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Multiple predictors of coronary restenosis after drug-eluting stent implantation in patients with diabetes

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Objectives: To identify parameters influencing the likelihood of restenosis after implantation of drug-eluting stents (DES) in patients with diabetes.

Methods: Stented patients (n = 840) with DES were retrospectively reviewed for inclusion in the study from the Multicenter PCI Database Registry. From this database, 211 (25.1%) of 840 patients with six-month angiographic follow up had diabetes. Predictors of coronary restenosis were identified with univariate and multivariate logistic regression analyses.

Results: Restenosis occurred in 92 of 629 (14.6%) patients without diabetes and in 44 (20.9%) of 211 patients with diabetes ($p < 0.001$). Multivariate parameters for predicting restenosis in the diabetic group were current smoking (odds ratio (OR) 1.923, 95% confidence interval (CI) 1.055 to 4.725, p = 0.036), higher C reactive protein concentration (OR 1.031, 95% CI 1.011 to 1.075, p = 0.043), use of the paclitaxel-eluting stent (OR 2.638, 95% CI 1.338 to 5.200, p = 0.005), longer stent length (OR 1.065, 95% CI 1.021 to 1.119, p = 0.033), smaller reference diameter before DES implantation (OR 0.501, 95% CI 0.110 to 0.965, p = 0.040), smaller reference diameter (OR 0.455, 95% CI 0.120 to 0.814, p = 0.026) and minimum lumen diameter (OR 0.447, 95% CI 0.068 to 0.876, p = 0.039) after DES implantation.

Conclusion: Even with the introduction of DES, diabetes remains a significant predictor of coronary restenosis, especially in cases of a small baseline vessel size, small vessel size after percutaneous coronary intervention, longer stent length, use of the paclitaxel-eluting stent, current smoking and high C reactive protein concentration.

People with diabetes mellitus are more prone to coronary heart disease, stroke and peripheral vascular disease.[1–3] Diabetes mellitus has been regarded as an independent risk factor for the progression of coronary artery disease.[4 5] Several studies have reported that diabetes increased the risk of cardiovascular mortality in both men and women.[6 7] Moreover, diabetes has been considered to be a predictor of poor prognosis after coronary artery bypass surgery[8] and percutaneous transluminal coronary angioplasty.[9 10] Long-term clinical and angiographic outcomes after percutaneous coronary intervention (PCI) with bare metal stents (BMS) have been shown to be worse in patients with than in those without diabetes.[11 12]

With the introduction of drug-eluting stents (DES), the angiographic rates of restenosis in later months have been reduced dramatically in several studies.[13 14] Even with DES, however, patients with diabetes had increased rates of restenosis and late loss index compared with patients who did not have diabetes. In the era of DES, no study has identified the clinical and angiographic predictors of coronary restenosis in patients with diabetes after DES implantation. The objective of this observational retrospective cohort study was to identify parameters influencing coronary restenosis after DES implantation in patients with diabetes.

METHODS

Study patients

Patients were retrospectively identified for inclusion in the study from the Multicenter PCI Database Registry from March 2003 to January 2005. Five cardiovascular centres in five major cities in Korea participated in the Multicenter PCI Database Registry. All clinical and angiographic data were sent to the core laboratory (Korea University, Seoul, Korea) and were entered on to the PCI database. Patients who received intracoronary DES implantation with complete clinical and angiographic six-month follow up were included in the study. From this database, 211 (25.1%) of 840 patients with six-month clinical and angiographic follow up had diabetes. Restenosis (> 50% of the luminal diameter stenosis during the six-month follow up) occurred in 44 (20.9%) of 211 patients with diabetes. Diabetes mellitus was defined as a history of diabetes, a fasting plasma glucose concentration > 7.0 mmol/l or the use of hypoglycaemia drugs. Systemic hypertension was defined as a systolic blood pressure ⩾ 130 mm Hg, diastolic pressure ⩾ 80 mm Hg or the use of hypertension drugs. Hyperlipidaemia was defined as a total cholesterol concentration ⩾ 5.18 mmol/l, low-density lipoprotein cholesterol concentration ⩾ 3.37 mmol/l or treatment with a lipid-lowering agent. Smoking was defined as current or recent history of smoking within the preceding year. Family history of premature coronary artery disease was defined as coronary artery disease in a male first-degree relative < 55 years old and a female first-degree relatives < 65 years old. Body mass index was calculated by dividing the weight in kilograms by the square of the height in metres. We excluded patients with acute myocardial infarction, a history of interventional or surgical treatment for coronary artery disease, coronary artery total occlusion, or a contra-indication to antiplatelet or anticoagulation treatment. Written informed consent was obtained from each patient in accordance with the Declaration of Helsinki, and the study was approved by the institutional review committees.

Abbreviations: BMS, bare metal stents; CRP, C reactive protein; DES, drug-eluting stents; IVUS, intravascular ultrasound; MLD, minimum lumen diameter; NRG, no restenosis group; PCI, percutaneous coronary intervention; OR, odds ratio; RG, restenosis group

Angiographic analysis

Coronary angiograms were recorded at baseline, immediately after stenting and at six months of follow up. Two identical orthogonal views were obtained after the intracoronary administration of nitrates and were stored on digital CD-ROM. End diastolic frames were chosen for quantitative analysis with a computer-based TCS system, V.2.02 (Medcon Inc, Tel Aviv, Israel) by an operator who was unaware of the patient's information. The average diameter of normal segments distal and proximal to the treated lesion was used as the reference diameter. Minimum lumen diameter (MLD), percentage of stenosis and lesion length were calculated as the average value of the two orthogonal views. The same views and calibration were used at follow-up angiography. Restenosis was defined as stenosis of $>$ 50% of the lumen diameter.

Stent implantation

Balloon angioplasty and stent implantation were performed according to standard clinical practice. The femoral approach was used, and all patients took 100 mg of aspirin combined with either 300 mg of clopidogrel or 500 mg of ticlopidine on the day before the procedure. Aspirin was given indefinitely, and 75 mg of clopidogrel or 250 mg of ticlopidine once daily was given for six months. At the beginning of the intervention, a heparin bolus of 100 U/kg was administered after sheath insertion, and supplemental doses were then given to maintain an activated clotting time of $>$ 300 s. A Judkins 6 French or 7 French large lumen guiding catheter and a 0.014 inch guidewire were used. All patients in the study underwent balloon predilatation before stenting, and the size of the balloon was determined by the target vessel size. Either sirolimus-eluting stents (Cypher; Cordis, Johnson & Johnson Corp, Miami, Florida, USA) or paclitaxel-eluting stents (Taxus; Boston Scientific Corp, Natick, Massachusetts, USA) were selected at the discretion of the operator. High-pressure balloon inflation was used in selected patients to avoid stent underexpansion. Intravascular ultrasound (IVUS) was used in some cases if necessary. Procedural myocardial infarction was defined as the presence of new Q waves that were 0.03 s wide, one third of the QRS complex in $\geqslant$ 2 contiguous leads or a $\geqslant$ 3-fold increase in creatine kinase MB concentration from the upper normal limit.

Follow up

A complete clinical workup was scheduled at one month, three months and six months after the procedure. Angiographic follow up was scheduled at six months after the procedure. All major adverse cardiac events occurring in hospital, out of hospital and cumulatively at 180 days after stent implantation were determined. Major adverse cardiac events were noted: all cause death, myocardial infarction and the need for repeated target lesion revascularisation within six months. A 12-lead ECG was recorded immediately after the procedure and 6, 12 and 24 h after the procedure. Creatine kinase activity was measured at the same time points. The end points were defined as cardiac death, myocardial infarction and the need for repeat revascularisation of the target vessel.

Statistical analysis

For continuous variables, data are expressed as mean (SD) and compared by the unpaired Student's t test. Data for the categorical variables are expressed as the number and the percentage of patients. Fisher's exact test or a χ^2 test was used as needed. To identify the predictors of coronary restenosis in patients with diabetes, multivariate logistic models were used. Quantitative coronary angiographic parameters were entered as continuous variables into the univariate logistic regression. Univariate variables with $p < 0.20$ were entered into the multivariate logistic models. A value of $p < 0.05$ was considered significant. Data were statistically analysed with commercially available software (SPSS V.10.0 for Windows; SPSS Inc, Chicago, Illinois, USA).

RESULTS

Study patients

Age, sex and body mass index of patients in the restenosis group (RG, n = 44) and the no restenosis group (NRG, n = 167) were similar (table 1). However, the rates of hypertension (71.9% *v* 51.7%, p = 0.038) and current smoking (45.5% *v* 28.1%, p = 0.028) at baseline were

Table 1 Baseline patient characteristics

Variable	No restenosis group (n = 167)	Restenosis group (n = 44)	p Value
Age (years)	60.1 (9.8)	62.2 (10.5)	0.200
Men	58/167 (34.7%)	12/44 (27.3%)	0.350
Body mass index (kg/m^2)	22.9 (8.7)	24.8 (3.2)	0.562
Risk factor			
Hypertension	74/143 (51.7%)	23/32 (71.9%)	0.038
Hyperlipidaemia	31/128 (24.2%)	9/27 (33.3%)	0.325
Current smoking	47/167 (28.1%)	20/44 (45.5%)	0.028
Family history of CAD	15/155 (9.7%)	6/38 (15.8%)	0.278
Left ventricular ejection fraction (%)	56.6 (12.2)	56.6 (11.4)	0.997
Stable angina	80/167 (47.9%)	12/44 (27.3%)	0.014
Unstable angina	59/167 (35.3%)	20/44 (45.5%)	0.217
Drugs at baseline			
Oral diabetes drugs	112/167 (67.1%)	28/44 (63.6%)	0.668
Insulin	38/167 (22.8%)	13/44 (29.5%)	0.349
Aspirin	95/122 (77.9%)	14/17 (82.4%)	0.674
ACE inhibitor	55/122 (45.1%)	7/17 (41.2%)	0.762
Angiotensin II receptor blocker	23/122 (18.9%)	2/17 (11.8%)	0.476
β blocker	63/122 (51.6%)	7/17 (41.2%)	0.419
Calcium channel blocker	28/122 (23.0%)	4/17 (23.5%)	0.958
Diuretics	28/122 (23.0%)	4/17 (23.5%)	0.958
Nitrate	44/122 (36.1%)	5/17 (29.4%)	0.591
Nicorandil	8/122 (6.6%)	4/17 (23.5%)	0.020
Prior stroke	1/125 (0.8%)	0/17	1.000

Data are number (%) or mean (SD).
ACE, angiotensin-converting enzyme; CAD, coronary artery disease.

Table 2 Results of angiographic characteristics

Variable	No restenosis group (n = 167)	Restenosis group (n = 44)	p Value
Type of lesion*			
B_1	11/138 (8.0%)	3/32 (9.4%)	0.795
B_2	96/138 (69.6%)	17/32 (53.1%)	0.076
C	31/138 (22.5%)	12/32 (37.5%)	0.078
Target vessel			
Left main lesion	14/182 (7.7%)	9/56 (16.1%)	0.063
Left anterior descending lesion	89/182 (48.9%)	26/56 (46.4%)	0.746
Circumflex lesion	37/182 (20.3%)	10/56 (17.9%)	0.684
Right coronary lesion	42/182 (23.1%)	11/56 (19.6%)	0.589
Number of diseased vessels			
1	152/167 (91.0%)	32/44 (72.7%)	0.001
2	14/167 (8.4%)	12/44 (27.3%)	0.001
3	1/167 (0.6%)	0/44 (0.0%)	1.000
Baseline			
Reference diameter (mm)	3.06 (0.57)	2.78 (0.49)	<0.001
Minimum lumen diameter (mm)	0.64 (0.31)	0.62 (0.34)	0.703
Stenosis (%)	78.4 (10.3)	77.8 (12.2)	0.751
Mean lesion length (mm)	19.9 (6.0)	22.5 (8.0)	0.027
Post-procedure			
Reference diameter (mm)	3.14 (0.54)	2.83 (0.50)	0.002
Minimum lumen diameter (mm)	2.85 (0.42)	2.63 (0.29)	0.001
Stenosis (%)	9.4 (10.7)	7.6 (9.3)	0.308
Acute gain (mm)	2.20 (0.44)	2.00 (0.38)	0.004
Mean stent length (mm)	22.2 (5.6)	25.1 (5.4)	0.002
Mean stent diameter (mm)	2.9 (0.3)	2.8 (0.4)	0.408

*Modified American College of Cardiology/American Heart Association lesion classification.
Data are number (%) or mean (SD).

significantly higher in the RG than in the NRG. Restenosis occurred in 92 of 629 (14.6%) patients without and in 44 (20.9%) of 211 patients with diabetes ($p < 0.001$). Only 4.7% ($n = 8$) of patients in the NRG underwent IVUS study, and 4.5% ($n = 2$) of patients in the RG had IVUS study.

Angiographic characteristics

Table 2 lists the results of quantitative coronary angiography. More patients in the RG than in the NRG had two-vessel disease (27.3% *v* 8.4%, $p = 0.001$). Baseline reference diameter was significantly larger in the NRG than in the RG (3.06 (0.57) mm *v* 2.78 (0.49) mm, $p < 0.001$). Mean lesion length was significantly greater in the RG than in the NRG (22.5 (8.0) mm *v* 19.9 (6.0) mm, $p = 0.027$). Postprocedural reference diameter and MLD were significantly larger in the NRG than in the RG (3.14 (0.54) mm *v* 2.83 (0.50) mm, $p = 0.002$ and 2.85 (0.42) mm *v* 2.63 (0.29) mm, $p = 0.001$, respectively). A mean of 1.1 (0.3) and 1.3 (0.5) stents were implanted in each patient in the NRG and the RG, respectively. In the NRG, 130/182 (71.4%) sirolimus-eluting stents and 52/182 (28.6%) paclitaxel-eluting stents were used compared with 26/56 (46.4%) sirolimus-eluting stents and 30/56 (53.6%) paclitaxel-eluting stents in the RG.

Six-month clinical outcomes and multivariate analysis for predicting restenosis

Six-month clinical follow up showed significantly higher rates of target vessel revascularisation (52.3% *v* 5.4%, $p < 0.001$) and target lesion revascularisation (22.7% *v* 0.0%, $p < 0.001$) in the RG than in the NRG (table 3). Rates of death ($p = 1.000$) and myocardial infarction ($p = 0.111$) were similar between the two groups during six months of follow up. Among 44 patients in the RG, 20 received sirolimus-eluting stents and 24 received paclitaxel-eluting stents. The restenosis pattern in patients with sirolimus-eluting stents was predominantly a focal type ($n = 19$, 95.0%) (lesions $\leqslant 10$ mm in length), and one patient (5%) had a diffuse type of restenosis. The predominant restenosis pattern in patients with paclitaxel-eluting stents was also a focal type ($n = 17$, 70.8%); however, relatively more patients ($n = 7$, 29.2%) had diffuse type of restenosis after paclitaxel-eluting stent implantation. Among 10 patients with target lesion revascularisation, seven received paclitaxel-eluting stents and three received sirolimus-eluting stents.

Univariate analysis showed that the clinical predictors of restenosis in patients with diabetes were a history of stable angina (odds ratio (OR) 0.408, 95% confidence interval (CI) 0.197 to 0.846, $p = 0.016$), hypertension (OR 2.383, 95% CI 1.031 to 5.506, $p = 0.042$) and smoking (OR 2.127, 95% CI 1.075 to 4.210, $p = 0.030$) (table 4). Moreover, the angiographic predictors of restenosis by univariate analysis were pre-PCI reference diameter (OR 0.306, 95% CI 0.138 to 0.680, $p = 0.004$), post-PCI reference diameter (OR 0.283, 95% CI 0.123 to 0.653, $p = 0.003$), post-PCI MLD (OR 0.131, 95% CI 0.047 to 0.369, $p = 0.001$), stent length (OR 1.104, 95% CI

Table 3 Number of six-month clinical outcomes

Variable	No restenosis group (n = 167)	Restenosis group (n = 44)	p Value
Death	1 (0.6%)	0	1.000
Myocardial infarction	1 (0.6%)	2 (4.5%)	0.111
Target vessel revascularisation	9 (5.4%)	23 (52.3%)	<0.001
Target lesion revascularisation	0	10 (22.7%)	<0.001
Percutaneous coronary intervention	0	10 (22.7%)	<0.001
Coronary bypass	0	0	NA

NA, not applicable.

Table 4 Logistic regression analysis for predicting restenosis in patients with diabetes

	Univariate			Multivariate		
Parameter	**p Value**	**OR**	**95% CI**	**p Value**	**OR**	**95% CI**
Age	0.199	1.024	0.988 to 1.062			
Women	0.352	0.705	0.338 to 1.471			
Body mass index	0.565	1.038	0.914 to 1.178			
Unstable angina	0.219	1.525	0.778 to 2.990			
Stable angina	0.016	0.408	0.197 to 0.846	0.229	0.794	0.440 to 1.663
Left ventricular ejection fraction	0.997	1.000	0.967 to 1.033			
Risk factor						
Hypertension	0.042	2.383	1.031 to 5.506	0.184	1.677	0.740 to 7.556
Smoking	0.030	2.127	1.075 to 4.210	0.036	1.923	1.055 to 4.725
Hypercholesterolaemia	0.328	1.564	0.638 to 3.834			
Lesion location						
Left anterior descending	0.138	0.587	0.290 to 1.186			
Left circumflex	0.966	1.017	0.460 to 2.252			
Right coronary	0.984	0.992	0.461 to 2.136			
Left main	0.129	2.474	0.985 to 6.213			
Quantitative coronary angiography						
Pre-PCI reference diameter	0.004	0.306	0.138 to 0.680	0.040	0.501	0.110 to 0.965
Pre-PCI MLD	0.702	0.811	0.279 to 2.363			
Post-PCI reference diameter	0.003	0.283	0.123 to 0.653	0.026	0.455	0.120 to 0.814
Post-PCI MLD	0.001	0.131	0.047 to 0.369	0.039	0.447	0.068 to 0.876
Stent length (mm)	0.003	1.104	1.035 to 1.178	0.033	1.065	1.021 to 1.119
PES implantation	<0.001	5.160	2.521 to 10.565	0.005	2.638	1.338 to 5.200
Laboratory analysis						
hsCRP	0.016	1.218	1.037 to 1.430	0.043	1.031	1.011 to 1.075
ESR	0.052	1.033	1.000 to 1.068			
Total cholesterol	0.015	1.014	1.003 to 1.026	0.489	1.008	0.892 to 1.326
HDL cholesterol	0.020	1.041	1.006 to 1.078	0.527	0.997	0.903 to 1.578
Triglycerides	0.834	0.999	0.994 to 1.005			
LDL cholesterol	0.204	1.009	0.995 to 1.023			
Creatinine	0.558	0.800	0.380 to 1.685			

ESR, erythrocyte sedimentation rate; HDL, high-density lipoprotein; hsCRP, high-sensitive C reactive protein; LDL, low-density lipoprotein; MLD, minimum lumen diameter; OR, odds ratio; PCI, percutaneous coronary intervention; PES, paclitaxel-eluting stent.

1.035 to 1.178, p = 0.003) and the use of the paclitaxel-eluting stent (OR 5.160, 95% CI 2.521 to 10.565, p < 0.001). The laboratory predictors of restenosis by univariate analysis were high-sensitive C reactive protein (CRP) (OR 1.218, 95% CI 1.037 to 1.430, p = 0.016), total cholesterol (OR 1.014, 95% CI 1.003 to 1.026, p = 0.015) and high-density lipoprotein cholesterol (OR 1.041, 95% CI 1.006 to 1.078, p = 0.020). Multivariate logistic regression analysis showed that smoking (OR 1.923, 95% CI 1.055 to 4.725, p = 0.036), pre-PCI reference diameter (OR 0.501, 95% CI 0.110 to 0.965, p = 0.040), post-PCI reference diameter (OR 0.455, 95% CI 0.120 to 0.814, p = 0.026), post-PCI MLD (OR 0.447, 95% CI 0.068 to 0.876, p = 0.039), stent length (OR 1.065, 95% CI 1.021 to 1.119, p = 0.033), the use of the paclitaxel-eluting stent (OR 2.638, 95% CI 1.338 to 5.200, p = 0.005) and CRP (OR 1.031, 95% CI 1.011 to 1.075, p = 0.043) were independent predictors of coronary restenosis in patients with diabetes (table 4).

DISCUSSION

Even in the era of DES, diabetes remains a significant predictor of coronary restenosis especially in patients with small baseline and post-PCI vessel size, longer stent length, current smoking and high CRP concentration. Restenosis was a main clinical and angiographic concern after BMS implantation, especially in patients with diabetes. Diabetes has been known as a major risk factor for in-stent restenosis after implantation of BMS.[15] With the introduction of the DES, the angiographic rates of restenosis have decreased dramatically but less prominently in patients with diabetes. We also found 20.9% restenosis in patients with diabetes compared with 14.6% in patients without diabetes even after DES implantation. Several studies have reported clinical and angiographic parameters of coronary restenosis after BMS implantation,[16–18] and various parameters associated with coronary restenosis after BMS implantation have been reported in diabetic populations.[19 20] However, clinical and angiographic parameters of coronary restenosis in patients with diabetes after DES implantation have never been reported, to the best of our knowledge.

In-stent restenosis in patients with diabetes is associated with complex pathophysiological processes that have not been completely understood. Several suggested pathophysiological mechanisms of coronary restenosis in patients with diabetes are related to a greater degree of underlying vascular inflammation, endothelial dysfunction, raised fractions of activated platelets with thrombus formation, dysregulation of growth factor expression and raised advanced glycosylation end products.[21 22] Coronary restenosis in patients with diabetes results from neointimal hyperplasia, which causes late luminal loss. Insulin resistance in patients with diabetes aggravates coronary restenosis through a direct growth factor-like effect of insulin on vascular smooth muscle and neointimal cells.[23] Adjunctive treatment with glycoprotein IIb/IIIa inhibitor, and maintenance of aspirin and a thienopyridine for longer than one year should be considered for patients with diabetes with multiple predictors of restenosis.[24] Angiotensin-converting enzyme inhibitor, angiotensin receptor blocker and 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitor should be given when clinically indicated. Moreover, the thiazolidinediones may further reduce coronary restenosis in patients with diabetes by activating the nuclear transcription factor peroxisome proliferator-activated receptor γ.[25] In addition to optimal adjunctive pharmacotherapy to prevent coronary restenosis in patients with diabetes, strict glycaemic control may decrease the restenosis rate in patients with diabetes.[20 26] These data suggest that strict control of diabetes to achieve haemoglobin A1c concentrations to $\leqslant$ 7.0% may reduce the restenosis rate and may improve clinical outcomes after PCI.

Using new devices such as DES reduces the restenosis rate in patients with diabetes by decreasing late luminal loss. By

reducing coronary restenosis, DES improved the major limitation of BMS in patients with diabetes. Many studies have shown that the blockade of smooth muscle cell proliferation with DES preserves normal vessel phenotype and function, thereby decreasing the rate of neointimal hyperplasia and in-stent restenosis.[27 28] Since the introduction of paclitaxel and sirolimus-eluting stents, these devices are regarded by many to be the standard of treatment for patients with diabetes undergoing stent implantation. Even though DES can lower restenosis rates by preventing smooth muscle cell proliferation at the stented site, atherosclerosis can progress at other coronary sites. Therefore, combined approaches based on systemic treatments are required to prevent neointimal proliferation and to prevent atherosclerosis progression at other coronary sites in patients with diabetes. We observed in our patients in the NRG that atherosclerosis can progress in other coronary sites and may lead to target vessel revascularisation (5.4% target vessel revascularisation in the NRG).

Identifying parameters of coronary restenosis is important, especially in patients with diabetes, as angiographic outcomes can be predicted from baseline clinical and angiographic parameters. Moreover, modifiable risk factors such as smoking in the present study can be adjusted to reduce the restenosis rate, and patients with multiple predictors of coronary restenosis can be considered for sirolimus-eluting stents preferentially. The use of the sirolimus-eluting stent in patients with diabetes was associated with a decreased rate of restenosis, suggesting a reduced risk of target lesion revascularisation in the present study. In the recently published ISAR-DIABETES study, the use of the sirolimus-eluting stent was associated with a decrease in late luminal loss and clinical restenosis compared with the use of the paclitaxel-eluting stent in patients with diabetes with coronary artery disease.[29] Although the total percentage of patients with diabetes with restenosis after DES implantation has decreased compared with BMS implantation, various predictors of restenosis in patients with diabetes with DES overlap with those of patients with diabetes with BMS.[19] The smaller pre-PCI and post-PCI reference diameters were predictors of restenosis in the present study. As coronary restenosis resulted mostly from neointimal hyperplasia, binary restenosis was more likely to occur in patients with a small baseline and post-PCI vessel diameter. Furthermore, the smaller post-PCI MLD was a predictor of restenosis, and for every millimetre of increase in the post-PCI MLD, the OR was 0.447 (95% CI 0.068 to 0.876) for coronary restenosis in the present study. The progressively longer stent length was associated with an increased risk of restenosis, and for every millimetre of increase in the stent length, the OR was 1.065 (95% CI 1.021 to 1.119) for restenosis. Small pre-and post-PCI vessel sizes and longer stent length were the major angiographic predictors of restenosis even in the era of DES. A high concentration of CRP in the RG, representing more active inflammatory status, in the present study (50.6 (22.6) mg/l *v* 30.7 (31.3) mg/l, p = 0.012) and smoking further aggravated endothelial dysfunction in patients with diabetes by providing a more inflammatory environment. Smokers have been paradoxically reported in some studies to have lower rates of repeat revascularisation during follow up, as smokers appeared to be less sensitive to restenosis for unknown reasons.[30] Close clinical follow up with routine stress testing or routine angiographic follow up should be recommended for smokers.[30] As a final point, patients with diabetes who receive DES should be treated with adjunctive systemic pharmacotherapy to modify underlying pathophysiological mechanisms responsible for neointimal formation and atherosclerosis progression, particularly in patients with multiple predictors of restenosis.

Study limitations

The present study showed the associations between various clinical and angiographic parameters and coronary restenosis in patients with diabetes; however, the cause and effect of these associations were not completely verified. Our RG included patients with $>$ 50% coronary restenosis, and the NRG included patients with $\leqslant$ 50% coronary stenosis. A patient with 51% coronary restenosis was therefore included in the RG, whereas a patient with 50% coronary restenosis was included in the NRG. Only selected patients underwent IVUS studies; therefore, some stents may have been underexpanded and short lesion coverage might have occurred. It is pertinent to note that the findings are based on a relatively short-term observational study. Moreover, the number of study participants was too small to generalise our results to all patients with diabetes with DES implantation. This study is not a randomised trial; thus, a larger prospective randomised clinical trial is warranted to confirm the multiple predictors of coronary restenosis in patients with diabetes.

Conclusions

Although DES implantation was observed to improve angiographic and clinical outcomes in patients with diabetes relative to BMS implantation, coronary restenosis after DES implantation remained significantly more common in patients with diabetes than in patients who did not have diabetes. Patients with diabetes undergoing PCI with DES are prone to coronary restenosis, especially in cases of small baseline and post-PCI reference diameters, longer stent length, the use of the paclitaxel-eluting stent, high CRP concentration and current smokers. Identifying patients with diabetes with predictors of coronary restenosis after DES implantation may help to alter modifiable predictors of restenosis such as preferentially using sirolimus-eluting stents, to apply more aggressive risk factor management and to consider other treatment modalities such as bypass surgery.

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IMAGES IN CARDIOLOGY

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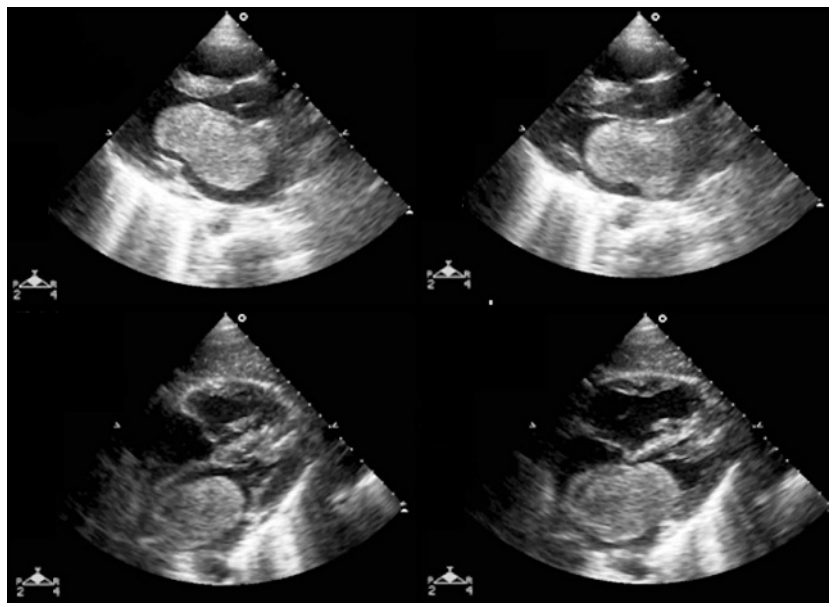
A large left atrial myxoma in a young fitness instructor

A 22-year-old woman had recurrent attendances to the emergency department with a history of increasing dyspnoea despite continuing her occupation as a fitness instructor. She had previously been labelled as suffering "panic attacks". Clinical examination revealed a soft diastolic murmur in the mitral area. Echocardiography was requested to exclude valvular pathology. The images show a large mass in the left atrium which prolapsed through the mitral valve during atrial systole. There was increased forward flow velocity through the mitral valve as measured by continuous wave Doppler. A diagnosis of left atrial myxoma was made and she underwent successful surgical resection.

Presentation of atrial myxoma may vary with dyspnoea present in around 30–40% of cases. Other manifestations include unexplained weight loss, palpitations, chest pain, fever, thromboembolic phenomenon or sudden death caused by complete occlusion of the mitral valve orifice. Our case demonstrates the need for thorough clinical examination and selection of the appropriate investigations, and the requirement for a high degree of suspicion in patients with recurrent symptoms.



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