J Korean Med Sci 1998; 13: 483-7
ISSN 1011-8934

Copyright © The Korean Academy of Medical Sciences

Comparison of Slotted Tube versus Coil Stent Implantation for Ostial Left Anterior Descending Coronary Artery Stenosis: Initial and Late Clinical Outcomes

Balloon angioplasty of ostial left anterior descending coronary artery (LAD) lesions has been associated with a high rate of acute complications and late restenosis. Recently, coronary stenting has been proposed as an effective treatment modality for ostial LAD lesions. To evaluate the effects of stent design on the development of late restenosis, we retrospectively analyzed the efficacy of slotted-tube stent implantation (40 patients, Palmaz-Schatz stent) and coil stent implantation (15 patients, tantalum Cordis stent) of ostial LAD stenosis. Six-month angiographic follow-up data were obtained in 31 patients (82%) with slotted-tube stent implantation and 12 patients (86%) with coil stent implantation. Angiographic restenosis was defined as ≥50% diameter stenosis. The angiographic restenosis rate was significantly lower in slotted-tube stent implantation (32%) than in coil stent implantation (67%) ($p<0.05$). Target lesion revascularization rate of slotted tube stent implantation was significantly lower (26%) than that of coil stent implantation (57%) ($p<0.05$). Coil stent implantation of ostial left anterior descending artery lesions was associated with higher late restenosis compared with slotted tube stent implantation. In conclusion, slotted-tube stent implantation might be considered to improve late clinical outcomes of ostial LAD lesions.

Key Words : *Stents; Restenosis; Coronary disease*

Seong-Wook Park, Hoon-Ki Park, Myeong-Ki Hong, Sang-Gon Lee, Il-Soo Lee, Jin-Woo Kim, Cheol Whan Lee, Jae-Joong Kim, Seung-Jung Park

Department of Internal Medicine, College of Medicine, University of Ulsan, Cardiovascular Center, Asan Medical Center, Seoul, Korea

Received : April 8, 1998
Accepted : June 18, 1998

Address for correspondence
Seung-Jung Park, M.D., Ph.D.
Departments of Internal Medicine, College of Medicine, University of Ulsan, Cardiovascular Center, Asan Medical Center, 388-1 Pungnap-dong, Songpa-gu, Seoul, Korea
Tel : +82.2-224-4818/3152, Fax : +82.2-475-6898

INTRODUCTION

Balloon angioplasty of ostial left anterior descending coronary artery (LAD) lesions has been associated with lower rates of initial success, higher rates of procedural complications and late restenosis compared with that of nonostial lesions (1-3). Therefore, new devices including stents and directional coronary atherectomy have been proposed to treat ostial LAD lesions (1, 4). Intracoronary stenting has been accepted as an effective treatment modality for the reduction of restenosis (5, 6). Although various stents are currently used to reduce restenosis, the impacts of stent design and configuration on late clinical outcomes have not been clearly elucidated for the ostial LAD lesions. To evaluate the effects of stent design on ostial LAD stenosis, we compared the 6 month angiographic restenosis rate of slotted-tube stent implantation with that of coil stent implantation.

METHODS

Selection of patients

We analyzed retrospectively 55 consecutive patients (slotted tube stent implantation in 40 patients and coil stent implantation in 15 patients) who underwent coronary intervention for ostial LAD stenosis. The inclusion criteria were 1) clinical symptoms or objective evidences of myocardial ischemia either on exercise ECG test or thallium SPECT and 2) angiographic evidence of ostial LAD stenosis of ≥70% by visual estimation. Ostial lesions were defined as lesions located within 3 mm of the origin of LAD (1). The criteria for exclusion were significant disease in the left main coronary artery and a contraindication to aspirin or ticlopidine. All patients gave their written informed consent to participate in the study. The study protocol was approved by the institutional review board.

Stent implantation procedure

Palmaz-Schatz stent was used for slotted-tube stent implantation and tantalum Cordis stent was used for coil stent implantation. In Palmaz-Schatz stent implantation, predilation before elective stent implantation was performed by conventional angioplasty balloons. The Palmaz-Schatz stent was deployed by inflating a balloon over the target lesion. After the implantation of the stent, the stented coronary segment was dilated further with high pressure balloon up to 18 atmospheres to achieve angiographic optimization with <20% residual stenosis by visual estimate (7). In tantalum Cordis stent implantation, the stent was delivered to the lesions by the premounted balloon system. The tantalum Cordis stents were usually deployed with balloon inflation up to 12 to 14 atmospheres (8, 9). The indications for stent implantation were elective stenting in all cases. During the procedure, patients received 10,000 U bolus of heparin with a repeat bolus of 5,000 U to maintain the activated clotting time of >250 seconds when needed.

Antithrombotic regimen

All patients received aspirin and ticlopidine as an antithrombotic regimen. Ticlopidine therapy (250 mg twice a day) was started at least 1 day before the procedure and continued for 1 month. All patients in the study received aspirin (200 mg a day) throughout the study.

Angiographic analysis

The analysis of coronary angiographic results was done by two experienced angiographers not involved in the stenting procedure. Percent diameter stenosis, minimal luminal diameter and reference diameter using an on-line quantitative system (ANCOR V2.0, Siemens) were measured pre-intervention, post-intervention and at follow-up in single, matched view showing the least luminal diameter. Angiographic calculation was made during diastole after intracoronary nitroglycerin administration. The guiding catheter was used as the reference object for magnification calibration.

Clinical and angiographic follow-up

Patients were requested to visit the out-patient clinic at 1, 3 and 6 months later for the evaluation of clinical recurrence of chest pain. Follow-up coronary angiography was requested at 6 months post-intervention in all the patients. Angiographic restenosis was defined as ≥50% diameter stenosis on the follow-up angiography. The primary endpoint of the study was angiographic restenosis.

Statistical analysis

Continuous variables, expressed as mean value ± standard deviation were analyzed with two-tailed t test. Discrete variables, expressed as counts, were compared by chi-square test. A value of $p<0.05$ denoted statistical significance.

RESULTS

Initial clinical outcomes

Baseline clinical and angiographic characteristics are shown in Table 1. There were no differences in baseline clinical and angiographic characteristics between the two groups. Procedural success rate was similar: 95% in slotted-tube stent implantation and 93% in coil stent

Table 1. Baseline clinical and angiographic characteristics of the 55 patients (%)

	Slotted-tube stent (n=40)	Coil stent (n=15)
Age (years)	58.5±11.6	56.3±10.7
Sex (Male/Female)	32/8	12/3
Risk Factors		
Hypertension	12 (30)	4 (27)
Diabetes mellitus	9 (23)	3 (20)
Hypercholesterolemia	5 (13)	2 (13)
Current smoker	14 (35)	5 (33)
Myocardial infarction		
Healed	2 (5)	1 (6)
Acute	3 (8)	1 (6)
Unstable angina	16 (40)	6 (40)
Number of narrowed coronary arteries		
1	22 (55)	8 (53)
2	17 (43)	7 (47)
3	1 (3)	0 (0)
Modified AHA/ACC lesion type		
B1	16 (40)	6 (38)
B2	19 (48)	7 (45)
C	5 (12)	2 (13)
Size of coronary stent, mm		
3.0	16 (40)	6 (40)
3.5	12 (30)	5 (33)
4.0	12 (30)	4 (27)
Procedural success	38 (95)	14 (93)

AHA, American Heart Association; ACC, American College of Cardiology.

Table 2. Quantitative angiographic measurements pre-intervention, post-intervention and at follow-up

	Slotted-tube stent (n=40)	Coil stent (n=15)
Ostial LAD lesions		
Reference vessel diameter, mm	3.3±0.7	3.3±0.4
Balloon-to-vessel ratio	1.12±0.05	1.14±0.06
Diameter stenosis (%)		
Baseline	72±14	70±16
Final	-8±4	-9±4
Follow-up*	32±15	65±21
Minimum lumen diameter, mm		
Baseline	0.9±0.5	1.0±0.5
Final	3.5±0.5	3.5±0.5
Follow-up*	2.1±1.1	1.1±0.6
Acute gain, mm	2.6±0.7	2.6±0.7
Late loss, mm*	1.4±1.0	2.4±1.0
Maximal inflation pressure, atm	14.5±3.1	13.2±2.0
Ostial left circumflex artery		
Minimum lumen diameter, mm		
Baseline	3.1±0.6	2.9±0.4
Final	2.9±0.6	2.7±0.4
Follow-up	2.8±0.8	2.6±0.3

LAD, left anterior descending coronary artery.
*p<0.05, slotted-tube vs coil stent implantation.

implantation. The in-hospital complications including acute closure, subacute stent thrombosis, myocardial infarction and death did not occur in the two groups. The ≥50% narrowing of ostial lumen of portion of left circumflex artery (LCX) occurred in 4 patients with slotted tube stent implantation and 2 patients with coil stent implantation. Among 6 patients, elective coronary artery bypass surgery during hospitalization was performed in 2 patients with slotted-tube stent implantation and 1 patient with coil stent implantation due to significant worsening condition of ostial portion of LCX after stenting. Therefore, 52 patients (38 patients with slotted-tube stent implantation and 14 patients with coil stent implantation) were eligible for the angiographic follow-up. The quantitative angiographic measurements of ostial portion of LAD and LCX pre- intervention, post-intervention and at follow-up are shown in Table 2. The mean reference vessel diameter and minimum lumen diameter post-intervention of both groups were 3.3 mm and 3.5 mm, respectively. The measurement of ostial portion of LCX revealed no significant difference of minimum lumen diameter pre-intervention, post-intervention and at follow-up.

Late clinical outcomes and angiographic restenosis

Six-month follow-up angiographic characteristics and late clinical events are shown in Table 3. Six-month angiographic follow-up was obtained in 31 patients (82 %) with slotted-tube stent implantation and 12 patients (86%) with coil stent implantation. Angiographic restenosis occurred in 32% (10/31) in slotted-tube stent implantation and 67% (8/12) in coil stent implantation ($p<0.05$). Seven patients with slotted-tube stent implantation and 2 patients with coil stent implantation refused to undergo follow-up angiography, and all these patients were asymptomatic. Target lesion revascularization rate was 26% in slotted-tube stent implantation and 57% in coil stent implantation ($p<0.05$). Two patients with slotted-tube stent implantation and 3 patients with coil stent implantation required elective bypass graft surgery. Rotational atherectomy with adjunct balloon angioplasty was performed in 5 patients with slotted-tube stent implantation and 2 patients with coil stent implantation. Balloon angioplasty was performed again in 3 patients with slotted-tube stent implantation and 3 patients with coiled stent implantation. There were no deaths during follow-up.

Table 3. Late clinical events of 52 patients (%)

	Slotted-tube stent (n=38)	Coil stent (n=14)
Follow-up angiography	31 (82)	12 (86)
Angiographic restenosis	10 (32)	8 (67)
Target lesion revascularization	10 (26)	8 (57)
Treatments after restenosis		
Elective coronary bypass surgery	2	3
Rotational atherectomy	5	2
Repeat balloon angioplasty	3	3

DISCUSSION

In balloon angioplasty of LAD ostium, acute complications may cause life-threatening consequences because of the large amount of myocardium at risk and the proximity to the left main coronary artery/LCX ostium (10). In a few series reporting long-term results of standard balloon angioplasty of ostial LAD stenosis, the restenosis rate was high (1). As a result, new revascularization techniques including stents and directional atherectomy have been proposed to overcome these limitations. However, subgroup analysis of randomized Coronary Angioplasty Versus Excisional Atherectomy Trial (CAVEAT-I) revealed both directional atherectomy and balloon angioplasty yielded similar rates of initial success and late restenosis in ostial LAD stenosis (1). In recent randomized study of patients with isolated stenosis of proximal LAD, stenting had advantages over standard balloon angioplasty in that it was associated with both a lower rate of restenosis and a better clinical outcome (11). The previous report of elective Palmaz-Schatz stent implantation for ostial LAD stenosis in a small number of patients reported a procedural success rate of 87% (10). In a report of coiled Wiktor stent implantation of ostial LAD lesions, it was suggested to avoid using Wiktor stent due to high initial failure rate (12). This high failure was explained by the unraveling of wire meshes caused by the single wire design of the Wiktor stent and by its low resistance to longitudinal stretching. In this study, however, such failure did not occur in all the patients with coiled tantalum Cordis stent implantation. The initial procedural success rate were similarly high in both slotted tube and coiled stent implantation.

In a recent study comparing stent implantation with directional atherectomy for ostial LAD lesions, worsening of the ostial portion of LCX was more frequently seen after stenting than directional atherectomy (4). In our study, the $\geq$50% narrowing of ostial portion of LCX occurred in 4 patients with slotted-tube stent implantation and 2 patients with coil stent implantation as a result of the snowplow effect. However, there were no statistically significant changes in diameter of the ostial portion of LCX at pre-intervention, post-intervention and at follow-up in the remained patients. This may be explained in part by the small number of study patients.

In previous studies, the angiographic restenosis rate of slotted-tube stent implantation of ostial LAD lesions was 22-31% (4, 10). These results were similar to that of our study. However, restenosis rate of coil stent implantation was significantly higher than that of slotted-tube stent implantation. This apparent discrepancy may be partly explained by the structural differences between the two. First, it is possible that the proximal portion of the single sinusoidal coil stent located at the distal end of the left main stem can not maintain the necessary radial force, since the proximal end of the coil stent might not be well apposed to the vessel wall due to size discrepancy of the distal left main stem and proximal LAD. Second, significantly larger amount of tissue prolapse might have been occurred through the coil stent struts than in the slotted-tube type. There is a higher concentration of elastic and muscle fibers around the ostium, which causes more elastic recoil after balloon inflations (10). The coil-design stent provides less resistance to both radial and longitudinal forces compared with the slotted-tubular design stent (10). This characteristics of coil stent might also have contributed to the development of late restenosis. However, these speculations remains to be proved by intravascular ultrasound or other methods.

In case of ostial LAD lesions with distal left main coronary artery stenosis, stenting of ostial LAD stenosis should probably be avoided or performed very carefully. Harmful dissection during procedure or disease progression during follow-up may occur at the distal left main coronary artery. Pre-intervention intravascular ultrasound may play an important role in determining treatment modalities. Therefore, in case of ostial LAD lesions combined with distal left main coronary artery stenosis by intravascular ultrasound, stent implantation of ostial LAD lesions might be avoided and aggressive directional atherectomy might be considered as a treatment modality (13).

This study was analyzed retrospectively. Thus, the current study is not conclusive that slotted-tube stent implantation is superior to coil stent implantation and further randomized, prospective studies would be necessary to confirm these findings.

In conclusion, coil stent implantation was associated with higher restenosis rate compared with slotted-tube stent implantation. We suggest that slotted-tube stent implantation might be considered for ostial LAD lesions to improve late clinical outcome.

REFERENCES

1. Boehrer JD, Ellis SG, Pieper K, Holmes DG, Keeler GP, Debowey D, Chapekis AT, Leya F, Mooney MR, Gottlieb RS, Serruys PW, Califf RM, Topol EJ for the CAVEAT-I investigators. *Directional atherectomy versus balloon angioplasty for coronary ostial and nonostial left anterior descending coronary artery lesions: results from a randomized multicenter trial. J Am Coll Cardiol 1995; 25: 1380-6.*
2. Ellis SG, Roubin GS, King SB III, Douglas JS, Weintraub WS, Thomas RG, Cox WR. *Angiographic and clinical predictors of acute closure after native vessel coronary angioplasty. Circulation 1988; 77: 372-9.*
3. Committee on Percutaneous Transluminal Coronary Angioplasty. *Guideline for percutaneous transluminal coronary angioplasty. J Am Coll Cardiol 1993; 22: 2033-54.*
4. Kimura T, Sawada Y, Shinoda E, Tamura T, Yokoi H, Nakagawa Y, Hamasaki N, Nosaka H, Nobuyoshi M. *Clinical and angiographic outcomes of directional coronary atherectomy and Palmaz-Schatz stent implantation for ostial left anterior descending coronary lesions. J Am Coll Cardiol 1997; 29: 457 [abstract].*
5. Serruys PW, Jaegere PD, Kiemeneij F, Macaya C, Rutsch W, Heyndrickx G, Emanuelson H, Marco J, Legrand V, Materne P, Belardi J, Sigwart U, Colombo A, Goy JJ, Van der Heuvel P, Delcan J, Morel MA for the Benestent Study Group. *A comparison of balloon expandable stent implantation with balloon angioplasty in patients with coronary artery disease. N Engl J Med 1994; 331: 489-95.*
6. Fischman DL, Leon MB, Baim DS, Schatz RA, Savage MP,

Penn I, Detre K, Veltri L, Ricci D, Nobuyoshi M, Cleman M, Heuser R, Almond D, Teirstein PS, Fish RD, Colombo A, Brinker J, Moses J, Shaknovich A, Hirshfeld J, Bailey S, Ellis S, Rake R, Goldberg S for the STent REStenosis Study (STRESS) investigator. *A randomized comparison of coronary-stent placement and balloon angioplasty in the treatment of coronary artery disease. N Engl J Med 1994; 331: 496-501.*

7. Park SJ, Park SW, Hong MK, Kim JJ, Cheong SS, Lee CW, Kang DH, Song JK, Choi KJ, Kim YH. *Late clinical outcome after intracoronary Palmaz-Schatz stenting with high pressure balloon dilation without anticoagulation. J Invas Cardiol 1997; 9: 469-74.*
8. Park SW, Park SJ, Hong MK, Kim JJ, Cho SY, Jang YS, Kim KB, Kim KS, Oh DJ, Oh BH, Kang JC. *Coronary stenting (Cordis) without anticoagulation. Am J Cardiol 1997; 79: 901-4.*
9. Park SJ, Park SW, Hong MK, Cheong SS, Lee CW, Kim JJ, Mintz GS, Leon MB. *Late clinical outcomes of Cordis tantalum coronary stenting without anticoagulation. Am J Cardiol 1997; 80: 943-7.*
10. De Cesare NB, Bartorelli AL, Galli S, Loaldi A, Fabbiocchi F, Sganzerla P, Montorsi P, Guazzi MD. *Treatment of ostial lesions of the left anterior descending coronary artery with Palmaz-Schatz coronary stent. Am Heart J 1996; 132: 716-20.*
11. Versaci F, Gaspardone A, Tomai F, Crea F, Chiariello L, Gioffre PA. *A comparison of coronary artery stenting with angioplasty for isolated stenosis of the proximal left anterior descending coronary artery. N Engl J Med 1997; 336: 817-22.*
12. Chalet Y, Panes F, Chevalier B, Monassier JP, Spaulding C, Lancelin B. *Should we avoid ostial implantation of Wiktor stent? Cathet Cardiovasc Diagn 1994; 32: 376-9.*
13. Hosokawa H, Suzuki T, Ueno K, Aizawa T, Fujita T, Takase S, Oda H. *Clinical and angiographic follow-up of adjunctive balloon angioplasty following coronary atherectomy study [abstract]. Circulation 1996; 94: 1318.*