recent ULTIMATE (Intravascular Ultrasound Versus Angiography-Guided Drug-Eluting Stent Implantation) trial clearly demonstrated the superior outcome by IVUS guidance for all-comers or the bifurcation lesion subset who underwent implantation of a drug-eluting stent (31). The comparison of IVUS guidance versus angiography guidance might be underpowered from our initial analysis on 1year outcome and was not performed for 3-year follow-up. As a result, further clinical trials identifying the importance of IVUS-guided stenting bifurcations are warranted. Second, new-generation antiplatelet medication was not prescribed in patients. Increased rate of ST in the PS group,

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particularly in patients for whom a rescue SB stent was used, may underscore the change of dual antiplatelet therapy strategy. Finally, CABG remains the standard approach for LM disease. The lack of comparison of the DK crush with CABG blocks the routine use of PCI for LM lesions, especially for lesions localized at the distal LM. However, results from the recent randomized EXCEL trial (1) and durable improvements in clinical outcomes after DK crush stenting by experienced operators suggest that the DK crush technique may be considered as an alternative approach for true UPLMb. Finally, a nonsignificant interaction p value for TLF should be interpreted cautiously, mainly due to the small sample size of each subgroup.

### CONCLUSIONS

In the present multicenter randomized trial, a planned DK crush 2-stent strategy reduced TLF and ST through 3-year follow-up compared with a PS strategy in patients with true distal LM bifurcation lesions.

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### PERSPECTIVES

WHAT IS KNOWN? PS is still the main technique for UPLMb lesions. In the randomized DKCRUSH-V trial, the DK crush technique resulted in significant improvement in 1-year TLF compared with a PS approach in patients with UPLMb.

WHAT IS NEW? The DK crush stent was associated with fewer TLF, TVMI, TLR, and ST through 3-year follow-up than PS for UPLMb.

WHAT IS NEXT? Further studies are required to determine whether results can be further improved with routine use of intravascular imaging or physiological lesion assessment.

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KEY WORDS double kissing crush, left main bifurcation lesions, provisional stenting, target lesion failure

**APPENDIX** For supplemental tables, please see the online version of this paper.