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Letter to the Editor

Prevalence of coronary artery spasm after stent placement and its association with inflammation☆,☆☆

Ming-Jui Hung [a,b], Kuang-Hung Hsu [c], Nen-Chung Chang [d,e], Sotirios Tsimikas [f], Ming-Yow Hung [e,g,h,*]

[a] Department of Cardiology, Chang Gung Memorial Hospital, Keelung, Taiwan
[b] Chang Gung University College of Medicine, Taoyuan, Taiwan
[c] Laboratory for Epidemiology, Department of Health Care Management and Healthy Aging Research Center, Chang Gung University, Taoyuan, Taiwan
[d] Division of Cardiology, Department of Internal Medicine, Taipei Medical University Hospital, Taipei, Taiwan
[e] Department of Internal Medicine, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan
[f] School of Medicine, University of California San Diego, La Jolla, CA, USA
[g] Division of Cardiology, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan
[h] Graduate Institute of Clinical Medical Sciences, Chang Gung University College of Medicine, Taoyuan, Taiwan

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Recent studies have shown impaired coronary vasomotion in the peristent region [1] and development of coronary artery spasm (CAS) after sirolimus-eluting stent and paclitaxel-eluting stent implantation [2]. In such cases, stent lengths were longer in spastic coronary arteries than in non-spastic coronary arteries [2]. CAS after bare-metal stent (BMS) implantation has also been reported [3]. These observations suggest that the polymer or drug in drug-eluting stents (DES) is unlikely to constitute a major direct cause of post-stent-implantation CAS. CAS in the absence of obstructive coronary artery disease is an inflammatory disease characterized by the presence of inflammatory markers such as monocytes and elevated plasma levels of high-sensitivity C-reactive protein (hs-CRP) [4,5]. The systemic inflammatory response to stenting appears similar in patients treated with DES and BMS [6]. Recently, the characteristics of titanium–nitric-oxide-coated bioactive stent (BAS) were described, and moreover, CAS after BAS implantation has not been reported. Accordingly, we sought to examine the prevalence of CAS and to determine the morphometric stent features associated with inflammation in Taiwanese patients with CAS-related recurrent chest pain after stent placement.

From January 1999 to February 2011, a total of 102 patients with previous stenting (174 stents) presented with recurrent chest pain suggestive of angina or acute myocardial infarction, and underwent follow-up coronary angiography due to suspected recurrent ischemia. Intracoronary methylergonovine testing was performed in all stented patients to diagnose post-stent-implantation CAS as previously reported [5], with the exception of patients with coronary arteries with obstructive stenosis or in-stent restenosis. Informed consent was obtained from each patient. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee (96-1069B, 103-4592B, 201011004).

Of the 102 patients with stents in our study population, 13 patients (13%) were diagnosed as having post-stent-implantation CAS. Among those patients, CAS occurred after BMS placement in 7 patients, after placement of BAS in 4 patients, and after DES placement in 2 patients (Fig. 1). Of the 174 implanted stents, CAS was related to 17 stents (10%); 9 of 55 BMS (16%), 5 of 93 BAS (5%) and 3 of 26 DES (12%) (Table 1). Regarding the locations of CAS in relation to a total of 17 stents, CAS occurred at segments distal to the stent alone in 6 stents (35%), at segments both proximal and distal to the stent in 9 stents (53%), at segments proximal to the stent alone in 1 stent (6%), and at a segment not related to the stent in patient 12 (6%). Among the 13 patients with post-stent-implantation CAS, 8 patients (62%) also had CAS in non-stented vessels.

In 6 left anterior descending arteries (LADs) with stents, CAS occurred in all of them, among which CAS occurred at segments distal to the stents in 4 vessels and both proximal and distal in 2 vessels, and also in 5 left circumflex arteries (LCXs) and 2 right coronary arteries

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* Corresponding author at: Division of Cardiology, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, No. 291, Zhongzheng Rd., Zhonghe District, New Taipei City 23561, Taiwan.
E-mail address: myhung6@ms77.hinet.net (M.-Y. Hung).

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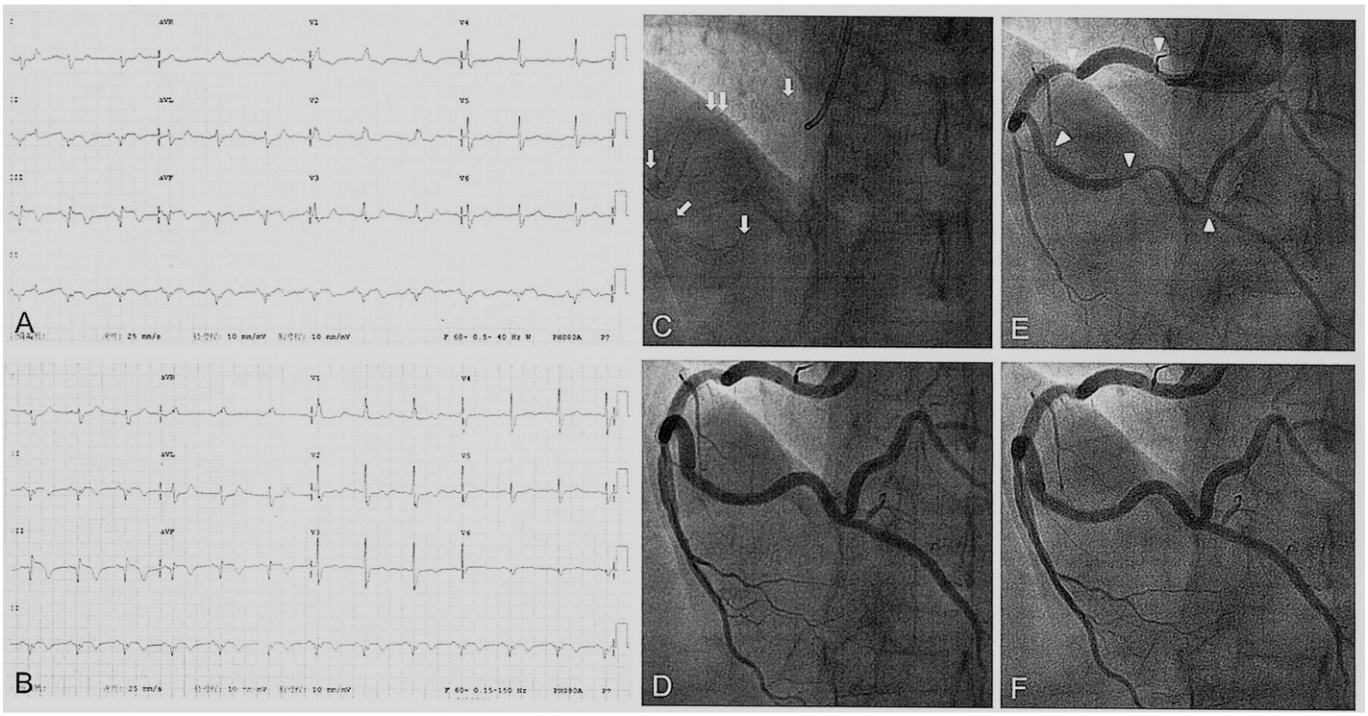

Fig. 1. ECG and angiogram in patient 2. The initial electrocardiography (ECG) (A) showed a pathological Q-wave, inverted T-wave and ST-segment elevation in the inferior leads, and complete right bundle branch block in the anterior precordial leads. The next-day, the ECG (B) showed less ST-segment elevation in the inferior leads, and revealed a normal QRS complex in the anterior precordial leads. Arrows (C) show the proximal and distal edges of the 3 bare-metal stents in the right coronary artery. Angiogram (D) shows no arterial stenosis. Arrowheads (E) show provocative spasms at locations proximal to, between, and distal to each stent. Spasms resolved after intracoronary nitroglycerin administration (F). Neither stenosis nor spasm was noted in the left coronary artery.

Table 1
Demographic and clinical characteristics of patients with post-stent-implantation CAS.

No.	Age, yrs/ gender	Current smoker	Associated disease	Previous stent			Presentation of spasm	Location of spasm	Time to spasm
				Type	Lesion type[a]	Location (no., type or size of stent)			
1	31/male	Yes	HC[b], heart failure	BMS[c] Gazelle	B	pLAD (1, 3.0 × 18)	STEMI (IRA mLCX)	dLCX	Immediately after mLCX Gazelle deployment
2	48/male	Yes	HC[c]	BMS Liberté & Vision	B	RCA (3), p (Liberte, 3.5 × 32), pm (Liberte, 3.5 × 32), m (Vision, 3.5 × 18)	STEMI (IRA RCA)	"Candy-wrapper" on either side of 3 stents	42 months
3	61/male	Yes	DM	BMS AVE	B	dRCA (1, 4.0 × 18)	Angina	"Candy-wrapper" on either side of stent	50 months
4	62/male	Yes	HTN	BMS driver	B	mLCX (1, 3.5 × 18)	Angina	pmLAD, dLCX, mRCA	18 months
5	53/male	Yes	DM, HTN	BMS driver	A	pLAD (1, 3.0 × 15)	Angina	dLAD, pmdLCX	16 months
6	80/male	No	HTN, PPM	BMS driver	B	mLAD (1, 3.0 × 18)	Angina	dLAD, dLCX, dRCA	72 months
7	71/male	No	HTN, HC, RCA spasm	BAS[d] titan	A	dLCX (1, 2.5 × 10)	Angina	mdLAD, mdLCX	13 months
8	62/male	No	HC	BAS titan	B	mLCX bifurcation (2, 3.0 × 10 and 3.0 × 16)	Angina	pdLCX	16 months
9	78/male	No	HTN, HC	BAS titan	A	pLAD (1, 3.0 × 13)	Angina	pdLAD, mdLCX, pmdRCA	4 months
10	73/male	No	RCA spasm	BAS titan	A	LAD D2 (1, 2.0 × 10)	Angina	mdLAD, mLCX	20 months
11	55/male	Yes	DM, HTN	DES[e] ZES	A	pLAD (1, 3.0 × 12), dRCA (1, 2.75 × 14)	Angina	mdLAD, pRCA	8 months
12	78/female	No	DM, HTN	DES SES	B	mLCX (1, 3.5 × 28)	Angina (LCX restenosis & OM stenosis)	RCA ostium	10 min after LCX tsunami (2.5 × 15) stent deployment
13	76/female	No	Atrial fibrillation, HC	DES PES	A	pmLAD (1, 3.5 × 12)	Angina	dLAD, pLCX	20 months

BAS = bioactive stent; BMS = bare-metal stent; d = distal; CAS = coronary artery spasm; DES = drug-eluting stent; DM = diabetes mellitus; HC = hypercholesterolemia; HTN = hypertension; LAD = left anterior descending artery; LCX = left circumflex artery; m = middle; p = proximal; PES = paclitaxel-eluting stent; PPM = permanent pacemaker implantation; RCA = right coronary artery; SES = sirolimus-eluting stent; STEMI = ST-elevation myocardial infarction; ZES = zotarolimus-eluting stents.

[a] The American College of Cardiology/American Heart Association lesion classification.

[b] Hypercholesterolemia was defined where serum total cholesterol was >200 mg/dl.

[c] BMS include Gazelle (Biosensors Europe SA), AVE (Medtronic, Santa Rosa, CA, USA), Liberté (Boston Scientific, Natick, MA, USA), Multi-Link Vision (Abbott Vascular, Santa Clara, CA, USA), Driver (Medtronic, Minneapolis, MN, USA) and Tsunami (Terumo Corp., Tokyo, Japan) stents.

[d] BAS is a titanium–nitric-oxide-coated stent (Titan 2, Hexacath, Paris, France).

[e] DES include PES (Taxus Liberté, Boston Scientific, Natick, MA, USA), ZES (Endeavor, Medtronic Vascular, Santa Rosa, CA, USA) and SES (Cypher, Cordis, Johnson & Johnson, Miami Lakes, FL, USA).