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Effect of Stent Length on Clinical Outcome in Patients with Coronary Artery Disease

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Abstract

Objectives: Stent length is an important predictor of adverse events after PCI. The study was aimed to evaluate the clinical outcome of long stent length. **Methodology**: The present one year prospective study included 660 consecutive patients who underwent long segment elective coronary artery stenting from April 2012 and March 2013. The patients were divided into three cohorts depending upon the stent length 24-28 mm, 29-32 mm and more than 32 mm. Study endpoint was Major Adverse Cardiac Events (MACE) including cardiac death, myocardial infarction, repeat revascularization and stent thrombosis. **Results**: The commonest age group was 51 to 60 years (45.91%) of the 660 patients, 211 (31.97%) had stent length between 24 to 28 mm, 198 (30%) had 29 to 32 mm and 251 (38.03%) had > 32 mm. Risk factors including hypertension, diabetes mellitus, smoking, dislipidemia, obesity, family history and cerebrovascular accident were comparable in patients with different stent lengths ($p>0.050$). Significantly higher number of patients with 32 mm stent length had overlapping, dissection and direct stenting ($p<0.050$). Overall MACE was significantly high in patients with stent length >32 mm ($p=0.045$) but no statistically significant difference was observed on comparison of individual variables ($p>0.050$). Also comparable outcomes were noted in patients with diabetes mellitus and without diabetes mellitus ($p>0.050$). **Conclusion and Interpretation**: Use of more than 32mm Drug Eluting Stent (DES) for the treatment of long lesions results in overall high MACE rate.

Keywords: Coronary Artery Disease, Drug-Eluting Stents, Major Adverse Cardiac Events (MACE), Percutaneous Coronary Intervention, Stent Length

1. Introduction

Drug-Eluting Stents (DES) have decreased the incidence of restenosis and need for repeat revascularization, Myocardial Infarction (MI) and stent thrombosis as compared to Bare-Metal Stents (BMS). Percutaneous Coronary Intervention (PCI) studies and meta-analyses have shown that DES as widely used in routine clinical practice including complex and long lesions[1]. Long lesions account for approximately 20% of PCI and present challenges for drug-eluting stenting[2–4]. Coverage of long lesions with single long stent is a preferred strategy of PCI. Stent length has been consider an important predictor of adverse effects after PCI. This study was undertaken to evaluate the effect of long stents on clinical outcome in patients with Coronary Artery Disease (CAD).

2. Methodology

This one year prospective study was carried out in the Department of Cardiology of a Tertiary Care Centre Situated in North Karnataka, India from April 2012 and March 2013. A total of 1519 patients underwent PCI during the study period out of which 660 consecutive patients aged more than 18 years and undergoing PCI with attempted implantation of long stent, and clinical indication for revascularization undergoing long segment elective coronary artery stenting were included in the

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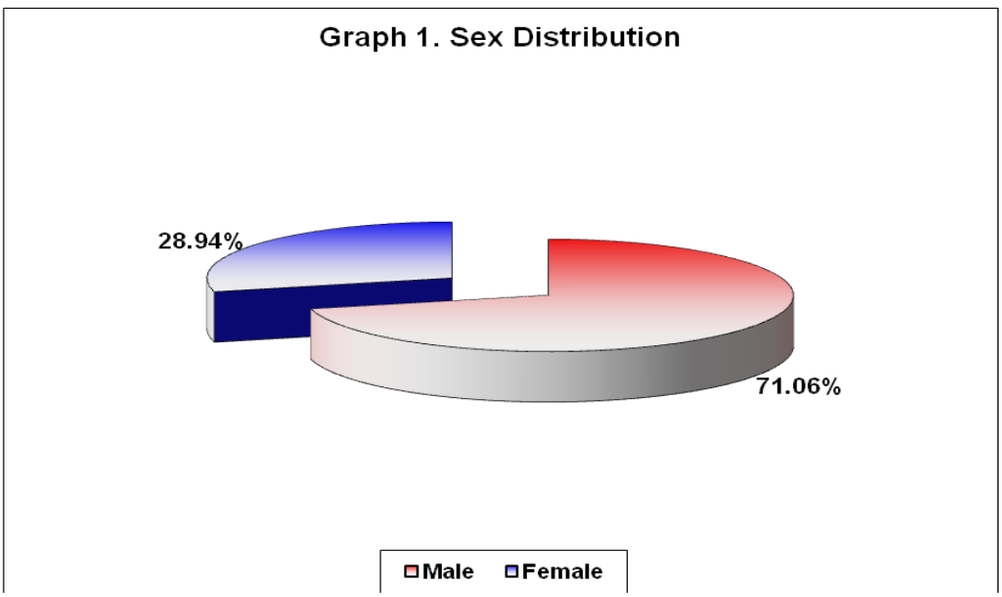
study. Patients with PCI or cardiac surgery within four weeks, acute ST-segment elevation myocardial infarction necessitating primary PCI, severely compromised ventricular dysfunction (Ejection Fraction [EF] <30%) or cardiogenic shock and patient with contraindication for long-term dual antiplatelet therapy were excluded from the study. Prior to the commencement, the ethical clearance was obtained from the Institutional Ethics Committee. The eligible patients were briefed about the nature of study and a written informed consent was obtained.

The selected patients were interviewed and the demographic, clinical data was obtained. Patients underwent clinical and systemic examination and these findings were recorded on a predesigned and pretested proforma. Further these patients were divided into three groups depending upon the stent length that is, 24-28 mm, 29-32 mm and more than 32 mm. All patients who underwent stent implantation received at 325 mg of aspirin and 600 mg loading dose of clopidogrel, Heparin was administered to maintain an activated clotting time ≥250 seconds. Post procedure, all patients received 150mg/day of aspirin indefinitely and 75mg twice daily clopidogrel for initial 24 months followed by 75mg/day indefinitely[5,6].

Clinical follow-up was performed for all patients at one, three and twelve months. Study endpoints were MACE including Target Lesion Revascularization (TLR), Target Vessel Revascularization (TVR), myocardial infarction, stent thrombosis and Death. Patients who complained of cardiac symptoms were evaluated clinically in the form of Non-invasive testing (Treadmill test [TMT]) unless contraindicated. Follow-up coronary angiography was done for all patients with recurrence of angina or positive non-invasive testing (TMT).

MACE event like Periprocedural MI was defined as an increase of creatine kinase-MB or creatine kinase ≥3 times the local upper limit of normal with preference given to creatine kinase-MB values or persistent ST-segment elevation >1mm in 2 contiguous electrocardiographic limb leads or 2 mm in 2 contiguous precordial leads. MI was defined as increased creatine kinase or creatine kinase-MB at presentation with at least twofold increase in enzyme levels after the procedure according to the Third Universal Definition of Myocardial Infarction7. Stent thrombosis was defined as definite or probable stent thrombosis according to the Academic Research Consortium definitions[8–9]. Stent overlap was defined as the presence of >2 stents within a single treated lesion and an overlapping stent zone of at least 1mm, as determined by quantitative coronary angiography. Overlapping stent zones were identified based on the position of the stent balloon markers of the second stent relative to the first stent.



3. Statistical Analysis

Data obtained was coded and entered into Microsoft excel spreadsheet. The data was analysed using SPSS version 20.0. Categorical data was expressed in terms of rates, ratios and percentages and continuous data was expressed as mean ± Standard Deviation (SD). The association of categorical data including risk factors, MACE was done using chi-squared test and mean values were compared using one way analysis of variance (ANOVA). A probability value of less than or equal to 0.050 at 95% confidence interval was considered as statistically significant.

4. Result

Majority of the patients in this study were males (71.06%) and male to female ratio was 2.52:1 (Graph 1). The commonest age group was 51 to 60 years comprised of 45.91% followed by more than 60 years (36.97%). The target vessel was Left Anterior Descending artery (LAD) in 65.30% (Graph 2). Of the 660 patients, 211 (31.97%) had stent length between 24 to 28 mm, 198 (30%) had 29 to 32 mm and 251 (38.03%) had > 32 mm. The mean stent diameter was comparable in patients with stent length between 24 to 28 mm, 29 to 32 mm and > 32 mm that is, 3.19 ± 2.7 mm, 3.12 ± 1.91 mm and 3.10 ± 0.34 mm respectively.

Among the males and females maximum (37.95% and 38.22% respectively) patients had stent length of > 32 mm (p=0.896). The mean age in patients with stent length between 24 to 28 mm was 58.0 ± 11.5 years, in patients with 29 to 32 mm and > 32 mm stent length the same was 59.3 ± 10.6 years and 60.1 ± 8.6 years (p>0.050). The risk profile of the patients with different lengths of stents is as shown in Table 1. It was observed that, risk factors including hypertension, diabetes mellitus, smoking, disylipidemia, obesity, family history and cerebrovascular accident were comparable in patients with different stent lengths (p>0.050). The angiographic data revealed significantly higher number of patients with overlapping, dissection, bifurcation and direct stenting in patients with more than 32 mm stent length (p<0.050).

The comparison of MACE in patients with different stent lengths is as shown in Table 3. Overall MACE was significantly high in patients with stent length > 32 mm (p=0.045). However no statistically significant difference was observed on comparison of individual variables that is, death, stent thrombosis, TVR, TLR and Myocardial infarction. In patients with diabetes mellitus (Table 4) and those without diabetes mellitus (Table 5), the overall MACE and individual components were comparable (p>0.050).

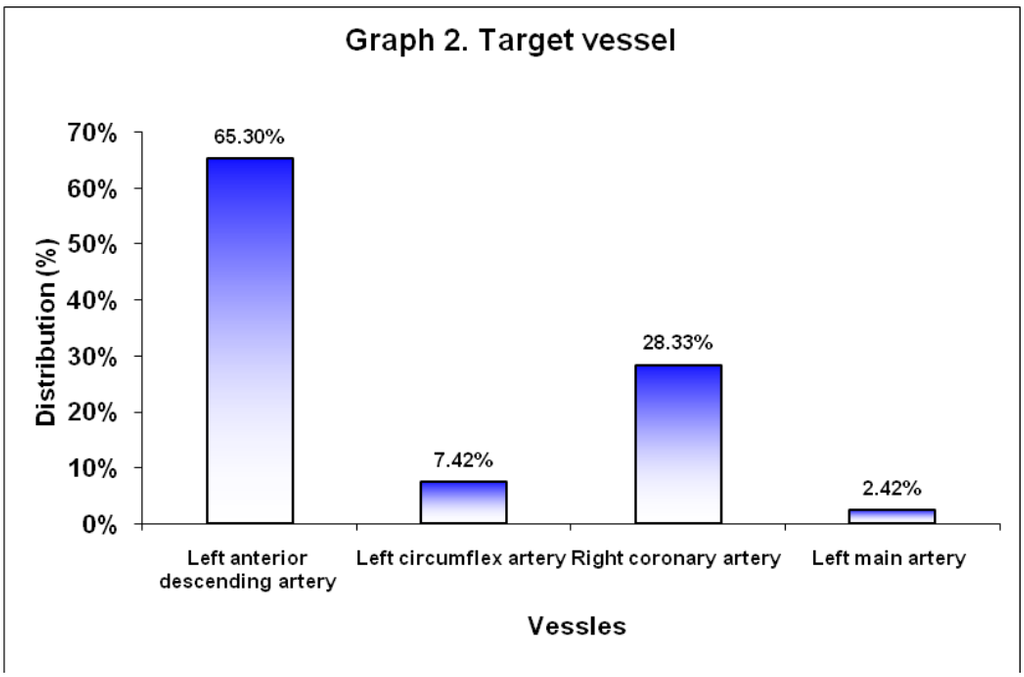


Table 1. Risk factors

Risk factors	Findings	Stent length 24 to 28 (n=211)		29 to 32 (n=198)		> 32 (n=251)		p value
		Number	Percent	Number	Percent	Number	Percent	
Hypertension	Yes	118	30.65	114	29.61	153	39.74	0.532
	No	93	33.82	84	30.55	98	35.64	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Diabetes mellitus	Yes	67	30.32	59	26.70	95	42.99	0.162
	No	144	32.80	139	31.66	156	35.54	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Smoking	Yes	80	31.62	75	29.64	98	38.74	0.958
	No	131	32.19	123	30.22	153	37.59	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Dyslipidemia	Yes	19	29.69	18	28.13	27	42.19	0.771
	No	192	32.21	180	30.20	224	37.58	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Obesity	Yes	12	27.91	11	25.58	20	46.51	0.495
	No	199	32.25	187	30.31	231	37.44	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Family history	Yes	22	32.35	20	29.41	26	38.24	0.993
	No	189	31.93	178	30.07	225	38.01	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
CVA	Yes	2	33.33	2	33.33	2	33.33	0.970
	No	209	31.96	196	29.97	249	38.07	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	

Table 2. Comparison of angiographical data with stent length

Variables	Findings	Stent length 24 to 28 (n=211)		29 to 32 (n=198)		> 32 (n=251)		p value
		Number	Percent	Number	Percent	Number	Percent	
Overalapping	Yes	10	4.27	49	20.94	175	74.79	<0.001
	No	201	47.18	149	34.98	76	17.84	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Dissection	Yes	3	6.98	15	34.88	25	58.14	0.001
	No	208	33.71	183	29.66	226	36.63	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Bifurcation	Yes	5	12.50	16	40.00	19	47.50	0.024
	No	206	33.23	182	29.35	232	37.42	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Direct stenting	Yes	102	42.68	69	28.87	68	28.45	<0.001
	No	109	25.89	129	30.64	183	43.47	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	

Table 3. Association of stent length with MACE

Variables	Findings	Stent length 24 to 28 (n=211)		29 to 32 (n=198)		> 32 (n=251)		p value
		Number	Percent	Number	Percent	Number	Percent	
Overall MACE	Yes	5	14.29	11	31.43	19	54.29	0.045
	No	206	32.96	187	29.92	232	37.12	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Death	Yes	0	0.00	1	50.00	1	50.00	0.611
	No	211	32.07	197	29.94	250	37.99	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Stent thrombosis	Yes	0	0.00	1	33.33	2	66.67	0.444
	No	211	32.12	197	29.98	249	37.90	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
TVR	Yes	3	18.75	5	31.25	8	50.00	0.467
	No	208	32.30	193	29.97	243	37.73	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
TLR	Yes	2	18.18	3	27.27	6	54.55	0.473
	No	209	32.20	195	30.05	245	37.75	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	
Myocardial Infarction	Yes	0	0.00	1	33.33	2	66.67	0.444
	No	211	32.12	197	29.98	249	37.90	
	Total	**211**	**31.97**	**198**	**30.00**	**251**	**38.03**	

Table 4. Association of stent length with MACE in patients with diabetes mellitus

Variables	Findings	Stent length 24 to 28 (n=211)		29 to 32 (n=198)		> 32 (n=251)		p value
		Number	Percent	Number	Percent	Number	Percent	
Overall MACE	Yes	3	13.04	5	21.74	15	65.22	0.057
	No	64	32.32	54	27.27	80	40.40	
	Total	**67**	**30.32**	**59**	**26.70**	**95**	**42.99**	
Death	Yes	0	0.00	0	0.00	1	100.00	0.514
	No	67	30.45	59	26.82	94	42.73	
	Total	**67**	**30.32**	**59**	**26.70**	**95**	**42.99**	
TLR	Yes	1	12.50	2	25.00	5	62.50	0.446
	No	66	30.99	57	26.76	90	42.25	
	Total	**67**	**30.32**	**59**	**26.70**	**95**	**42.99**	
TVR	Yes	2	18.18	3	27.27	6	54.55	0.630
	No	65	30.95	56	26.67	89	42.38	
	Total	**67**	**30.32**	**59**	**26.70**	**95**	**42.99**	
Stent thrombosis	Yes	0	0.00	0	0.00	3	100.00	0.133
	No	67	30.73	59	27.06	92	42.20	
	Total	**67**	**30.32**	**59**	**26.70**	**95**	**42.99**	

Table 5. Association of stent length with MACE in patients without diabetes mellitus

Variables	Findings	Stent length						p value
		24 to 28 (n=211)		29 to 32 (n=198)		> 32 (n=251)		
		Number	Percent	Number	Percent	Number	Percent	
Overall MACE	Yes	2	25.00	3	37.50	3	37.50	0.833
	No	142	32.95	136	31.55	153	35.50	
	Total	**144**	**32.80**	**139**	**31.66**	**156**	**35.54**	
TVR	Yes	1	20.00	2	40.00	2	40.00	0.822
	No	143	32.95	137	31.57	154	35.48	
	Total	**144**	**32.80**	**139**	**31.66**	**156**	**35.54**	
TLR	Yes	1	33.33	1	33.33	1	33.33	0.996
	No	143	32.80	138	31.65	155	35.55	
	Total	**144**	**32.80**	**139**	**31.66**	**156**	**35.54**	

5. Discussion

In complex coronary artery disease use of DES reduces the risk of restenosis making it a standard clinical practice among cardiologists especially in long lesion[5,6,10].

Long coronary artery lesions have an additional risk of adverse clinical outcomes[11], specifically stent deliverability, stent overlap, risk of restenosis, peri-procedural myocardial infarction, and stent thrombosis. Long stenting is frequently associated with prolonged intracoronary manipulation and overlapping stent placement, which may lead to injury to the vessel wall integrity. The currently available newer-generation DES has minimal restenosis risk, enhanced deliverability, and low risk of peri-procedural infarction. These benfits of newer generation DES can be attributed to specific design characteristics like thin struts, also, availability of long stent lengths helps prevent overlapping of stents to treat long segment lesion.

The present study showed no statistically significant association of MACE parameters including death, stent thrombosis, TVR, TLR and myocardial infarction in patients with varied stent length (p>0.050) though rate of overall MACE was significantly high in patients with stent length more than 32 mm compared to 29 to 32 mm and 24 to 28 mm (p=0.045). Stent length has been major predictor of adverse events after PCI, even with the use of Drug-Eluting Stents (DESs).

The EVERLONG registry examined clinical outcomes in long lesions (mean length 43.7mm) using overlapping EES stents; nine-month TLR and MACE rates were low at 0.4 and 5.4%, respectively[12].

The Drug-Eluting stenting followed by Cilostazol treatment reduces LAte REstenosis in patients with Long native coronary lesions (DECLARELong) trial using DESs defined a total stent length ≥ 32mm as the long DES group[13]. Another study reported that a stent length ≥ 31.5 mm was a threshold for predicting stent thrombosis[14]. The J-CYPHER registry data showed that a stent length ≥ 34 mm was associated with a greater incidence of stent thrombosis[15].

Ruchin et al[16]. reported a 9-month late stent thrombosis rate of 1.25% for a mean stent length ≥55mm. Suh et al[17]. evaluated the association between the length of the stented segment and the risk of stent thrombosis after DES implantation; they concluded that Length of the stented segment was independently associated with the incidence of stent thrombosis and death or myocardial infarction after DES implantation. The value of stent length >31.5mm is a threshold for the prediction of stent thrombosis. In this present study more than 32mm DES for treatment of long stent lesion had overall high MACE compared to other groups (24-28mm, 29-32mm).

The presence of diabetes has been associated with worse outcomes after percutaneous coronary intervention with BMS and DES[18,19]. Our study revealed that DM patients with more than 32mm stent length had overall MACE and individual MACE components including death, TLR, TVR and stent thrombosis higher compared to other group (24-28mm, 29-32mm) though the difference was statistically not significant (p>0.050).

Study limitation:

- It was single center study.
- Assessment of coronary lesion was done by principal operator by eye ball technique which may be bias.
- Coronary artery lesion may be under or over estimated due to inavailability of Intravascular Ultrasound Imaging (IVUS), Fractional Flow Reserve (FFR) and Optical Coherence Tomography (OCT).

6. Conclusion

The present study suggested that, use of more than 32mm DES for treatment of long stent lesions had a overall high MACE rate compared to other groups (24-28mm, 29-32mm) and in >32mm the subgroups of overlapping long DES and DM patients higher MACE rate.

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