Techniques to Improve Left Main Stenting

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Stenting of the left main coronary artery can be technically challenging due to the different diameters of the proximal and distal vessel, presence of disease in the bifurcation of the artery and limitations of the currently available stents. Bernard Chevalier, MD, Institut Cardiovasculaire Paris Sud, Massy, France, presented techniques for left main percutaneous coronary intervention (PCI). Achieving success with left main PCI is dependent on chosing proper patients, using appropriate techniques, and implanting the best type of stent for that particular patient, according to Prof. Chevalier.

There are a variety of treatment options for bifurcation lesions such as T-stenting or crush techniques which use multiple stents or provisional stenting which uses one stent to treat the main coronary artery and an additional stent in the other only if necessary. A recent analysis of the French Left Main Taxus registry of 5-year outcomes following unprotected left main stenting demonstrated a major adverse cardiac event (MACE) occurrence of 34.1% in patients with one stent compared with 17.8% in patients with two stents at 60 months (log-rank p=0.006) [Mylotte D et al. *EuroIntervention* 2012]. In addition, the rate of cardiac death was 18.2% in patients who received one stent and 8.5% in patients who received two stents (log-rank p=0.035). Similarly, a prospective analysis of the j-Cypher registry in Japan of 3-year outcomes following sirolimus-eluting stent (SES) implantation for unprotected left main coronary artery disease demonstrated an incidence of cardiac death of 5.5% for patients in which only the main branch was stented and 12.2% for in which the main branch and the side branch were stented at 1095 days post stent implantation (p=0.018) [Toyofuku M et al. *Circulation* 2009]. In the same analysis, the incidence of target lesion revascularization (TLR) was 11.1% for patients in which only the main branch was stented and 30.9% for patients in which the main branch and the side branch were stented (p<0.0001).

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The impact of stenting technique—T-stenting, V-stenting, or crush stenting—was evaluated in a study of 2-year outcomes with drug-eluting stent (DES) implantation in 773 patients with unprotected left main stenosis [Palmerini T et al. *Circ Cardiovasc Interv* 2008]. The MACE-free survival was similar across the techniques with a MACE-free rate of 66.5% in patients who received T-stenting, 69.3% in patients who received V-stenting, and 66.9% in patients who received crush stenting. Similarly, there was no significant difference in survival, myocardial infarction (MI)-free survival, cardiac death-free survival, or TLR-free survival between the three different techniques. In addition, there appears to be no clear consensus on the use of provisional versus multiple, as studies have demonstrated favorability for both techniques for TLR and side branch restenosis. However, provisional stenting is associated with lower MI or stent thrombosis as compared with the use of two stents.

Prof. Chevalier compared the French Left Main Taxus pilot registry and the Left Main Xience [LEMAX] registry in which the same operators performed a provisional T-stenting and final kissing balloon inflation strategy for left main stenting, and the Friend registry (Table 1). In the Taxus pilot and FRIEND registries, first generation paclitaxel-eluting stents (PES) were used, whereas second generation everolimus-eluting stents (EES) were used in the LEMAX registry. In the Taxus pilot study in 2004, 78% of the 291 patients had a distal lesion and and 42% had two stents [Vaquerizo B et al. *Circulation* 2009]. In the FRIEND registry, 69% of the 151 patients had a distal lesion while 26% were treated with two stents [Carrié D et al. *EuroIntervention* 2009]. In the LEMAX registry in 2008, 81% and 19% of the 174 patients had a distal lesion and two stents, respectively [Salvatella N et al. *EuroIntervention* 2011].

Table 1. Comparison of Left Main Studies With Drug-Eluting Stenting

	Pilot Taxus* 2004	FRIEND** 2006	LEMAX 2008
No. of patients	291	151	174
Distal lesion (%)	78	69	81
Two stents (%)	42	26	19
Mean LM stent diameter (mm)	3.44+0.39	3.59+0.49	3.63+0.33
12-month TLR	5.9%	2.7%	2.3%

LM= left main; TLR= target lesion revascularization.

*Vazquerizo B et al. *Circulation* 2009;119:2349-56; **Carrie D et al. *EuroIntervention* 2009;4:449-56.

Prof. Chevalier stated it is important to know the maximum expansion for the DES being used to treat a coronary lesion since expansion of the stent beyond this point had not been studied. It is possible that expansion beyond recommended size could result in loss of the structural integrity of the stent, increased metal fatigue, and an increased risk of stent fracture. It is unknown whether beyond-maximal expansion can cause an increased risk of dissection or plaque prolapse. When performing left main stenting, the maximum expansion of the stent should be taken into consideration when determining which stent to use (Table 2) [Foin N et al. *Int J Cardiol* 2013].

Prof. Chavalier noted that treating side branches is challenging because the diameters are frequently different from the main branch and the diameter of the branching ostia may be different from the diameter of the main branch. Prof. Chavalier recommended against using a balloon other than kissing balloon for inflation, as this technique can cause distortion of the stent [Sgueglia GA, Chevalier B. *JACC Cardiovasc Interv* 2012]. Instead, kissing inflation allows the use of multiple balloons of different sizes to expand the stent to the appropriate diameter. For example, before the bifurcation the main branch may have a larger diameter than after the bifurcation. In addition, different-sized balloons can expand a single stent to the correct diameter in different areas of the vessel.

In conclusion, Prof. Chevalier stated that provisional side branch stenting is a feasible and safe technique for both left main and non-left main bifurcation lesions in most patients. Using a complete simulation may be helpful in understanding the important steps of this technique, including the use of two wires, stent sizing, proximal optimization technique, and the use of kissing balloons. Prof. Chavalier pointed out that in the future, simulations may be extremely useful as a training tool, as well as a way to analyze the results of various treatments and the prediction of future events following treatment.

Table 2. Maximum Postdilation Expansion of Drug-Eluting Stents

Maximum Balloon Size		Element	Xience	Taxus	Integrity	BioMatrix	Cypher
4.0	2.25	Very small WH (2 cells); ME, 3.0 mm	Medium WH (6 crowns, 3 cells); ME, 4.4 mm	Small WH (6 crowns, 2 cells); ME, 3.4 mm	Small WH (7 crowns, 2 cells); ME, 4.9 mm; *1.5 cell in Resolute	Medium WH (6 crowns, 2 cells); ME, 4.6 mm	Medium WH (6 crowns, 6 cells); ME, 4.7 mm
	2.50	Small WH (8 crowns, 2 cells); ME, 3.8 mm					
5.0	2.75			Medium WH (9 crowns, 3 cells); ME,4.8 mm	Medium WH (10 crowns, 3 cells); ME, 5.4 mm		
	3.00	Medium WH (8 crowns, 2 cells); ME, 4.4 mm				Large WH (9 crowns, 3 cells); ME, 5.9 mm	Large WH (7 crowns, 7 cells); ME, 5.8 mm
	3.50		Large WH (9 crowns, 3 cells); ME, 5.6 mm				
6.9	4.00	Large WH (10 crowns, 2 cells); ME, 5.7 mm		Large WH (9 crowns, 3 cells); ME, 6.0 mm			
	4.50						
	5.0						

ME=maximum exposure; WH=workhorse.